Application Data Sheet 37 CFR 1.76	Attorney Docket Number	NC74925US-NP
	Application Number	

Title of Invention	Motion Prediction in Video Coding

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Application Information:

Title of the Invention	Motion Prediction in Video Coding		
Attorney Docket Number	NC74925US-NP	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
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Suggested Class (if any)		**Sub Class (if any)**	
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	NC74925US-NP
	Application Number	
Title of Invention	Motion Prediction in Video Coding	

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	Application Number	

Title of Invention	Motion Prediction in Video Coding

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MOTION PREDICTION IN VIDEO CODING

TECHNICAL FIELD

[0001] The present invention relates to an apparatus, a method and a computer program for producing and utilizing motion prediction information in video encoding and decoding.

BACKGROUND INFORMATION

[0002] A video codec may comprise an encoder which transforms input video into a compressed representation suitable for storage and/or transmission and a decoder that can uncompress the compressed video representation back into a viewable form, or either one of them. The encoder may discard some information in the original video sequence in order to represent the video in a more compact form, for example at a lower bit rate.

[0003] Many hybrid video codecs, operating for example according to the International Telecommunication Union's ITU-T H.263 and H.264 coding standards, encode video information in two phases. In the first phase, pixel values in a certain picture area or "block" are predicted. These pixel values can be predicted, for example, by motion compensation mechanisms, which involve finding and indicating an area in one of the previously encoded video frames (or a later coded video frame) that corresponds closely to the block being coded. Additionally, pixel values can be predicted by spatial mechanisms which involve finding and indicating a spatial region relationship, for example by using pixel values around the block to be coded in a specified manner.

[0004] Prediction approaches using image information from a previous (or a later) image can also be called as Inter prediction methods, and prediction approaches using image information within the same image can also be called as Intra prediction methods.

[0005] The second phase is one of coding the error between the predicted block of pixels and the original block of pixels. This is typically accomplished by transforming the difference in pixel values using a specified transform. This transform may be e.g. a Discrete Cosine Transform (DCT) or a variant thereof. After transforming the difference, the transformed difference may be quantized and entropy encoded.

[0006] By varying the fidelity of the quantization process, the encoder can control the balance between the accuracy of the pixel representation, (in other words, the quality of the picture) and the size of the resulting encoded video representation (in other words, the file size or transmission bit rate).

[0007] An example of the encoding process is illustrated in Figure 1.

[0008] The decoder reconstructs the output video by applying a prediction mechanism similar to that used by the encoder in order to form a predicted representation of the pixel blocks (using the motion or spatial information created by the encoder and stored in the compressed representation of the image) and prediction error decoding (the inverse operation of the prediction error coding to recover the quantized prediction error signal in the spatial domain).

[0009] After applying pixel prediction and error decoding processes the decoder combines the prediction and the prediction error signals (the pixel values) to form the output video frame.

[0010] The decoder (and encoder) may also apply additional filtering processes in order to improve the quality of the output video before passing it for display and/or storing as a prediction reference for the forthcoming frames in the video sequence.

[0011] An example of the decoding process is illustrated in Figure 2.

[0012] Motion Compensated Prediction (MCP) is a technique used by video compression standards to reduce the size of an encoded bitstream. In MCP, a prediction for a current frame is formed using a previously coded frame(s), where only the difference between original and prediction signals, representative of the current and predicted frames, is encoded and sent to a decoder. A prediction signal, representative of a prediction frame, is formed by first dividing a current frame into blocks, e.g., macroblocks, and searching for a best match in a reference frame for each block. In this way, the motion of a block relative to the reference frame is determined and this motion information is coded into a bitstream as motion vectors. A decoder is able to reconstruct the exact prediction frame by decoding the motion vector data encoded in the bitstream.

[0013] An example of a prediction structure is presented in Figure 8. Boxes indicate pictures, capital letters within boxes indicate coding types, numbers within boxes are picture numbers (in decoding order), and arrows indicate prediction dependencies. In this example I-pictures are intra pictures which do not use any reference pictures and thus can be decoded irrespective of the decoding of other pictures. P-pictures are so called uni-predicted pictures i.e. they refer to one reference picture, and B-pictures are bi-predicted pictures which use two other pictures as reference pictures, or two prediction blocks within one reference picture. In other words, the reference blocks relating to the B-picture may be in the same reference picture (as illustrated with the two arrows from picture P7 to picture B8 in Figure 8) or in two different reference pictures (as illustrated e.g. with the arrows from picture P2 and from picture B3 to picture B4 in Figure 8).

[0014] It should also be noted here that one picture may include different types of blocks i.e. blocks of a picture may be intra-blocks, uni-predicted blocks, and/or bi-predicted blocks. Motion vectors often relate to blocks wherein for one picture a plurality of motion vectors may exist.

[0015] In some systems the uni-predicted pictures are also called as uni-directionally predicted pictures and the bi-predicted pictures are called as bi-directionally predicted pictures.

[0016] The motion vectors are not limited to having full-pixel accuracy, but could have fractional-pixel accuracy as well. That is, motion vectors can point to fractional-pixel positions/locations of the reference frame, where the fractional-pixel locations can refer to, for example, locations "in between" image pixels. In order to obtain samples at fractional-pixel locations, interpolation filters may be used in the MCP process. Conventional video coding standards describe how a decoder can obtain samples at fractional-pixel accuracy by defining an interpolation filter. In MPEG-2, for example, motion vectors can have at most, half-pixel accuracy, where the samples at half-pixel locations are obtained by a simple averaging of neighboring samples at full-pixel locations. The H.264/AVC video coding standard supports motion vectors with up to quarter-pixel accuracy. Furthermore, in the H.264/AVC video coding standard, half-pixel samples are obtained through the use of symmetric and separable 6-tap filters, while quarter-pixel samples are obtained by averaging the nearest half or full-pixel samples.

[0017] In typical video codecs, the motion information is indicated by motion vectors associated with each motion compensated image block. Each of these motion vectors represents the displacement of the image block in the picture to be coded (in the encoder) or decoded (at the decoder) and the prediction source block in one of the previously coded or decoded images (or pictures). In order to represent motion vectors efficiently, motion vectors are typically coded differentially with respect to block specific predicted motion vector. In a typical video codec, the predicted motion vectors are created in a predefined way, for example by calculating the median of the encoded or decoded motion vectors of the adjacent blocks.

[0018] In typical video codecs the prediction residual after motion compensation is first transformed with a transform kernel (like DCT) and then coded. The reason for this is that often there still exists some correlation among the residual and transform can in many cases help reduce this correlation and provide more efficient coding.

[0019] Typical video encoders utilize the Lagrangian cost function to find optimal coding modes, for example the desired macro block mode and associated motion vectors. This type of cost function uses a weighting factor or λ to tie together the exact or estimated image distortion due to lossy coding methods and the exact or estimated amount of information required to represent the pixel values in an image area.

[0020] This may be represented by the equation:

$$C=D+\lambda R \qquad (1)$$

[0021] where C is the Lagrangian cost to be minimised, D is the image distortion (for example, the mean-squared error between the pixel values in original image block and in coded image block) with the mode and motion vectors currently considered, λ is a Lagrangian coefficient and R is the number of bits needed to represent the required data to reconstruct the image block in the decoder (including the amount of data to represent the candidate motion vectors).

[0022] Some hybrid video codecs, such as H.264/AVC, utilize bi-directional motion compensated prediction to improve the coding efficiency. In bi-directional prediction, prediction signal of the block may be formed by combining, for example by averaging two motion compensated prediction blocks. This averaging operation may further include either up or down rounding, which may introduce rounding errors.

[0023] The accumulation of rounding errors in bi-directional prediction may cause degradation in coding efficiency. This rounding error accumulation may be removed or decreased by signalling whether rounding up or rounding down have been used when the two prediction signals have been combined for each frame. Alternatively the rounding error could be controlled by alternating the usage of the rounding up and rounding down for each frame. For example, rounding up may be used for every other frame and, correspondingly, rounding down may be used for every other frame.

[0024] In figure 9 an example of averaging two motion compensated prediction blocks using rounding is illustrated. Sample values of the first prediction reference is input 902 to a first filter 904 in which values of two or more full pixels near the point which the motion vector is referring to are used in the filtering. A rounding offset may be added 906 to the filtered value. The filtered value added with the rounding offset is right shifted 908 x-bits i.e. divided by 2^x to obtain a first prediction signal P1. Similar operation is performed to the second prediction reference as is illustrated with blocks 912, 914, 916 and 918 to obtain a second prediction signal P2. The first prediction signal P1 and the second prediction signal P2 are combined e.g. by summing the prediction signals P1, P2. A rounding offset may be added 920 with the combined signal after which the result is right shifted y-bits i.e. divided by 2^y. The rounding may be upwards, if the rounding offset is positive, or downwards, if the rounding offset is negative. The direction of the rounding may always be the same, or it may alter from time to time, e.g. for each frame. The direction of the rounding may be signaled in the bitstream so that in the decoding process the same rounding direction can be used.

[0025] However, these methods increase somewhat the complexity as two separate code branches need to be written for bi-directional averaging. In addition, the motion estimation routines in the encoder may need to be doubled for both cases of rounding and truncation.

SUMMARY

[0026] The present invention introduces a method which enables reducing the effect of rounding errors in bi-directional and multi-directional prediction. According to some embodiments of the invention prediction signals are maintained in a higher precision during the prediction calculation and the precision is reduced after the two or more prediction signals have been combined with each other.

[0027] In some example embodiments prediction signals are maintained in higher accuracy until the prediction signals have been combined to obtain the bi-directional or

multidirectional prediction signal. The accuracy of the bi-directional or multidirectional prediction signal can then be downshifted to an appropriate accuracy for post processing purposes. Then, no rounding direction indicator need not be included in or read from the bitstream

[0028] According to a first aspect of the present invention there is provided a method comprising:

determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

determining a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combining said first prediction and said second prediction to obtain a combined prediction; and

decreasing the precision of said combined prediction to said first precision.

[0029] According to a second aspect of the present invention there is provided an apparatus comprising:

a processor; and

a memory unit operatively connected to the processor and including:

computer code configured to determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

computer code configured to determine a type of the block;

computer code configured to, if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

[0030] According to a third aspect of the present invention there is provided a computer readable storage medium stored with code thereon for use by an apparatus, which when executed by a processor, causes the apparatus to perform:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

determine a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

[0031] According to a fourth aspect of the present invention there is provided at least one processor and at least one memory, said at least one memory stored with code thereon, which when executed by said at least one processor, causes an apparatus to perform:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

determine a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

[0032] According to a fifth aspect of the present invention there is provided an apparatus comprising:

an input to determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

a determinator to determine a type of the block; wherein if the determining indicates that the block is a block predicted by using two or more reference blocks, said determinator further to determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

a first predictor to use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

a second predictor to use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

a combiner to combine said first prediction and said second prediction to obtain a combined prediction; and

a shifter to decrease the precision of said combined prediction to said first precision.

[0033] According to a sixth aspect of the present invention there is provided an apparatus comprising:

means for determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

means for determining a type of the block;

means for determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block, if the determining indicates that the block is a block predicted by using two or more reference blocks;

means for using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

means for using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

means for combining said first prediction and said second prediction to obtain a combined prediction; and

means for decreasing the precision of said combined prediction to said first precision.

[0034] This invention removes the need to signal the rounding offset or use different methods for rounding for different frames. This invention may keep the motion compensated prediction signal of each one of the predictions at highest precision possible after interpolation and perform the rounding to the bit-depth range of the video signal after both prediction signals are added.

DESCRIPTION OF THE DRAWINGS

[0035] For better understanding of the present invention, reference will now be made by way of example to the accompanying drawings in which:

[0036] Figure 1 shows schematically an electronic device employing some embodiments of the invention;

[0037] Figure 2 shows schematically a user equipment suitable for employing some embodiments of the invention;

[0038] Figure 3 further shows schematically electronic devices employing embodiments of the invention connected using wireless and wired network connections;

[0039] Figure 4a shows schematically an embodiment of the invention as incorporated within an encoder;

[0040] Figure 4b shows schematically an embodiment of an inter predictor according to some embodiments of the invention;

[0041] Figure 5 shows a flow diagram showing the operation of an embodiment of the invention with respect to the encoder as shown in figure 4a;

[0042] Figure 6 shows a schematic diagram of a decoder according to some embodiments of the invention;

[0043] Figure 7 shows a flow diagram of showing the operation of an embodiment of the invention with respect to the decoder shown in figure 6;

[0044] Figure 8 illustrates an example of a prediction structure in a video sequence;

[0045] Figure 9 depicts an example of a bit stream of an image;

[0046] Figure 10 depicts an example of bi-directional prediction using rounding;

[0047] Figure 11 depicts an example of bi-directional prediction according to an example embodiment of the present invention; and

[0048] Figure 12 illustrates an example of some possible prediction directions for a motion vector.

DETAILED DESCRIPTION OF SOME EXAMPLE EMBODIMENTS

[0049] The following describes in further detail suitable apparatus and possible mechanisms for the provision of reducing information to be transmitted in video coding systems and more optimal codeword mappings in some embodiments. In this regard reference is first made to Figure 1 which shows a schematic block diagram of an exemplary apparatus or electronic device 50, which may incorporate a codec according to an embodiment of the invention.

[0050] The electronic device 50 may for example be a mobile terminal or user equipment of a wireless communication system. However, it would be appreciated that embodiments of the invention may be implemented within any electronic device or apparatus which may require encoding and decoding or encoding or decoding video images.

[0051] The apparatus 50 may comprise a housing 30 for incorporating and protecting the device. The apparatus 50 further may comprise a display 32 in the form of a liquid crystal display. In other embodiments of the invention the display may be any suitable display technology suitable to display an image or video. The apparatus 50 may further comprise a keypad 34. In other embodiments of the invention any suitable data or user interface mechanism may be employed. For example the user interface may be implemented as a virtual keyboard or data entry system as part of a touch-sensitive display. The apparatus may comprise a microphone 36 or any suitable audio input which may be a digital or analogue signal input. The apparatus 50 may further comprise an audio output device which in embodiments of the invention may be any one of: an earpiece 38, speaker, or an analogue audio or digital audio output connection. The apparatus 50 may also comprise a battery 40 (or in other embodiments of the invention the device may be powered by any suitable mobile energy device such as solar cell, fuel cell or clockwork generator). The apparatus may further comprise an infrared port 42 for short range line of sight communication to other devices. In other embodiments the apparatus 50 may further comprise any suitable short range communication solution such as for example a Bluetooth wireless connection or a USB/firewire wired connection.

[0052] The apparatus 50 may comprise a controller 56 or processor for controlling the apparatus 50. The controller 56 may be connected to memory 58 which in embodiments of the invention may store both data in the form of image and audio data and/or may also store instructions for implementation on the controller 56. The controller 56 may further be connected to codec circuitry 54 suitable for carrying out coding and decoding of audio and/or video data or assisting in coding and decoding carried out by the controller 56.

[0053] The apparatus 50 may further comprise a card reader 48 and a smart card 46, for example a UICC and UICC reader for providing user information and being suitable for providing authentication information for authentication and authorization of the user at a network.

[0054] The apparatus 50 may comprise radio interface circuitry 52 connected to the controller and suitable for generating wireless communication signals for example for communication with a cellular communications network, a wireless communications system or a wireless local area network. The apparatus 50 may further comprise an antenna 44 connected to the radio interface circuitry 52 for transmitting radio frequency signals generated at the radio interface circuitry 52 to other apparatus(es) and for receiving radio frequency signals from other apparatus(es).

[0055] In some embodiments of the invention, the apparatus 50 comprises a camera capable of recording or detecting individual frames which are then passed to the codec 54 or controller for processing. In some embodiments of the invention, the apparatus may receive the video image data for processing from another device prior to transmission and/or storage. In some embodiments of the invention, the apparatus 50 may receive either wirelessly or by a wired connection the image for coding/decoding.

[0056] With respect to Figure 3, an example of a system within which embodiments of the present invention can be utilized is shown. The system 10 comprises multiple communication devices which can communicate through one or more networks. The system 10 may comprise any combination of wired or wireless networks including, but not limited to a wireless cellular telephone network (such as a GSM, UMTS, CDMA network etc), a wireless local area network (WLAN) such as defined by any of the IEEE 802.x standards, a Bluetooth personal area network, an Ethernet local area network, a token ring local area network, a wide area network, and the Internet.

[0057] The system 10 may include both wired and wireless communication devices or apparatus 50 suitable for implementing embodiments of the invention.

[0058] For example, the system shown in Figure 3 shows a mobile telephone network 11 and a representation of the internet 28. Connectivity to the internet 28 may include, but is not limited to, long range wireless connections, short range wireless connections, and various wired connections including, but not limited to, telephone lines, cable lines, power lines, and similar communication pathways.

[0059] The example communication devices shown in the system 10 may include, but are not limited to, an electronic device or apparatus 50, a combination of a personal digital assistant (PDA) and a mobile telephone 14, a PDA 16, an integrated messaging device (IMD) 18, a desktop computer 20, a notebook computer 22. The apparatus 50 may be stationary or mobile when carried by an individual who is moving. The apparatus 50 may also be located in a mode of transport including, but not limited to, a car, a truck, a taxi, a bus, a train, a boat, an airplane, a bicycle, a motorcycle or any similar suitable mode of transport.

[0060] Some or further apparatus may send and receive calls and messages and communicate with service providers through a wireless connection 25 to a base station 24. The base station 24 may be connected to a network server 26 that allows communication between the mobile telephone network 11 and the internet 28. The system may include additional communication devices and communication devices of various types.

[0061] The communication devices may communicate using various transmission technologies including, but not limited to, code division multiple access (CDMA), global systems for mobile communications (GSM), universal mobile telecommunications system (UMTS), time divisional multiple access (TDMA), frequency division multiple access (FDMA), transmission control protocol-internet protocol (TCP-IP), short messaging service (SMS), multimedia messaging service (MMS), email, instant messaging service (IMS), Bluetooth, IEEE 802.11 and any similar wireless communication technology. A communications device involved in implementing various embodiments of the present invention may communicate using various media including, but not limited to, radio, infrared, laser, cable connections, and any suitable connection.

[0062] Various embodiments can extend conventional two-stage sub-pixel interpolation algorithms, such as the algorithm used in the H.264/AVC video coding standard, without the need to increase the complexity of the decoder. It should be noted here that Figure 11 illustrates only some full pixel values which are the nearest neighbors to the example block of pixels but in the interpolation it may also be possible to use full pixel values located farther from the block under consideration. Furthermore, the present invention is not only limited to implementations using one-dimensional interpolation but the fractional pixel samples can also be obtained using more complex interpolation or filtering.

[0063] It should be noted that various embodiments can be implemented by and/or in conjunction with other video coding standards besides the H.264/AVC video coding standard.

[0064] With respect to Figure 4a, a block diagram of a video encoder suitable for carrying out embodiments of the invention is shown. Furthermore, with respect to Figure 5, the operation of the encoder exemplifying embodiments of the invention specifically with respect to the utilization of higher accuracy calculation of prediction signals is shown as a flow diagram.

[0065] Figure 4a shows the encoder as comprising a pixel predictor 302, prediction error encoder 303 and prediction error decoder 304. Figure 4a also shows an embodiment of the pixel predictor 302 as comprising an inter-predictor 306, an intra-predictor 308, a mode selector 310, a filter 316, and a reference frame memory 318. The mode selector 310 comprises a block processor 381 and a cost evaluator 382. Figure 4b also depicts an embodiment of the inter-predictor 306 which comprises a block selector 360 and a motion vector definer 361, which may be implemented e.g. in a prediction processor 362. The inter-predictor 306 may also have access to a parameter memory 404. The mode selector 310 may also comprise a quantizer 384.

[0066] The pixel predictor 302 receives the image 300 to be encoded at both the inter-predictor 306 (which determines the difference between the image and a motion compensated reference frame 318) and the intra-predictor 308 (which determines a prediction for an image block based only on the already processed parts of current frame or picture). The output of both the inter-predictor and the intra-predictor are passed to the mode selector 310. The intra-predictor 308 may have more than one intra-prediction modes. Hence, each mode may perform the intra-prediction and provide the predicted signal to the mode selector 310. The mode selector 310 also receives a copy of the image 300.

[0067] The block processor 381 determines which encoding mode to use to encode the current block. If the block processor 381 decides to use an inter-prediction mode it will pass the output of the inter-predictor 306 to the output of the mode selector 310. If the block processor 381 decides to use an intra-prediction mode it will pass the output of one of the intra-predictor modes to the output of the mode selector 310.

[0068] According to some example embodiments the pixel predictor 302 operates as follows. The inter predictor 306 and the intra prediction modes 308 perform the prediction of the current block to obtain predicted pixel values of the current block. The inter predictor 306 and the intra prediction modes 308 may provide the predicted pixel values of the current block to the block processor 381 for analyzing which prediction to select. In addition to the predicted values of the current block, the block processor 381 may, in some embodiments, receive an indication of a directional intra prediction mode from the intra prediction modes.

[0069] The block processor 381 examines whether to select the inter prediction mode or the intra prediction mode. The block processor 381 may use cost functions such as the equation (1) or some other methods to analyze which encoding method gives the most efficient result with respect to a certain criterion or criteria. The selected criteria may include coding efficiency, processing costs and/or some other criteria. The block processor 381 may examine the prediction for each directionality i.e. for each intra prediction mode and inter prediction mode and calculate the cost value for each intra prediction mode and inter prediction mode, or the block processor 381 may examine only a subset of all available prediction modes in the selection of the prediction mode.

[0070] In some embodiments the inter predictor 306 operates as follows. The block selector 360 receives a current block to be encoded (block 504 in Figure 5) and examines whether a previously encoded image contains a block which may be used as a reference to the current block (block 505). If such a block is found from the reference frame memory 318, the motion estimator 365 may determine whether the current block could be predicted by using one or two (or more) reference blocks i.e. whether the current block could be a uni-predicted block or a bi-predicted block (block 506). If the motion estimator 365 has determined to use uni-prediction, the motion estimator 365 may indicate the reference block to the motion vector definer 361. If the motion estimator 365 has selected to use bi-prediction, the motion estimator 365 may indicate both reference blocks, or if more than two reference blocks have been selected, all the selected reference blocks to the motion vector definer 361. The motion vector definer 361 utilizes the reference block information and defines a motion vector (block 507) to indicate the correspondence between pixels of the current block and the reference block(s).

[0071] In some embodiments the inter predictor 306 calculates a cost value for both one-directional and bi-directional prediction and may then select which kind of prediction to use with the current block.

[0072] In some embodiments the motion vector may point to a full pixel sample or to a fraction pixel sample i.e. to a half pixel, to a quarter pixel or to a one-eighth pixel. The motion vector definer 361 may examine the type of the current block to determine whether the block is a bi-predicted block or another kind of a block (block 508). The type may be determined by the block type indication 366 which may be provided by the block selector 360 or another element of the encoder. If the type of the block is a bi-predicted block, two (or more) motion vectors are defined by the motion vector definer 361 (block 509). Otherwise, if the block is a uni-predicted block, one motion vector shall be defined (block 510).

[0073] It is also possible that the type of the block is determined before the motion vector is calculated.

[0074] The motion vector definer 361 provides motion vector information to the block processor 381 which uses this information to obtain the prediction signal.

[0075] When the cost has been calculated with respect to intra prediction mode and possibly with respect to the inter prediction mode(s), the block processor 381 selects one intra prediction mode or the inter prediction mode for encoding the current block.

[0076] When the inter prediction mode was selected, the predicted pixel values or predicted pixel values quantized by the optional quantizer 384 are provided as the output of the mode selector.

[0077] The output of the mode selector is passed to a first summing device 321. The first summing device may subtract the pixel predictor 302 output from the image 300 to produce a first prediction error signal 320 which is input to the prediction error encoder 303.

[0078] The pixel predictor 302 further receives from a preliminary reconstructor 339 the combination of the prediction representation of the image block 312 and the output 338 of the prediction error decoder 304. The preliminary reconstructed image 314 may be passed to the intra-predictor 308 and to a filter 316. The filter 316 receiving the preliminary representation may filter the preliminary representation and output a final reconstructed image 340 which may be saved in a reference frame memory 318. The reference frame memory 318 may be connected to the inter-predictor 306 to be used as the reference image against which the future image 300 is compared in inter-prediction operations.

[0079] The operation of the pixel predictor 302 may be configured to carry out any known pixel prediction algorithm known in the art.

[0080] The pixel predictor 302 may also comprise a filter 385 to filter the predicted values before outputting them from the pixel predictor 302.

[0081] The operation of the prediction error encoder 303 and prediction error decoder 304 will be described hereafter in further detail. In the following examples the encoder generates images in terms of 16x16 pixel macroblocks which go to form the full image or picture. Thus, for the following examples the pixel predictor 302 outputs a series of predicted macroblocks of size 16x16 pixels and the first summing device 321 outputs a series of 16x16 pixel residual data macroblocks which may represent the difference between a first macro-block in the image 300 against a predicted macro-block (output of pixel predictor 302). It would be appreciated that other size macro blocks may be used.

[0082] The prediction error encoder 303 comprises a transform block 342 and a quantizer 344. The transform block 342 transforms the first prediction error signal 320 to a transform domain. The transform is, for example, the DCT transform. The quantizer 344 quantizes the transform domain signal, e.g. the DCT coefficients, to form quantized coefficients.

[0083] The entropy encoder 330 receives the output of the prediction error encoder and may perform a suitable entropy encoding/variable length encoding on the signal to provide error detection and correction capability. Any suitable entropy encoding algorithm may be employed.

[0084] The prediction error decoder 304 receives the output from the prediction error encoder 303 and performs the opposite processes of the prediction error encoder 303 to produce a decoded prediction error signal 338 which when combined with the prediction representation of the image block 312 at the second summing device 339 produces the preliminary reconstructed image 314. The prediction error decoder may be considered to comprise a dequantizer 346, which dequantizes the quantized coefficient values, e.g. DCT coefficients, to reconstruct the transform signal and an inverse transformation block 348, which performs the inverse transformation to the reconstructed transform signal wherein the output of the inverse transformation block 348 contains reconstructed block(s). The prediction error decoder may also comprise a macroblock filter (not shown) which may filter the reconstructed macroblock according to further decoded information and filter parameters.

[0085] The operation and implementation of the mode selector 310 is shown in further detail with respect to Figure 5. On the basis of the prediction signals from the output of the inter-predictor 306, the output of the intra-predictor 308 and/or the image signal 300 the block processor 381 determines which encoding mode to use to encode the current image block. This selection is depicted as the block 500 in figure 5. The block processor 381 may calculate a rate-distortion cost (RD) value or another cost value for the prediction signals which are input to the mode selector 310 and select such an encoding mode 503, 504 for which the determined cost is the smallest.

[0086] The mode selector 310 provides an indication of the encoding mode of the current block (501). The indication may be encoded and inserted to a bit stream or stored into a memory together with the image information.

[0087] If the intra-prediction mode is selected, the block is predicted by an intra-prediction method (503). Respectively, if the inter-prediction mode is selected, the block is predicted by an inter-prediction method (504-510).

[0088] An example of the operation of the mode selector when the inter-prediction mode is selected and the type of the block is a bi-predicted block, is illustrated as a block diagram in figure 11. Motion vector information provided by the motion vector definer 361contains indication of a first reference block and a second reference block. In multi-prediction applications the motion vector information may contain indication of more than two reference blocks. The block processor 381 uses the motion vector information to determine which block is used as a first reference block for the current block and which block is used as a second reference block for the current block. The block processor 381 then uses some pixel values of the first reference block to obtain first prediction values and some pixel values of the second reference block to obtain second prediction values. For example, if a first motion vector points to a fraction of a pixel (a subpixel) illustrated by the square b in the example of figure 12, the block processor 381 may use pixel values of several full pixels on the same row, for example, than said fraction of the pixel to obtain a reference pixel value. The block processor 381 may use e.g. a P-tap filter such as a six-tap filter in which P pixel values of the reference block are used to calculate the prediction value. In the example of figure 12 these pixel values could be pixels E, F, G, H, I and J. The taps of the filter may be e.g. integer values. An example of such a six-tap filter is [1 -5 20 20 -5 1] / 32. Hence, the filter 1102 would receive 1101 the pixel values of pixels E, F, G, H, I and J and filter these values by the equation $P1 = (E_1-5*F_1+20*G_1+20*H_1-5*I_1+J_1)$, in which E_1 is the value of the pixel E in the first reference block, F_1 is the value of the pixel F in the first reference block, G_1 is the value of the pixel G in the first reference block, H_1 is the value of the pixel H in the first reference block, I_1 is the value of the pixel I in the first reference block, and J_1 is the value of the pixel J in the first reference block. In the first rounding offset insertion block 1103 a first rounding offset may be added to the value P1 i.e. P1 + rounding offset. Then, the sum may be shifted by the first shifting block 1104 to the right so that the precision of the sum becomes M bits. The precision M is higher than the precision of the expected prediction value. For example, pixel values and the prediction values may be represented by N bits wherein M > N. In some example implementations N is 8 bits and M is 16 bits but it is obvious that also other bit lengths can be used with the present invention.

[0089] The second prediction can be obtained similarly by the second filter 1106, which receives 1105 some pixel values of the second reference block. These pixel values are determined on the basis of the second motion vector. The second motion vector may point to the same pixel (or a fraction of the pixel) in the second reference block to which the first motion vector points in the first reference block (using the example above that pixel is the subpixel b) or to another full pixel or a subpixel in the second reference block. The second filter 1106 uses similar filter than the first filter 1102 and outputs the second filtering result P2. According to the example above the filter is a six-tap filter [1 -5 20 20 -5 1] / 32, wherein $P2 = (E_2-5*F_2+20*G_2+20*H_2-5*I_2+J_2)$, in which E_2 is the value of the pixel E in the second reference block, F_2 is the value of the pixel F in the second reference block, G_2 is the value of the pixel G in the second reference block, H_2 is the value of the pixel H in the second reference block, I_2 is the value of the pixel I in the second reference block, and J_2 is the value of the pixel J in the second reference block. In the second rounding offset insertion block 1107 the first rounding offset may be added to the value P2 i.e. P2 + rounding offset. Then, the sum may be shifted by the second shifting block 1108 to the right so that the precision of the sum becomes M bits.

[0090] In the combining block 1109 the two prediction values P1, P2 are combined e.g. by summing and the combined value is added with a second rounding value in the third rounding value insertion block 1110. The result is converted to a smaller precision e.g. by shifting bits of the result to the right y times in the third shifting block 1111. This corresponds with dividing the result by 2^y. After the conversion the precision of the prediction signal corresponds with the precision of the input pixel values. However, the intermediate results are at a higher precision, wherein possible rounding errors have a smaller effect to the prediction signal compared to existing methods such as the method illustrated in figure 10.

[0091] In an alternative embodiment the rounding offset is not added separately to the results of the first 1102 and the second filter 1106 but after combining the results in the combining block 1110. In this case the value of the rounding offset is twice the value of the first rounding offset because in the embodiment of figure 11 the first rounding offset is actually added twice, once to P1 and once to P2.

[0092] In some embodiments also the first shifting block 1105 and the second shifting block 1109 are not needed when the precision of registers which store the filtering results is sufficient without reducing the precision of the filtering results. In that case the third shifting block may need to shift the prediction result more than y bits to the right so that the right shifted value P has the same prediction than the input pixel values, for example 8 bits.

[0093] In some other example embodiments may partly differ from the above. For example, if a motion vector of one of the prediction directions point to an integer sample, the bit-depth of prediction samples with integer accuracy may be increased by shifting the samples to the left so that the filtering can be performed with values having the same precision.

[0094] Samples of each one of the prediction directions could be rounded at an intermediate step to a bit-depth that is still larger than the input bit-depth to make sure all the intermediate values fit to registers of certain length, e.g. 16-bit registers. For example, let’s consider the same example above but using filter taps: {3, -17, 78, 78, -17, 3}. Then P1 and P2 are obtained as:

$P1 = (3*E_1-17*F_1+78*G_1+78*H_1-17*I_1+3*J_1 + 1) >> 1$

$P2 = (3*E_2-17*F_2+78*G_2+78*H_2-17*I_2+3*J_2 + 1) >> 1$

The bi-directional prediction signal may then be obtained using:

$P = (P1 + P2 + 32) >> 6$.

[0095] When a motion vector points between two full pixels i.e. to a fraction of the pixel, the value for that the reference pixel value may be obtained in several ways. Some possibilities were disclosed above but in the following some further non-limiting examples shall be provided with reference to figure 12.

[0096] If a motion vector points to the block labeled j the corresponding reference pixel value could be obtained by using full pixel values on the same diagonal than j, or by a two-phase process in which e.g. pixel values of rows around the block j are used to calculate a set of intermediate results and then these intermediate results could be filtered to obtain the reference pixel value. In an example embodiment the full pixel values A and B could be used to calculate a first intermediate result to represent a fraction pixel value aa, full pixel values C and D could be used to calculate a second intermediate result to represent a fraction pixel value bb, and full pixel values E to J could be used to calculate a third intermediate result to represent a fraction pixel value b. Similarly, fourth, fifth and sixth intermediate values to represent fraction pixel values s, gg, hh could be calculated on the basis of full pixel values K to Q; R, S; and T, U. These intermediate results could then be filtered by a six-tap filter, for example.

[0097] The prediction signal P obtained by the above described operations need not be provided to a decoder but the encoder uses this information to obtain predicted blocks and prediction error. The prediction error may be provided to the decoder so that the decoder can use corresponding operations to obtain the predicted blocks by prediction and correct the prediction results on the basis of the prediction error. The encoder may also provide motion vector information to the decoder.

[0098] In an example embodiment, as is depicted in figure 9, the bit stream of an image comprises an indication of the beginning of an image 910, image information of each block of the image 920, and indication of the end of the image 930. The image information of each block of the image 920 may include a block type indicator 932, and motion vector information 933. It is obvious that the bit stream may also comprise other information. Further, this is only a simplified image of the bit stream and in practical implementations the contents of the bit stream may be different from what is depicted in figure 9.

[0099] The bit stream may further be encoded by the entropy encoder 330.

[00100] Although the embodiments above have been described with respect to the size of the macroblock being 16x16 pixels, it would be appreciated that the methods and apparatus described may be configured to handle macroblocks of different pixel sizes.

[00101] In the following the operation of an example embodiment of the decoder 600 is depicted in more detail with reference to figure 6.

[00102] At the decoder side similar operations are performed to reconstruct the image blocks. Figure 6 shows a block diagram of a video decoder suitable for employing embodiments of the invention and Figure 7 shows a flow diagram of an example of a method in the video decoder. The decoder shows an entropy decoder 600 which performs an entropy decoding on the received signal. The entropy decoder thus performs the inverse operation to the entropy encoder 330 of the encoder described above. The entropy decoder 600 outputs the results of the entropy decoding to a prediction error decoder 602 and a pixel predictor 604.

[00103] The pixel predictor 604 receives the output of the entropy decoder 600. The output of the entropy decoder 600 may include an indication on the prediction mode used in encoding the current block. A predictor selector 614 within the pixel predictor 604 determines that an intra-prediction, an inter-prediction, or interpolation operation is to be carried out. The predictor selector may furthermore output a predicted representation of an image block 616 to a first combiner 613. The predicted representation of the image block 616 is used in conjunction with the reconstructed prediction error signal 612 to generate a preliminary reconstructed image 618. The preliminary reconstructed image 618 may be used in the predictor 614 or may be passed to a filter 620. The filter 620 applies a filtering which outputs a final reconstructed signal 622. The final reconstructed signal 622 may be stored in a reference frame memory 624, the reference frame memory 624 further being connected to the predictor 614 for prediction operations.

[00104] The prediction error decoder 602 receives the output of the entropy decoder 600. A dequantizer 692 of the prediction error decoder 602 may dequantize the output of the entropy decoder 600 and the inverse transform block 693 may perform an inverse transform operation to the dequantized signal output by the dequantizer 692. The output of the entropy decoder 600 may also indicate that prediction error signal is not to be applied and in this case the prediction error decoder produces an all zero output signal.

[00105] The decoder selects the 16x16 pixel residual macroblock to reconstruct. The selection of the 16x16 pixel residual macroblock to be reconstructed is shown in step 700.

[00106] The decoder receives information on the encoding mode used when the current block has been encoded. The indication is decoded, when necessary, and provided to the reconstruction processor 691 of the prediction selector 614. The reconstruction processor 691 examines the indication (block 701 in figure 7) and selects one of the intra-prediction modes (block 703), if the indication indicates that the block has been encoded using intra-prediction, or an inter-prediction mode (blocks 704—711), if the indication indicates that the block has been encoded using inter-prediction.

[00107] If the current block has been encoded using inter-prediction, the pixel predictor 604 may operate as follows. The pixel predictor 604 receives motion vector information (block 704). The pixel predictor 604 also receives (block 705) block type information and examines whether the block is a bi-predicted block or not (block 706). If the block type is a bi-predicted block, the pixel predictor 604 examines the motion vector information to determine which reference frames and reference block in the reference frames have been used in the construction of the motion vector information. The reconstruction processor 691 calculates the motion vectors (709) and uses the value of the (fraction of the) pixel of the reference blocks to which the motion vectors point to obtain a motion compensated prediction (710) and combines the prediction error with the value to obtain a reconstructed value of a pixel of the current block (block 711).

[00108] If the block type is a uni-predicted block, the pixel predictor 604 examines the motion vector information to determine which reference frame and reference block in the reference frame has been used in the construction of the motion vector information. The reconstruction processor 691 calculates the motion vector (707) and uses the value of the (fraction of the) pixel of the reference block to which the motion vector points to obtain a motion compensated prediction (708) and combines the prediction error with the value to obtain a reconstructed value of a pixel of the current block (block 711).

[00109] When the motion vector does not point to a full pixel sample in the reference block, the reconstruction processor 691 calculates using e.g. a one-directional interpolation or P-tap filtering (e.g. six-tap filtering) to obtain the values of the fractional pixels. Basically, the operations may be performed in the same way than in the encoder i.e. maintaining the higher accuracy values during the filtering until in the final rounding operation the accuracy may be decreased to the accuracy of the input pixels. Therefore, the effect of possible rounding errors may not be so large to the predicted values than in known methods.

[00110] The above described procedures may be repeated to each pixel of the current block to obtain all reconstructed pixel values for the current block.

[00111] In some embodiments the reconstruction processor 691 use the interpolator 694 to perform the calculation of the fractional pixel values.

[00112] In some embodiments the reconstruction processor 691 provides the fractional pixel values to the predictor 695 which combines the fractional pixel values with prediction error to obtain the reconstructed values of the pixels of the current block.

[00113] In some embodiments the interpolation may also be performed by using full pixel values, half pixel values, and/or quarter pixel values which may have been stored into a reference frame memory. For example, the encoder or the decoder may comprise a reference frame memory in which the full pixel samples, half pixel values and quarter pixel values can be stored.

[00114] Furthermore, in some embodiments the type of the block may also be a multi-predicted block wherein the prediction of a block may be based on more than two reference blocks.

[00115] The embodiments of the invention described above describe the codec in terms of separate encoder and decoder apparatus in order to assist the understanding of the processes involved. However, it would be appreciated that the apparatus, structures and operations may be implemented as a single encoder-decoder apparatus/structure/operation. Furthermore in some embodiments of the invention the coder and decoder may share some or all common elements.

[00116] Although the above examples describe embodiments of the invention operating within a codec within an electronic device, it would be appreciated that the invention as described below may be implemented as part of any video codec. Thus, for example, embodiments of the invention may be implemented in a video codec which may implement video coding over fixed or wired communication paths.

[00117] Thus, user equipment may comprise a video codec such as those described in embodiments of the invention above.

[00118] It shall be appreciated that the term user equipment is intended to cover any suitable type of wireless user equipment, such as mobile telephones, portable data processing devices or portable web browsers.

[00119] Furthermore elements of a public land mobile network (PLMN) may also comprise video codecs as described above.

[00120] In general, the various embodiments of the invention may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. For example, some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the invention is not limited thereto. While various aspects of the invention may be illustrated and described as block diagrams, flow charts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[00121] The embodiments of this invention may be implemented by computer software executable by a data processor of the mobile device, such as in the processor entity, or by hardware, or by a combination of software and hardware. Further in this regard it should be noted that any blocks of the logic flow as in the Figures may represent program steps, or interconnected logic circuits, blocks and functions, or a combination of program steps and logic circuits, blocks and functions. The software may be stored on such physical media as memory chips, or memory blocks implemented within the processor, magnetic media such as hard disk or floppy disks, and optical media such as for example DVD and the data variants thereof, CD.

[00122] The memory may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor-based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory. The data processors may be of any type suitable to the local technical environment, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multi-core processor architecture, as non-limiting examples.

[00123] Embodiments of the inventions may be practiced in various components such as integrated circuit modules. The design of integrated circuits is by and large a highly automated process. Complex and powerful software tools are available for converting a logic level design into a semiconductor circuit design ready to be etched and formed on a semiconductor substrate.

[00124] Programs, such as those provided by Synopsys, Inc. of Mountain View, California and Cadence Design, of San Jose, California automatically route conductors and locate components on a semiconductor chip using well established rules of design as well as libraries of pre-stored design modules. Once the design for a semiconductor circuit has been completed, the resultant design, in a standardized electronic format (e.g., Opus, GDSII, or the like) may be transmitted to a semiconductor fabrication facility or "fab" for fabrication.

[00125] The foregoing description has provided by way of exemplary and non-limiting examples a full and informative description of the exemplary embodiment of this invention. However, various modifications and adaptations may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings and the appended claims. However, all such and similar modifications of the teachings of this invention will still fall within the scope of this invention.

[00126] A method according to a first embodiment comprises:

determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

determining a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combining said first prediction and said second prediction to obtain a combined prediction; and

decreasing the precision of said combined prediction to said first precision.

[00127] In some methods according to the first embodiment a first rounding offset is inserted to said first prediction and said second prediction.

[00128] In some methods according to the first embodiment the precision of said first prediction and said second prediction is reduced to an intermediate prediction after adding said first rounding offset, said intermediate prediction being higher than said first precision.

[00129] In some methods according to the first embodiment a second rounding offset is inserted to the combined prediction before said decreasing.

[00130] In some methods according to the first embodiment said type of the block is a bi-directional block.

[00131] In some methods according to the first embodiment said type of the block is a multidirectional block.

[00132] In some methods according to the first embodiment the first rounding offset is 2^y, and said decreasing comprises right shifting the combined prediction y+1 bits.

[00133] In some methods according to the first embodiment the first precision is 8 bits.

[00134] In some methods according to the first embodiment the value of y is 5.

[00135] In some methods according to the first embodiment said first prediction and said second prediction are obtained by filtering pixel values of said reference blocks.

[00136] In some methods according to the first embodiment the filtering is performed by a P-tap filter.

[00137] An apparatus according to a second embodiment comprises:

a processor; and

a memory unit operatively connected to the processor and including:

computer code configured to determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

computer code configured to determine a type of the block;

computer code configured to, if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

[00138] In some apparatuses according to the second embodiment the computer code is further configured to insert a first rounding offset to said first prediction and said second prediction.

[00139] In some apparatuses according to the second embodiment the computer code is further configured to reduce the precision of said first prediction and said second prediction to an intermediate prediction after adding said first rounding offset, said intermediate prediction being higher than said first precision.

[00140] In some apparatuses according to the second embodiment the computer code is further configured to insert a second rounding offset to the combined prediction before said decreasing.

[00141] In some apparatuses according to the second embodiment said type of the block is a bi-directional block.

[00142] In some apparatuses according to the second embodiment said type of the block is a multidirectional block.

[00143] In some apparatuses according to the second embodiment the first rounding offset is 2^y, and said decreasing comprises right shifting the combined prediction y+1 bits.

[00144] In some apparatuses according to the second embodiment the first precision is 8 bits.

[00145] In some apparatuses according to the second embodiment the value of y is 5.

[00146] In some apparatuses according to the second embodiment the computer code is further configured to obtain said first prediction and said second prediction by filtering pixel values of said reference blocks.

[00147] In some apparatuses according to the second embodiment said filtering comprises a P-tap filter.

[00148] According to a third embodiment there is provided a computer readable storage medium stored with code thereon for use by an apparatus, which when executed by a processor, causes the apparatus to:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

determine a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

[00149] According to a fourth embodiment there is provided at least one processor and at least one memory, said at least one memory stored with code thereon, which when executed by said at least one processor, causes an apparatus to perform:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

determine a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

[00150] According to some example embodiments the apparatus is an encoder.

[00151] According to some example embodiments the apparatus is a decoder.

[00152] An apparatus according to a fifth embodiment comprises:

an input to determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

a determinator to determine a type of the block; wherein if the determining indicates that the block is a block predicted by using two or more reference blocks, said determinator further to determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

a first predictor to use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

a second predictor to use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

a combiner to combine said first prediction and said second prediction to obtain a combined prediction; and

a shifter to decrease the precision of said combined prediction to said first precision.

[00153] An apparatus according to a sixth embodiment comprises:

means for determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

means for determining a type of the block;

means for determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block, if the determining indicates that the block is a block predicted by using two or more reference blocks;

means for using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

means for using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

means for combining said first prediction and said second prediction to obtain a combined prediction; and

means for decreasing the precision of said combined prediction to said first precision.

WHAT IS CLAIMED IS:

1. A method comprising:

determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

determining a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combining said first prediction and said second prediction to obtain a combined prediction; and

decreasing the precision of said combined prediction to said first precision.

2. The method according to claim 1 further comprising:

inserting a first rounding offset to said first prediction and said second prediction.

3. The method according to claim 1 further comprising:

reducing the precision of said first prediction and said second prediction to an intermediate prediction after adding said first rounding offset, said intermediate prediction being higher than said first precision.

4. The method according to claim 2 further comprising:

inserting a second rounding offset to the combined prediction before said decreasing.

5. The method according to any of the claims 1, wherein said type of the block is a bi-directional block or a multidirectional block.

6. The method according to claim 2, wherein the first rounding offset is 2^y, and said decreasing comprises right shifting the combined prediction y+1 bit.

7. The method according to any of the claims 1, wherein the first precision is 8 bits.

8. The method according to any of the claims 1 further comprising:

obtaining said first prediction and said second prediction by filtering pixel values of said reference blocks.

9. An apparatus comprises:

a processor; and

a memory unit operatively connected to the processor and including:

computer code configured to determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

computer code configured to determine a type of the block;

computer code configured to, if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

10. The apparatus according to claim 9, wherein the computer code is further configured to:

insert a first rounding offset to said first prediction and said second prediction.

11. The apparatus according to claim 9, wherein the computer code is further configured to:

reduce the precision of said first prediction and said second prediction to an intermediate prediction after adding said first rounding offset, said intermediate prediction being higher than said first precision.

12. The apparatus according to claim 10, wherein the computer code is further configured to:

insert a second rounding offset to the combined prediction before said decreasing.

13. The apparatus according to any of the claims 9, wherein said type of the block is a bi-directional block or a multidirectional block.

14. The apparatus according to claim 10, wherein the first rounding offset is 2^y, and said decreasing comprises right shifting the combined prediction y+1 bits.

15. The apparatus according to any of the claims 9, wherein the first precision is 8 bits.

16. The apparatus according to any of the claims 9, wherein the computer code is further configured to:

obtain said first prediction and said second prediction by filtering pixel values of said reference blocks.

17. A computer readable storage medium stored with code thereon for use by an apparatus, which when executed by a processor, causes the apparatus to:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

determine a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

18. An apparatus comprising:

an input to determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

a determinator to determine a type of the block; wherein if the determining indicates that the block is a block predicted by using two or more reference blocks, said determinator further to determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

a first predictor to use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

a second predictor to use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

a combiner to combine said first prediction and said second prediction to obtain a combined prediction; and

a shifter to decrease the precision of said combined prediction to said first precision.

19. An apparatus comprising:

means for determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

means for determining a type of the block;

means for determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block, if the determining indicates that the block is a block predicted by using two or more reference blocks;

means for using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

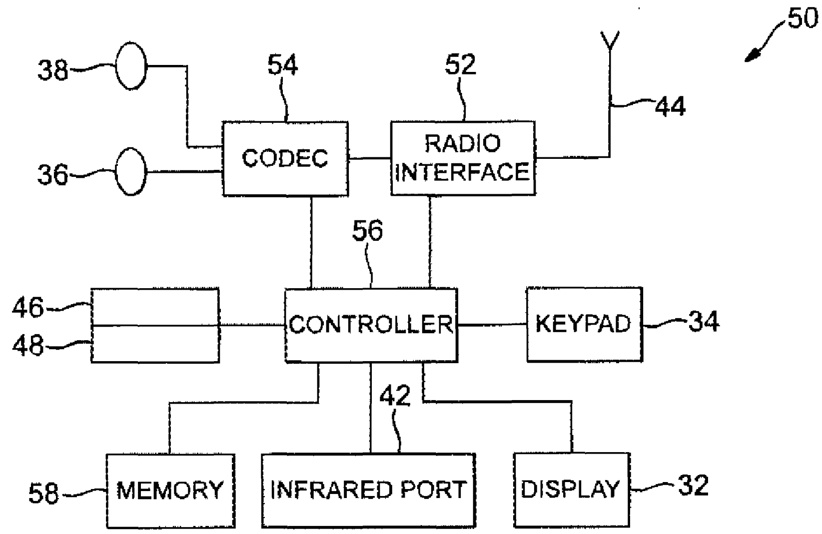
means for using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

means for combining said first prediction and said second prediction to obtain a combined prediction; and

means for decreasing the precision of said combined prediction to said first precision.

ABSTRACT

There is disclosed apparatuses, methods and computer programs for utilizing motion prediction in video coding. A block of pixels of a video representation encoded in a bitstream is read, and a type of the block is determined. If the determining indicates that the block is a block predicted by using two or more reference blocks, a first reference pixel location in a first reference block is determined and a second reference pixel location in a second reference block is determined. The first reference pixel location is used to obtain a first prediction. Said first prediction has a second precision, which is higher than the first precision. The second reference pixel location is used to obtain a second prediction, which also has the second precision. The first prediction and the second prediction are combined to obtain a combined prediction; and the precision of the combined prediction is reduced to the first precision.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38
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52
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CODEC
RADIO INTERFACE
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46
48
CONTROLLER
KEYPAD
34
42
58
MEMORY
INFRARED PORT
DISPLAY
32

FIG:1

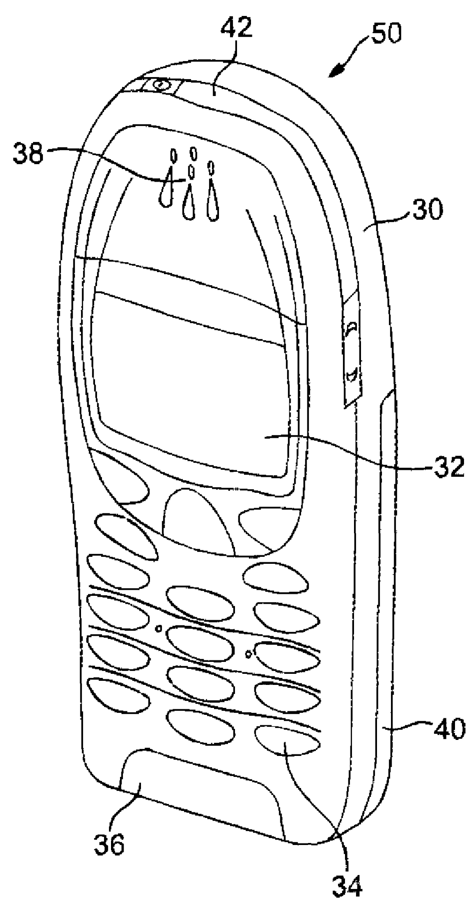
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FIG. 2

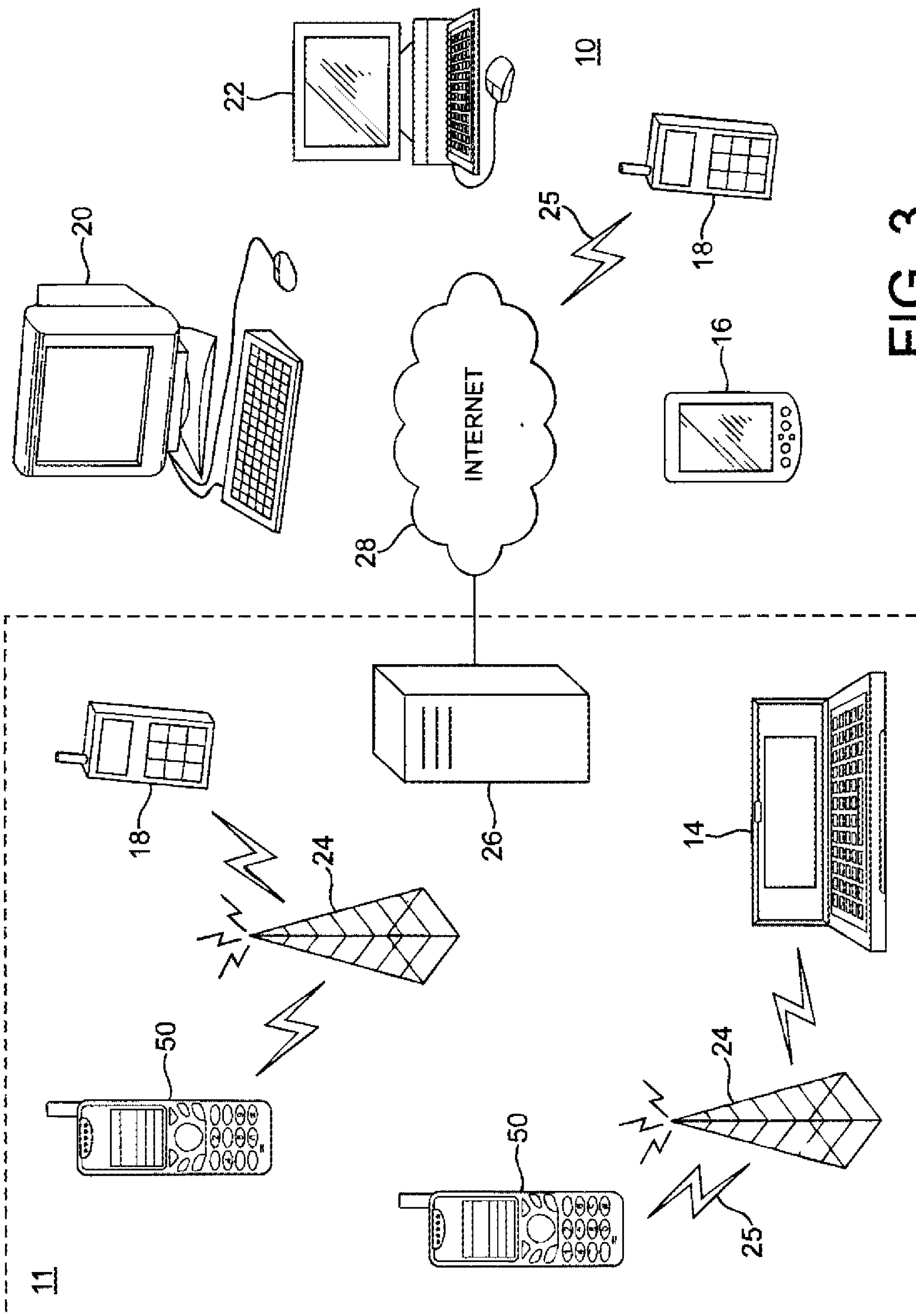
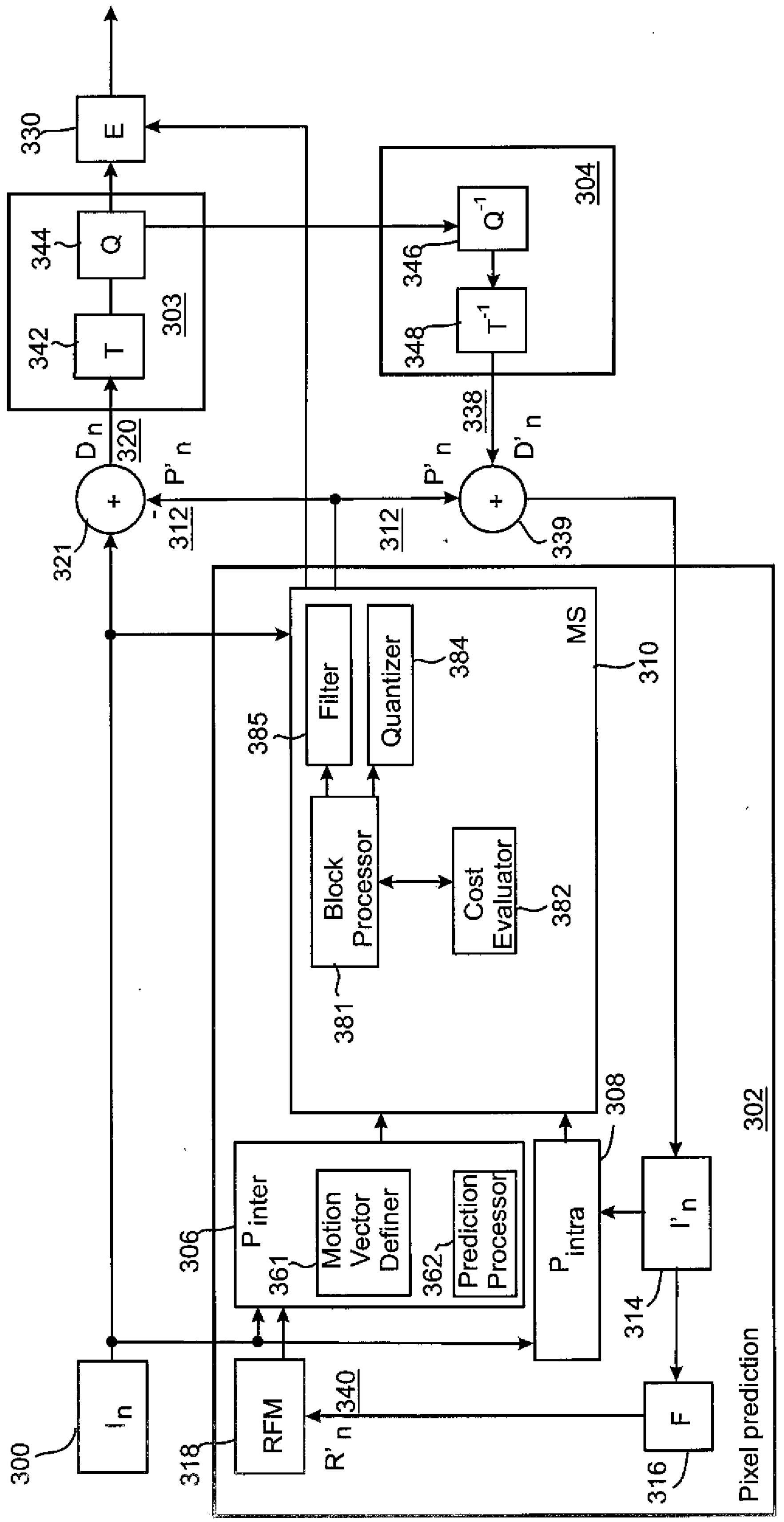


FIG. 3



300
I n
318
RFM
R' n
340
316
F
314
I' n
Pixel prediction
302
306
P inter
361
Motion Vector Definer
362
Prediction Processor
P intra
308
MS
310
381
Block Processor
382
Cost Evaluator
385
Filter
Quantizer
384
321
+
-
312
P' n
D n
320
303
342
T
344
Q
330
E
304
346
Q-1
348
T-1
338
D' n
P' n
+
339

Fig. 4a

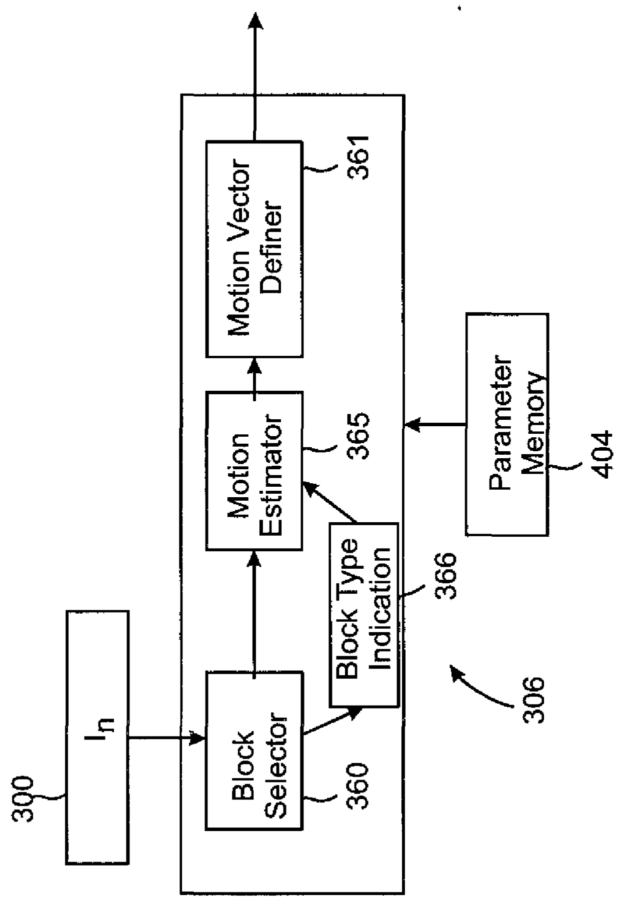

300
I_n
Block Selector
360
Block Type Indication
366
Motion Estimator
365
Motion Vector Definer
361
Parameter Memory
404
306

Fig. 4b

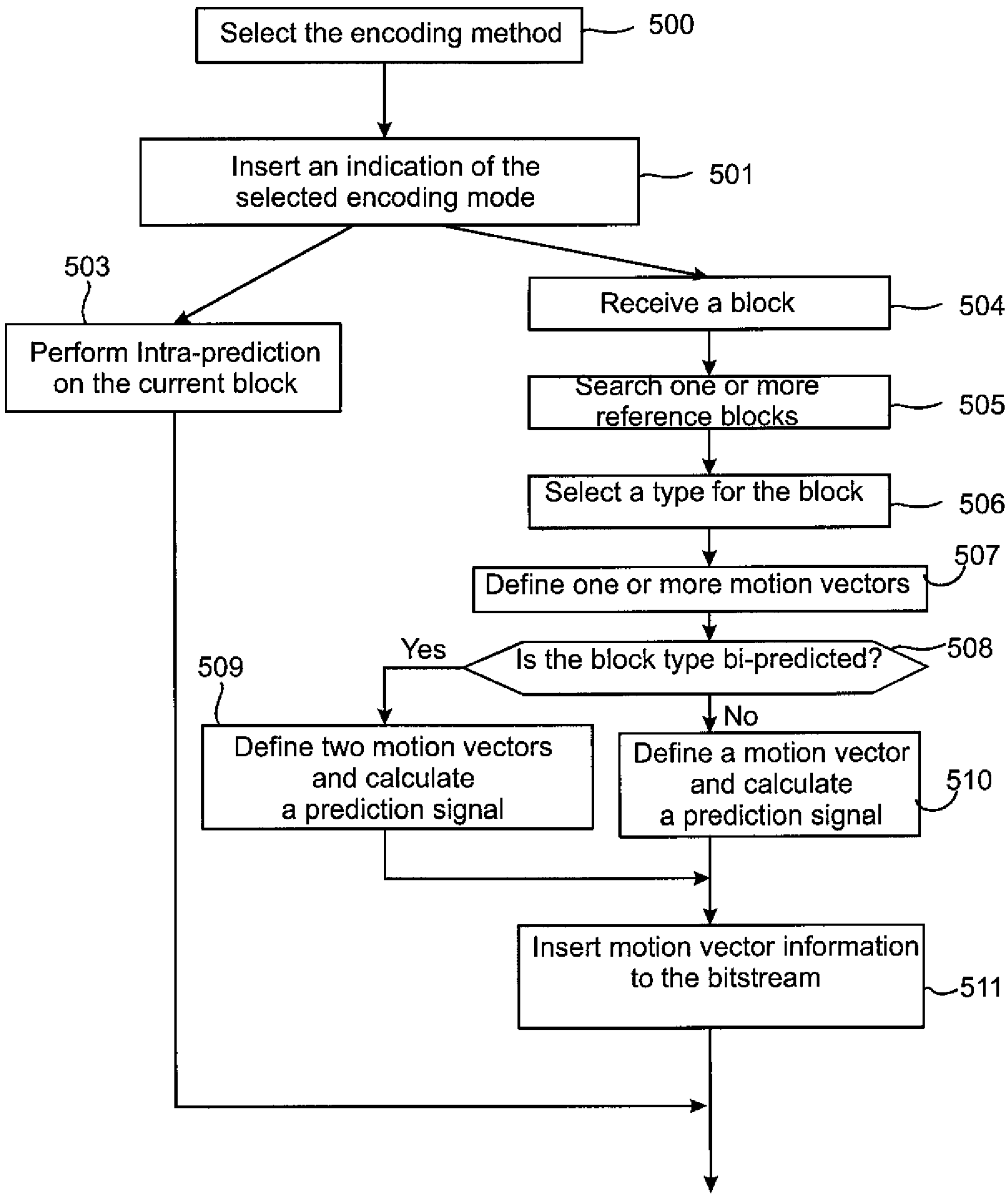

Select the encoding method
500
Insert an indication of the selected encoding mode
501
503
Perform Intra-prediction on the current block
Receive a block
504
Search one or more reference blocks
505
Select a type for the block
506
Define one or more motion vectors
507
Is the block type bi-predicted?
508
Yes
No
509
Define two motion vectors and calculate a prediction signal
Define a motion vector and calculate a prediction signal
510
Insert motion vector information to the bitstream
511

Fig. 5

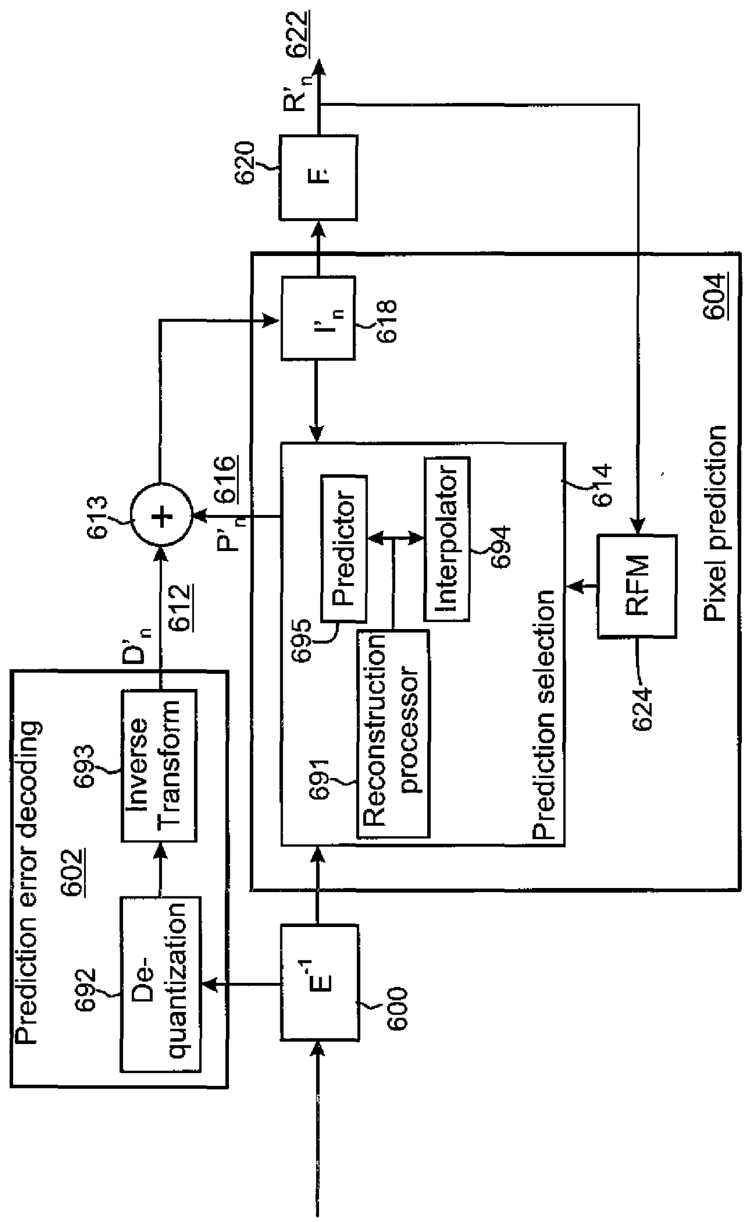

Prediction error decoding
602
692
De-quantization
693
Inverse Transform
D'n
612
613
+
P'n 616
600
E-1
Pixel prediction
604
Prediction selection
614
691
Reconstruction processor
695
Predictor
Interpolator
694
RFM
624
I'n
618
F
620
R'n 622

Fig. 6

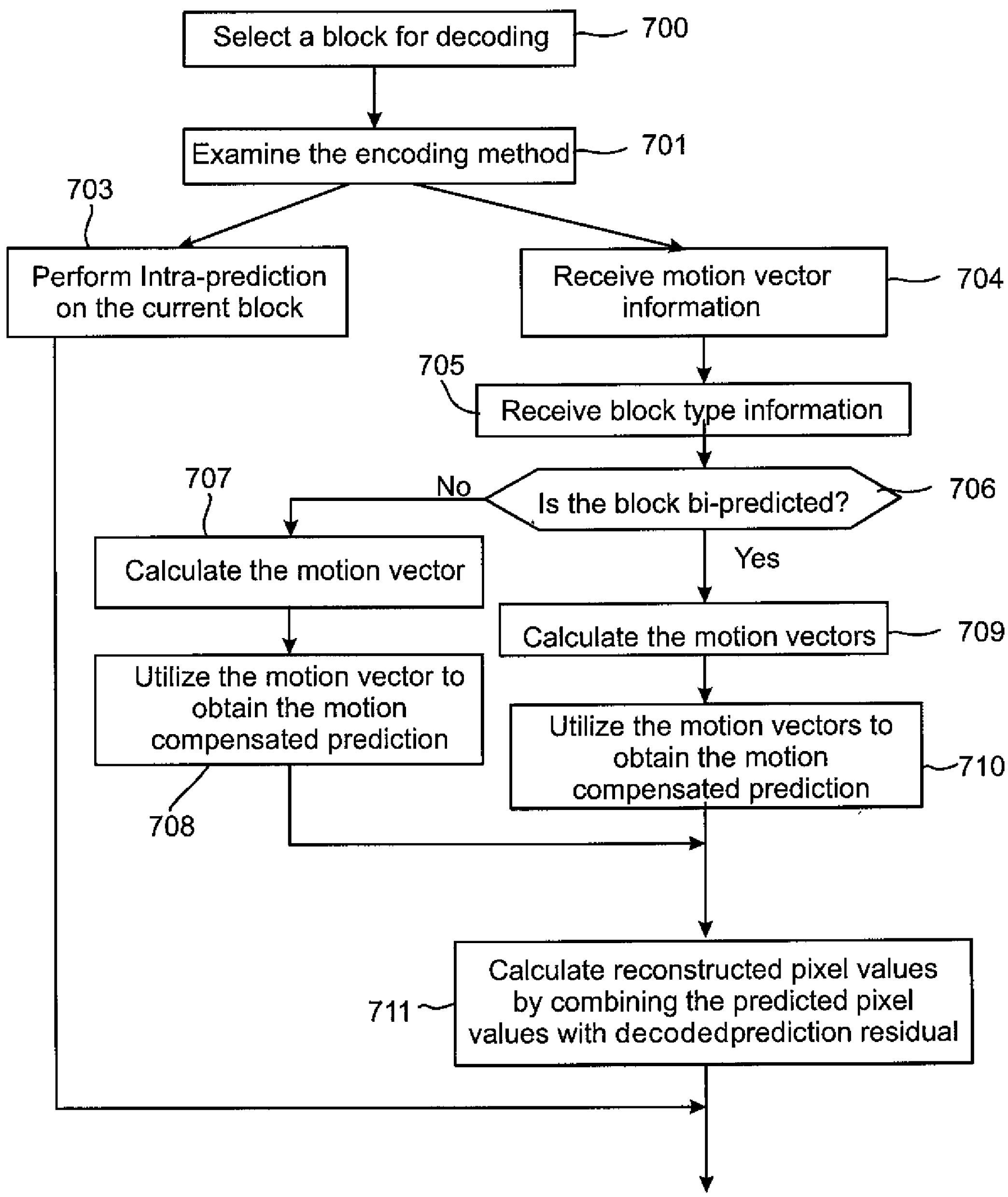

Select a block for decoding
700
Examine the encoding method
701
703
Perform Intra-prediction on the current block
Receive motion vector information
704
705
Receive block type information
707
No
Is the block bi-predicted?
706
Yes
Calculate the motion vector
Calculate the motion vectors
709
Utilize the motion vector to obtain the motion compensated prediction
Utilize the motion vectors to obtain the motion compensated prediction
710
708
711
Calculate reconstructed pixel values by combining the predicted pixel values with decodedprediction residual

Fig. 7

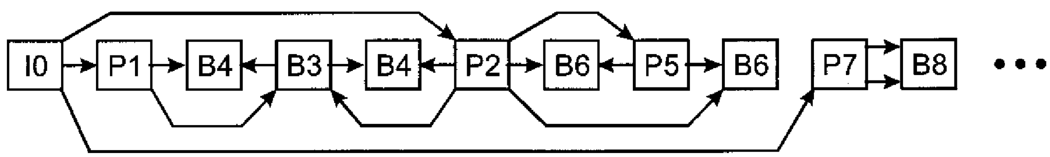
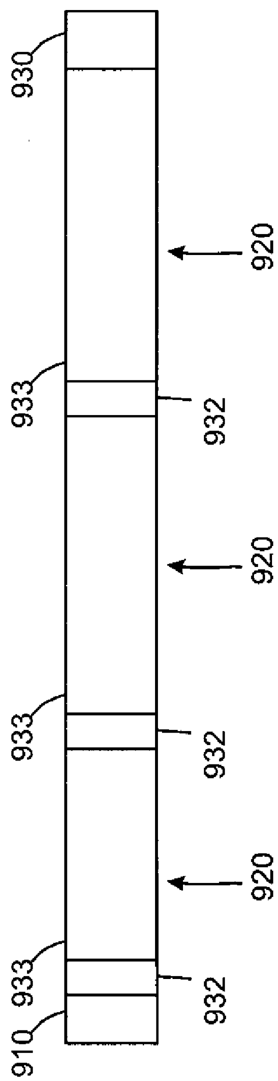


Fig. 8



930
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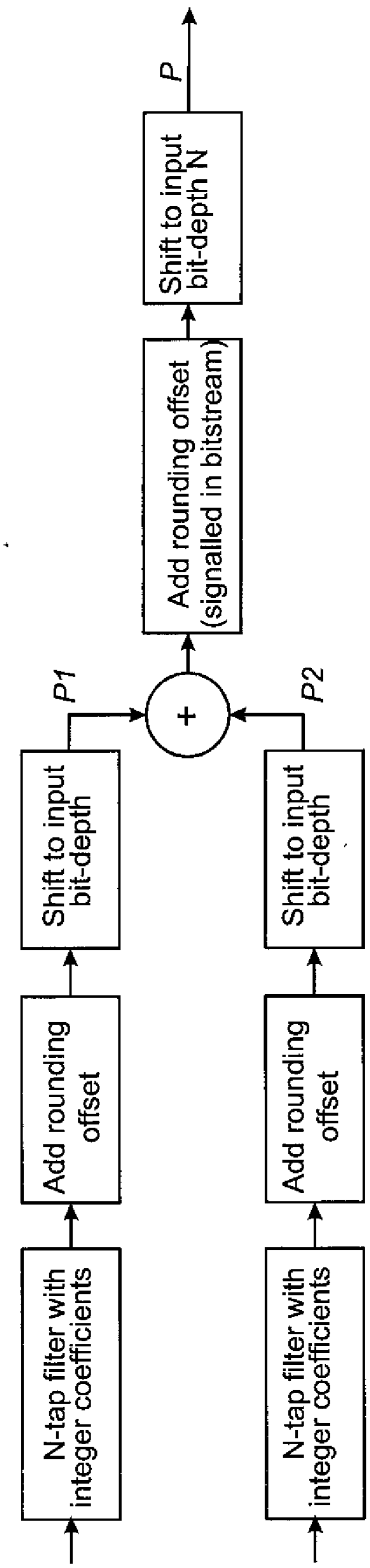
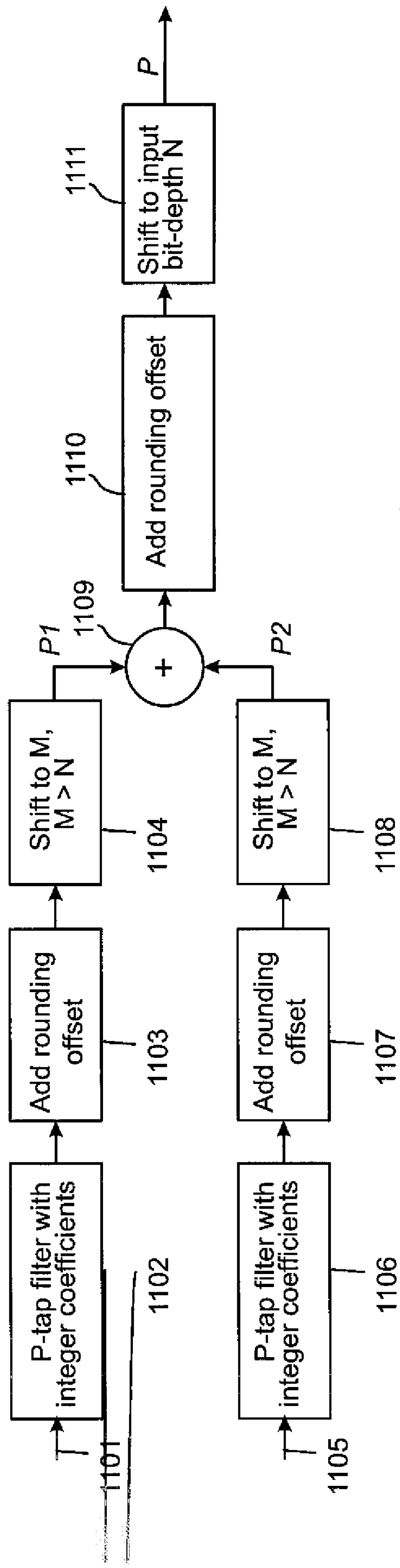
Fig. 9



N-tap filter with integer coefficients
Add rounding offset
Shift to input bit-depth
P1
N-tap filter with integer coefficients
Add rounding offset
Shift to input bit-depth
P2
+
Add rounding offset (signalled in bitstream)
Shift to input bit-depth N
P

Fig. 10



P-tap filter with integer coefficients
Add rounding offset
Shift to M, M > N
P-tap filter with integer coefficients
Add rounding offset
Shift to M, M > N
P1
P2
+
Add rounding offset
Shift to input bit-depth N
P
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111

Fig. 11

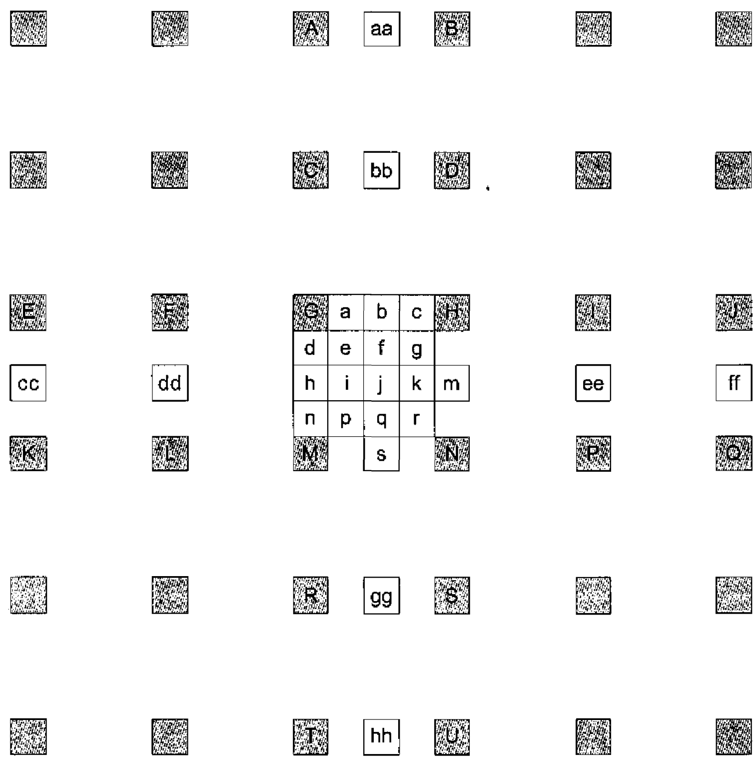

A
aa
B
C
bb
D
E
F
G
a
b
c
H
I
J
d
e
f
g
cc
dd
h
i
j
k
m
ee
ff
n
p
q
r
K
L
M
s
N
P
Q
R
gg
S
T
hh
U

Fig. 12

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Filer:	Ragip Kurceren/Denise Wilson
Attorney Docket Number:	NC74925US-NP

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	380	380
Utility Search Fee	1111	1	620	620
Utility Examination Fee	1311	1	250	250
Pages:				
Claims:				
Independent claims in excess of 3	1201	2	250	500
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1750**

Electronic Acknowledgement Receipt

EFS ID:	11776630
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Customer Number:	73658
Filer:	Ragip Kurceren/Denise Wilson
Filer Authorized By:	Ragip Kurceren
Attorney Docket Number:	NC74925US-NP
Receipt Date:	06-JAN-2012
Filing Date:	
Time Stamp:	14:10:27
Application Type:	Utility under 35 USC 111(a)

Payment information:

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Payment Type	Deposit Account
Payment was successfully received in RAM	$1750
RAM confirmation Number	449
Deposit Account	500270
Authorized User	

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	ADS.pdf	841099 f1fcf353702b9f3ecd7ab8e9efadd133bbaef99c	no	5
Warnings:					
Information:					
2		application.pdf	165407 e137371c1f34f857da1fcccfb520edb336e3b785	yes	37

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Specification	1	30
Claims	31	36
Abstract	37	37

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
Warnings:					
Information:					
3	Drawings-only black and white line drawings	drawings.pdf	410578 a7402e267ed735bb98f7a40fb29cdd942c66682d	no	11
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	36492 bd2c6eeb009949324e4d589cf26252f3098a253c	no	2
Warnings:					
Information:					
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New International Application Filed with the USPTO as a Receiving Office
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/344,893	01/06/2012	Kemal UGUR	NC74925US-NP

CONFIRMATION NO. 2120

73658
Nokia, Inc.
6021 Connection Drive, MS 2-5-520
Irving, TX 75039

FORMALITIES LETTER

OC000000052099722

Date Mailed: 01/20/2012

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is missing.
  A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
  Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The application is informal since it does not comply with the regulations for the reason(s) indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- A replacement abstract not exceeding 150 words in length and commencing on a separate sheet in compliance with 37 CFR 1.72(b) and 37 CFR 1.121 is required.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- A surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $**130** for a non-small entity, must be submitted.

SUMMARY OF FEES DUE:

Total fee(s) required within **TWO MONTHS** from the date of this Notice is $**130** for a non-small entity
- $**130** Surcharge.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/344,893	01/06/2012	2482	1750	NC74925US-NP	19	5

CONFIRMATION NO. 2120

FILING RECEIPT

OC000000052099721

73658
Nokia, Inc.
6021 Connection Drive, MS 2-5-520
Irving, TX 75039

Date Mailed: 01/20/2012

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Kemal UGUR, Tampere, FINLAND;
Jani LAINEMA, Tampere, FINLAND;
Antti Olli HALLAPURO, Tampere, FINLAND;

Assignment For Published Patent Application

NOKIA CORPORATION, Espoo, FINLAND

Power of Attorney: None

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/430,694 01/07/2011

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If Required, Foreign Filing License Granted: 01/19/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/344,893**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

Title

Motion Prediction in Video Coding

Preliminary Class

375

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/344,893

APPLICATION AS FILED - PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	380
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	620
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	19 minus 20 =	*			OR	x 60 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	5 minus 3 =	* 2				x 250 =	500
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
			TOTAL			TOTAL	1750

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED - PART II

AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Kemal UGUR	§	Docket No.:	NC74925US-NP
Serial No.:	13/344,893	§	Examiner:	Unknown
Filed:	01-06-2012	§	Art Unit:	2482
Conf. No.:	2120	§		
Title:	Motion Prediction in Video Coding	§		

Commissioner for Patents
Mail Stop: Amendment
PO Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Dear Sir or Madam:

Prior to examination, please amend the above-identified application as follows.

Replacement of the Abstract begin on **page 2** of this paper.

Remarks begin on **page 3** of this paper.

Abstract

This abstract will replace all prior versions of abstract in the application:

There is disclosed apparatuses, methods and computer programs for utilizing motion prediction in video coding. Coding type of a block of pixels of a video representation encoded in a bitstream is read, where values of said pixels having a first precision. If the type of the block is a block predicted by using two or more reference blocks, a first reference pixel location in a first reference block is determined and a second reference pixel location in a second reference block is determined. The first reference pixel location is used to obtain a first prediction having a second precision, which is higher than the first precision. The second reference pixel location is used to obtain a second prediction, also having the second precision. The first prediction and the second prediction are combined to obtain a combined prediction having the first precision.

Remarks

The abstract has been replaced. No new matter has been added. An early formal notice of allowance of claims is respectfully requested. Examiner is invited to contact the undersigned with any questions.

Please charge any deficiency or credit any overpayment that may be due in this matter to Deposit Account Number 50-0270.

Respectfully submitted,

/Thomas J. Arria/

Thomas J. Arria
Reg. No. 60,223

Date: April 6, 2012

NOKIA INC.
Intellectual Property Rights
ATTN: Docketing
200 South Mathilda Ave.
Sunnyvale, CA 94086

Electronic Patent Application Fee Transmittal				
Application Number:	13344893			
Filing Date:	06-Jan-2012			
Title of Invention:	Motion Prediction in Video Coding			
First Named Inventor/Applicant Name:	Kemal UGUR			
Filer:	Thomas Joseph Arria/Thao Pham			
Attorney Docket Number:	NC74925US-NP			
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Late filing fee for oath or declaration	1051	1	130	130
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	1251	1	150	150
Miscellaneous:				
		Total in USD ($)		**280**

Electronic Acknowledgement Receipt	
EFS ID:	12492393
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	73658
Filer:	Thomas Joseph Arria/Thao Pham
Filer Authorized By:	Thomas Joseph Arria
Attorney Docket Number:	NC74925US-NP
Receipt Date:	07-APR-2012
Filing Date:	06-JAN-2012
Time Stamp:	00:00:13
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$280
RAM confirmation Number	4992
Deposit Account	500270
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	74925US_signed_declaration.pdf	79949 dfb26fe6d13c59e47efa53a0fde7233dcb7c93ae	no	3
Warnings:					
Information:					
2		74925US_POA_373b.pdf	268303 1130eedd70f2fcd7e9b9f219072c3f96a482dfcd	yes	7

Multipart Description/PDF files in .zip description

Document Description	Start	End
Power of Attorney	1	2
Assignee showing of ownership per 37 CFR 3.73(b).	3	7

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
Warnings:					
Information:					
3	Preliminary Amendment	74925US_preliminary_amendment.pdf	100765 7ca9eea746f2d25a523e5bff1780a64526f200fc	no	3
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	32123 c996d0aa90d7a4db94441e9ce3f5d8d43ce6fb08	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			481140		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No.: NC74925US-NP

DECLARATION (37 CFR 1.63) FOR UTILITY APPLICATION
USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Motion Prediction in Video Coding

As the below named inventor(s), I/we declare that:

This Declaration is directed to (check all that apply):

☐ The attached application, or

☒ U.S. Application No. 13/344,893 filed on 01-06-2012

which is a 371 National Stage of ________ filed on ________

As amended on ________ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application nand the national or PCT International filing date of the continuation-in-part application.

All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF THE INVENTOR(S)

Inventor one: Kemal UGUR Date: March-16-2012

Signature: ________ Citizen of: TR

Docket No.: NC74925US-NP

All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF THE INVENTOR(S)

Inventor two: Jani LAINEMA

Date: MARCH-16-2012

Signature:

Citizen of: FI

Docket No.: NC74925US-NP

All statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF THE INVENTOR(S)

Inventor three: Antti HALLAPURO Date: March-16-2012

Signature: [signature] Citizen of: FI

PTO/SB/81 (01-06)
Approved for use through 12/31/2008. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY and CORRESPONDENCE ADDRESS INDICATION FORM

Application Number	13/344,893
Filing Date	01-06-2012
First Named Inventor	Kemal UGUR
Title	Motion Prediction in Video Coding
Art Unit	2482
Examiner Name	TBD
Attorney Docket Number	NC74925US-NP

I hereby revoke all previous powers of attorney given in the above-identified application.

I hereby appoint:

☑ Practitioners associated with the Customer Number: 73658

OR

☐ Practitioner(s) named below:

Name	Registration Number

as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith.

Please recognize or change the correspondence address for the above-identified application to:

☑ The address associated with the above-mentioned Customer Number:

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the:

☐ Applicant/Inventor.

☑ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

SIGNATURE of Applicant or Assignee of Record

Signature	/Thomas J. Arria/	Date	April 6, 2012
Name	Thomas J. Arria	Telephone	781-219-8760
Title and Company	Senior IPR Specialist, Nokia Corporation		

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☑ *Total of one forms are submitted.

NOKIA

LIMITED POWER OF ATTORNEY

that we, the undersigned, under the authority granted to each of us to sign jointly on behalf of

NOKIA CORPORATION
Keilalahdentie 4
02150 Espoo
Finland

hereby authorize the following person

Thomas Arria
Nokia Corporation
5 Wayside Road
01803 Burlington
U.S.A.

Nokia Corporation
P.O.Box 226,
FI-00045 NOKIA GROUP, Finland
(Keilalahdentie 4, 02150 ESPOO)

Tel +358 7180 08000
Fax +358 7180 38226

Business Identity Code
0112038-9, Helsinki

in his capacity as Senior IP Specialist, Patenting, to sign alone in the name of Nokia Corporation all the documents that relate to the filing, prosecution and registration of patent applications, as well as post-grant operations relating to patents granted based on such patent applications. Such documents may include without limitation Assignment Deeds for assigning the ownership of an invention to Nokia, Novelty Declarations and Inventorship Declarations.

The rights granted under this Power of Attorney may not be transferred further.

The authority granted by this Power of Attorney shall expire six (6) months from the date of execution.

Notwithstanding the foregoing, the authority granted by this Power of Attorney shall expire when the authorized person's employment with Nokia ends.

This Power of Attorney is duly signed on this day of January 1, 2012.

NOKIA CORPORATION

By:	By:
Name: Harri Honkasalo	Name: Paul Melin
Title: Director,	Title: Vice President,
Legal and Intellectual Property	Legal and Intellectual Property

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Kemal UGUR

Application No./Patent No.: 13/344,893 Filed/Issue Date: 01-06-2012

Entitled: Motion Prediction in Video Coding

Nokia Corporation, a Corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. ☑ the assignee of the entire right, title, and interest; or

2. ☐ an assignee of less than the entire right, title and interest
(The extent (by percentage) of its ownership interest is_________ %)

in the patent application/patent identified above by virtue of either:

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel ____________, Frame __________, or for which a copy thereof is attached.

OR

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: ______________________ To: ______________________
The document was recorded in the United States Patent and Trademark Office at
Reel __________, Frame ___________________, or for which a copy thereof is attached.

2. From: ______________________ To: ______________________
The document was recorded in the United States Patent and Trademark Office at
Reel ______________, Frame ________________, or for which a copy thereof is attached.

3. From: ______________________ To: ______________________
The document was recorded in the United States Patent and Trademark Office at
Reel ______________, Frame ________________, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet.

☑ As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.,* a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Thomas J. Arria/	April 6, 2012
Signature	Date
Thomas J. Arria	781-219-8760
Printed or Typed Name	Telephone Number
Senior IPR Specialist, Nokia Corporation	
Title	

Docket No.: NC74925US-NP

ASSIGNMENT

Title of Invention	Motion Prediction in Video Coding

This Assignment is directed to (check all that apply):

☐ U.S. Provisional No. ____________ filed on ____________

☒ U.S. Application No. 13/344,893 filed on 01-06-2012

☐ which is a 371 National Stage of ____________ filed on ____________

As the below named inventor(s), I/we have invented certain improvements in the patent application for which I/we have filed an application for Letters Patent of the United States of America as identified above;

WHEREAS, I/we authorize the attorney of record to update this document to include Patent Office information as deemed necessary (i.e., filing date, serial number, etc.);

WHEREAS, NOKIA CORPORATION, a corporation organized under the laws of Finland, having its principal office in Espoo, Finland (hereinafter referred to as "ASSIGNEE"), is desirous of acquiring the entire right, title and interest in and under the said invention and the said application, and in and to any and all Letters Patent which shall be granted therefore in the United States of America and in any and all foreign countries;

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, I/we have sold and do hereby sell, assign, transfer and convey unto said ASSIGNEE, its successors, assigns and legal representatives, the entire right, title and interest in and to said invention and application, and in all divisionals, reissues, substitutions, continuations, continuation-in-part and, in any and all Letters Patents of the United States of America and all foreign countries or reissues, reexaminations, or extensions thereof which may be granted therefore or thereon, for the full end of the term for which said Letters Patent may be granted, together with the right to claim the priority of said application in all foreign countries in accordance with the International Convention, the same to be held and enjoyed by said ASSIGNEE, its successors and assigns, as fully and entirely as the same would have been held and enjoyed by me if this assignment and sale had not been made.

I/WE ALSO HEREBY authorize and request the Commissioner of Patents and Trademarks to issue all patents for said invention, or patents resulting therefrom to the said ASSIGNEE of my/our entire right, title and interest.

I/WE FURTHER HEREBY sell and assign to said ASSIGNEE, its successors, assigns and legal representatives the full and exclusive rights, title and interest to the invention disclosed in said application throughout the world, including, without limitation, the right to file applications and obtain patents, utility models, industrial models and designs for said invention in its own name throughout the world including all rights of priority, all rights to publish cautionary notices reserving ownership of said invention and all rights to register said invention in appropriate registries. I/we further agree to execute any and all powers of attorney, applications, assignments, declarations, affidavits, and any other papers in connection therewith necessary to perfect such rights, title and interest in ASSIGNEE, its successors, assigns and legal representatives.

I/WE HEREBY covenant that I/we have not and I/we will not execute any agreement in conflict herewith.

ASSIGNMENT

I/WE HEREBY further covenant, and agree to bind my/our heirs, legal representatives, and assigns, promptly to communicate to said ASSIGNEE or its representatives any facts known to me relating to said invention, to testify in any interference or legal proceedings involving said invention, to execute any additional papers which may be requested to confirm the right of the assignee, its representatives, successors, or assigns to secure patent or similar protection for the said invention in all countries and to vest in the assignee complete title to the said invention and Letters Patent, without further compensation, but at the expense of said ASSIGNEE, its successors, assigns, and other legal representatives.

IN WITNESS WHEREOF, I/we have hereunto set my/our hand and seal on the date indicated below.

Inventor: Kemal UGUR

Date: March 16 - 2012

Signature:

Residence: Tampere, Finland

Witness Signature:

Printed Name: Roope Järvinen

Date: March - 16 - 2012

ASSIGNMENT

IN WITNESS WHEREOF, I/we have hereunto set my/our hand and seal on the date indicated below.

Inventor: Jani LAINEMA Date: MARCH - 16 - 2012

Signature: Residence: Tampere, Finland

Witness Signature:

Printed Name: Roope Järvinen Date: March - 16 - 2012

ASSIGNMENT

IN WITNESS WHEREOF, I/we have hereunto set my/our hand and seal on the date indicated below.

Inventor: Antti HALLAPURO Date: March - 16 - 2012

Signature: [signature] Residence: Tampere, Finland

Witness Signature: [signature]

Printed Name: Roope Järvinen Date: March -16- 2012

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/344,893	01/06/2012	2482	1880	NC74925US-NP	19	5

CONFIRMATION NO. 2120

UPDATED FILING RECEIPT

73658
Nokia, Inc.
Attn: Intellectual Property Rights Docketing
200 South Mathilda Ave
Sunnyvale, CA 94086

OC000000053694668

Date Mailed: 04/17/2012

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Kemal UGUR, Tampere, FINLAND;
Jani LAINEMA, Tampere, FINLAND;
Antti HALLAPURO, Tampere, FINLAND;

Assignment For Published Patent Application

NOKIA CORPORATION, Espoo, FINLAND

Power of Attorney: The patent practitioners associated with Customer Number 73658

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/430,694 01/07/2011

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 01/19/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/344,893**

Projected Publication Date: 07/26/2012

Non-Publication Request: No

Early Publication Request: No

Title

Motion Prediction in Video Coding

Preliminary Class

375

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

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NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Application or Docket Number
13/344,893

APPLICATION AS FILED - PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	380
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	620
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	19 minus 20 =	*			OR	x 60 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	5 minus 3 =	* 2				x 250 =	500
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
			TOTAL			TOTAL	1750

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED - PART II

AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/344,893	01/06/2012	Kemal UGUR	NC74925US-NP

CONFIRMATION NO. 2120

POA ACCEPTANCE LETTER

OC000000053694581

73658
Nokia, Inc.
Attn: Intellectual Property Rights Docketing
200 South Mathilda Ave
Sunnyvale, CA 94086

Date Mailed: 04/17/2012

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 04/07/2012.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/dgela/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13344893
	Filing Date	2012-01-06
	First Named Inventor	Kemal Ugur
	Art Unit	2482
	Examiner Name	TBD
	Attorney Docket Number	NC74925-US-NP

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6512523		2003-01-28	Gross	
	2	6539058		2003-03-25	Pearlstein et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20100086027	A1	2010-04-08	Panchal et al.	
	2	20090257503	A1	2010-10-15	Ye et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2729615	CA	A1	2010-01-07	Kabushiki kaisha toshiba		☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13344893
	Filing Date	2012-01-06
	First Named Inventor	Kemal Ugur
	Art Unit	2482
	Examiner Name	TBD
	Attorney Docket Number	NC74925-US-NP

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	UGUR et al., "High precision bi-directional averaging", Joint CollaborativeTeam on Video Coding (JCT.VC) of ITV-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 4th Meeting, January 20-28, 2011, pp. 1-3.	☐
	2	UGUR et al., "On clipping in bi-directional averaging", Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 5th Meeting, March 16-23, 2011, pp. 1-4.	☐
	3	"Advanced Video Coding for Generic Audiovisual Services", Series H: Audiovisual And Multimedia Systems, Infrastructure of audiovisual services – Coding of moving video, ITU-T Recommendation H.264, November, 2007, 564 pages.	☐
	4	International Search Report and Written Opinion received for corresponding Patent Cooperation Treaty Application No. PCT/IB2012/050089, dated May 09, 2012, 14 pages.	☐

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13344893
	Filing Date	2012-01-06
	First Named Inventor	Kemal Ugur
	Art Unit	2482
	Examiner Name	TBD
	Attorney Docket Number	NC74925-US-NP

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Thomas J. Arria/	Date (YYYY-MM-DD)	2012-06-19
Name/Print	Thomas J. Arria	Registration Number	60223

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	13050801
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	73658
Filer:	Thomas Joseph Arria/Thao Pham
Filer Authorized By:	Thomas Joseph Arria
Attorney Docket Number:	NC74925US-NP
Receipt Date:	19-JUN-2012
Filing Date:	06-JAN-2012
Time Stamp:	14:52:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	NPL_3_Advanced_Video_Coding_For_Generic_Audiovisual_Services_Part.pdf	2529712 ce7f6118cc2e0507da4831729122a3481aa965e5	no	564

Warnings:

Information:

2	Non Patent Literature	NPL_1_High_precision_bi-directional_averaging.PDF	428896 f39ca76f950c07610235b7447906c018d4b3eaeb	no	3
Warnings:					
Information:					
3	Non Patent Literature	NPL_2_Onclipping_in_bi-directional_averaging.PDF	351568 f4fa9650012b02bf7b243adb89fa55c8bea7f19f	no	4
Warnings:					
Information:					
4	Non Patent Literature	NPL_4_PCTIB2012050089_ISR_05_09_2012.pdf	869374 368ff8f8c1c4b1f2138fa7d0acd14e825524b173	no	14
Warnings:					
Information:					
5	Foreign Reference	FOR_1_CA2729615_PUB_01_07_2010.pdf	1038450 dbfc17730ee68e86ac94ab80aaf08aa2dbea7152	no	30
Warnings:					
Information:					
6	Information Disclosure Statement (IDS) Form (SB08)	NC74925_IDS_Form.pdf	612448 aec41375a8305ecdddd002dc9001dd22968bbb2b	no	4
Warnings:					
Information:					
		Total Files Size (in bytes):	5830448		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: Nokia Corporation IPR Department, Ari Aarnio Keilalahdentie 4 FI-02150 Espoo Finland	**PCT** WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43*bis*.1)
	Date of mailing *(day/month/year)* 09-05-2012
Applicant's or agent's file reference NC74925WO	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB2012/050089	06-01-2012	07-01-2011

International Patent Classification (IPC) or both national classification and IPC
See Supplemental Box

Applicant
Nokia Corporation et al

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☒ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will no be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/SE	Date of completion of this opinion	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	09-05-2012	Alexander Lakic Telephone No. + 46 8 782 25 00

Form PCT/ISA/237 (cover sheet) (July 2009)

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: cover sheet

International Patent Classification (IPC)

H04N 7/36 (2006.01)
H04N 7/46 (2006.01)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2012/050089

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:
   - [x] the international application in the language in which it was filed.
   - [ ] a translation of the international application into ______________ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. [ ] This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)
   - [ ] on paper
   - [ ] in electronic form

   b. (time)
   - [ ] in the international application as filed
   - [ ] together with the international application in electronic form
   - [ ] subsequently to this Authority for the purposes of search

4. [ ] In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Form PCT/ISA/237 (Box No. I) (July 2009)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2012/050089

Box No. II Priority

1. ☒ The validity of the priority claim has not been considered because the International Searching Authority does not have in its possession a copy of the earlier application whose priority has been claimed or, where required, a translation of that earlier application. This opinion has nevertheless been established on the assumption that the relevant data (Rules 43*bis*.1 and 64.1) is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43*bis*.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.

3. Additional observations, if necessary:

Form PCT/ISA/237 (Box No. II) (July 2009)

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2012/050089

Box No. V **Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	1-26	YES
	Claims		NO
Inventive step (IS)	Claims		YES
	Claims	1-26	NO
Industrial applicability (IA)	Claims	1-26	YES
	Claims		NO

2. Citations and explanations

The present application relates to a method and an apparatus for video coding/decoding, comprising bi-directional or multi-directional prediction. The above mentioned method and apparatus are aimed at solving problems related to rounding errors, which are present especially when sub-pixel motion vectors are used when performing bi- or multi-directional prediction. The problem is solved by skipping the intermediate rounding steps, or rounding to a precision that is still higher than the input bit-depth, and instead performing the rounding at the last step after the prediction signals are added.

Documents cited in the International Search Report:

D1: US 20100086027 A1
D2: US 20090257503 A1
D3: CA 2729615 A1
D4: US 6512523 B1
D5: US 6539058 B1

D1 and D2 are considered to be the most relevant documents, because D1 discloses methods for performing bi-directional averaging and D2 discloses a method for avoiding rounding errors when interpolating predictive video data.

D3-D5 are considered to represent the state of the art, and are therefore not considered being of particular relevance.

Referring to claims 1, 12 and 23-26:

D1 discloses a method for performing bi-directional averaging, where a block is predicted by adding a first reference block and a second reference block, and then the sum is divided by the number of frames used to predict the predictive video block of the B-frame. The subject matter of claim 1 differs in that the first and second predictive signals have a precision that is higher than the input bit-depth (the "first precision" in claim 1) and that the precision is decreased to said input bit-depth after said first and second signals are added. D1 discloses that the precision is decreased after the

.../...

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: Box No. V

addition (see for example paragraph [0060], equation (1) or paragraph [0062], equation (3)), but is silent about whether the first and second prediction signals are obtained with a higher precision than the input bit-depth.
Due to said difference, the technical effect is that accumulation of intermediate rounding errors are prevented, and also the rounding offset does not have be signaled in the bitstream.
Consequently, with the background of D1, the problem is to provide a modified method, which can cope with rounding errors. The problem as such is well known in the art, and D2 (see paragraphs [0010] and [0098]) discloses a solution to said problem by keeping the highest possible precision through the intermediate steps when calculating the first and the second prediction signals, and rounding is avoided until the very last step. It is also disclosed in D2 (see paragraph [0054]) that the techniques of avoiding intermediate rounding until the very last step, may be applied during inter-coding (including bi-directional prediction). Hence, a person skilled in the art faced with the problem of inaccuracies due to intermediates rounding when calculating the prediction signals, would find a solution in D2. Thus, a person skilled in the art using D1 as a starting point and aiming to solve the problem above would modify the method using the teachings of D2 in order to achieve an equivalent result as that of the method claimed in claim 1. Since both documents relate to video coding involving bi-directional prediction, the combination of what is known from D1 and D2 is considered obvious for a person skilled in the art. Therefore, the subject matter of claim 1 does not involve an inventive step.

The argumentation regarding claim 1 is also valid for claims 12 and 23-26. Hence, the subject matter of claims 12 and 23-26 is not considered to involve an inventive step.

Referring to claims 2-11 and 13-22:

The dependent claims are considered to involve measures or minor details, such as adding rounding offsets or performing right shifting, which are either disclosed in D1-D2 or obvious to a person skilled in the art. Therefore, the subject matter of these claims is not considered to involve an inventive step.

In view of the above, the subject matter of claims 1-26 is novel, but is not considered to involve an inventive step. The subject matter of claims 1-26 has industrial applicability.

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2012/050089

Box No. VI Certain documents cited

1. Certain published documents (Rules 43*bis*.1 and 70.10)

Application No. Patent No.	Publication date (*day/month/year*)	Filing date (*day/month/year*)	Priority date (valid claim) (*day/month/year*)

(P) UGUR K et al. "High precision bi-directional averaging", Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 4th meeting; Daegu 20-28 January, 2011, no. JCTVC-D321, 2011-01-21

(P) UGUR K et al. "On clipping in bi-directional averaging", Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 5th meeting; Geneva, 16-23 March, 2011, no. JCTVC-E242, 2011-03-10

2. Non-written disclosures (Rules 43*bis*.1 and 70.9)

Kind of non-written disclosure	Date of non-written disclosure (*day/month/year*)	Date of written disclosure referring to non-written disclosure (*day/month/year*)

Form PCT/ISA/237 (Box No. VI) (July 2009)

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claim 3 should only refer to claim 2 (instead of claim 1 or 2), because the "first rounding offset" is not mentioned in claim 1.

Claim 14 should only refer to claim 13 (instead of claim 12 or 13), because the "first rounding offset" is not mentioned in claim 12.

In claims 7 and 18, it is stated that the first rounding offset is 2^y, and the decreasing comprises right shifting the combined prediction y+1 bits. However, when considering the description (see page 16) and figure 11 of the application, it is clear that it is the <u>second</u> rounding offset that is 2^y and not the first.

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: Nokia Corporation IPR Department, Ari Aarnio Keilalahdentie 4 FI-02150 Espoo Finland	**PCT** NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION (PCT Rule 44.1) Date of mailing *(day/month/year)* 09-05-2012
Applicant's or agent's file reference NC74925WO	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/IB2012/050089	International filing date *(day/month/year)* 06-01-2012
Applicant Nokia Corporation et al	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statements under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Dyveke Frimodt Telephone No. + 46 8 782 25 00

Form PCT/ISA/220 (July 2010)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference NC74925WO	**FOR FURTHER ACTION** see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/IB2012/050089	International filing date *(day/month/year)* 06-01-2012	(Earliest) Priority Date *(day/month/year)* 07-01-2011
Applicant Nokia Corporation et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed.
      ☐ a translation of the international application into ________________ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.*6bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II).
3. ☐ **Unity of invention is lacking** (See Box No. III).
4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:
5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the **drawings**,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 11
      ☐ as suggested by the applicant.
      ☒ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2012/050089

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data, COMPENDEX, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	UGUR K et al. "High precision bi-directional averaging", Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 4th meeting; Daegu 20-28 January, 2011, no. JCTVC-D321, 2011-01-21; whole document --	1-26
P, X	UGUR K et al. "On clipping in bi-directional averaging", Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 5th meeting; Geneva, 16-23 March, 2011, no. JCTVC-E242, 2011-03-10; whole document --	1-26

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09-05-2012	09-05-2012
Name and mailing address of the ISA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Authorized officer Alexander Lakic Telephone No. + 46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 2009)

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 20100086027 A1 (PANCHAL RAHUL ET AL), 8 April 2010 (2010-04-08); paragraphs [0057]-[0062] --	1-26
Y	US 20090257503 A1 (YE YAN ET AL), 15 October 2009 (2009-10-15); paragraphs [0010], [0054], [0098]-[0102] --	1-26
A	CA 2729615 A1 (CHUJOH TAKESHI ET AL), 7 January 2010 (2010-01-07); whole document --	1-26
A	US 6512523 B1 (GROSS ORNIT), 28 January 2003 (2003-01-28); abstract; column 9, line 26 - line 43; figure 8 --	1-26
A	US 6539058 B1 (PEARLSTEIN LARRY ET AL), 25 March 2003 (2003-03-25); abstract -- --------	1-26

Continuation of: second sheet

International Patent Classification (IPC)

H04N 7/36 (2006.01)
H04N 7/46 (2006.01)

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Use the application number as username. The password is **FKQIRBLGDC**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2012/050089

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			EP	2345255 A1	20/07/2011
			JP	2012505601 A	01/03/2012
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			TW	201031220 A	16/08/2010
			WO	2010042518 A1	15/04/2010
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			EP	2272253 A1	12/01/2011
			JP	2011517239 A	26/05/2011
			KR	20100133005 A	20/12/2010
			TW	201010440 A	01/03/2010
			WO	2009126921 A1	15/10/2009
CA	2729615 A1	07/01/2010	AU	2009264603 A1	07/01/2010
			US	20110090966 A1	21/04/2011
			WO	2010001832 A1	07/01/2010
US	6512523 B1	28/01/2003	NONE		
US	6539058 B1	25/03/2003	NONE		

Form PCT/ISA/210 (patent family annex) (July 2009)

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CA 2729615 A1 2010/01/07

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(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

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(85) Entrée phase nationale/National Entry: 2010/12/29
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(51) Cl.Int./Int.Cl. *H04N 7/32* (2006.01)

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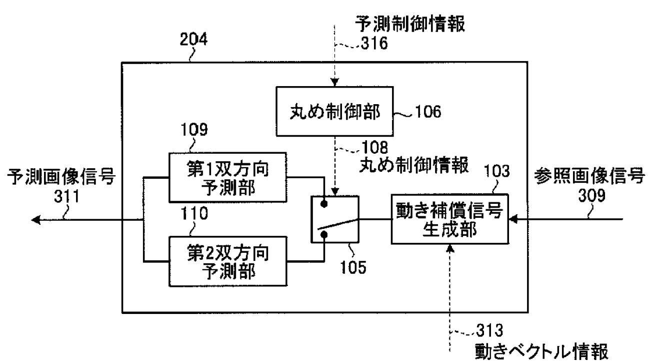
(54) Titre : DISPOSITIF DE PREDICTION/CODAGE D'IMAGE DYNAMIQUE ET DISPOSITIF DE PREDICTION/DECODAGE D'IMAGE DYNAMIQUE
(54) Title: VIDEO PREDICTIVE CODING DEVICE AND VIDEO PREDICTIVE DECODING DEVICE

[図3]



311 PREDICTED IMAGE SIGNAL
316 PREDICTION CONTROL INFORMATION
106 ROUNDING CONTROL UNIT
109 FIRST BIDIRECTIONAL PREDICTION UNIT
110 SECOND BIDIRECTIONAL PREDICTION UNIT
103 MOTION COMPENSATION SIGNAL GENERATION UNIT
309 REFERENCE IMAGE SIGNAL
313 MOTION VECTOR INFORMATION
108 ROUNDING CONTROL INFORMATION

(57) Abrégé/Abstract:
A rounding process upon generation of a predicted image is switched from one to the other depending on whether a decoded image corresponding to an image to be encoded is a reference image of other image to be encoded.

ABSTRACT

In generating a predicted image, rounding is switched according to whether or not a decoded image corresponding to an image to be coded is a reference image for another image to be coded.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A video coding device, comprising:

a motion compensation image signal generator that performs motion compensation using at least one reference image and plural pieces of motion vector information to generate motion compensation image signals for a block to be coded, for which bi-directional prediction is applied, the block being included in blocks that are within a unit of coding being bi-directionally predicted;

a bi-directional predictor that generates a predicted image signal for the block to be coded using the motion compensation image signals; and

a coder that codes a prediction error between an input image signal and the predicted image signal of the block to be coded;

wherein the bi-directional predictor selects a rounding method for each unit of coding if a decoded image signal for the unit of coding is allowed to be used as a reference image for another unit of coding.

2. The video coding device according to claim 1, wherein

the coder codes control information indicating the rounding method.

3. The video coding device according to claim 2, wherein:

(A) if a decoded image signal for the unit of coding is allowed to be used as a reference image for another unit of coding, the coder codes the control information; whereas

(B) if a decoded image signal for the unit of coding is not allowed to be used as a reference image for another unit of coding, the coder does not code the control information.

4. The video coding device according to claim 3, wherein:

the bi-directional predictor performs switching between

(1) a first arithmetic method of dividing a sum of two signals by 2; and

(2) a second arithmetic method of dividing a result of adding 1 to a sum of two signals by 2.

5. A video decoding device, comprising:

a decoder that extracts, from input coded data, plural pieces of motion vector information and prediction error information of a block to be decoded, for which bi-directional prediction has been applied, the block being included in blocks that are within a unit of coding that has been bi-directionally predicted;

a motion compensation image signal generator that generates motion compensation image signals for the block to be decoded using at least one reference image and the plural pieces of motion vector information;

a bi-directional predictor that generates a predicted image signal of the block to be decoded using the motion compensation image signals; and

a reproducer that adds the predicted image signal and the prediction error information to obtain a decoded image signal of the block to be decoded;

wherein the bi-directional predictor selects a rounding method for each unit of coding if a decoded image signal for the unit of coding is allowed to be used as a reference image for another unit of coding.

6. The video decoding device according to claim 5, wherein:

the decoder extracts control information indicating the rounding method from the coded data; and

the bi-directional predictor switches the rounding methods according to the control information.

7. The video decoding device according to claim 6, wherein:

the decoder extracts the control information if the decoded image signal for the unit of coding is allowed to be used as a reference image for another unit of coding; and

the bi-directional predictor switches the rounding methods according to the control information.

8. The video decoding device according to claim 7, wherein:

the bi-directional predictor performs switching between

(1) a first arithmetic method of dividing a sum of two signals by 2; and

(2) a second arithmetic method of dividing a result of adding 1 to a sum of two signals by 2.

DESCRIPTION

VIDEO PREDICTIVE CODING DEVICE AND VIDEO PREDICTIVE DECODING DEVICE

TECHNICAL FIELD

[0001] The present invention relates to a video predictive coding and a video predictive decoding.

BACKGROUND ART

[0002] In H.264/AVC, a so-called B slice, for which bi-directional prediction for generating a predicted value using two reference images is enabled, is also allowed to be used as a reference image for prediction of another slice. It is known that high coding efficiency can be achieved by a hierarchical bi-directional prediction structure in which the reference structures from B slices are arranged hierarchically (Nonpatent Literature 1).

[0003] When a bi-directionally predicted image is referred to, a rounding error is propagated because rounding in a prediction formula to calculate an average value for bi-directional prediction is fixed. Accordingly, the prediction efficiency is decreased.

[0004] In video coding technologies, the problem that the rounding error is propagated is already known in a motion compensation interpolation filter technology and a solution to the problem is proposed (Patent Document 1).

[0005] Patent Document 1: Japanese Patent No. 2998741

[0006] Nonpatent Literature 1: H. Schwarz, D. Marpe and T. Wiegand, Analysis of hierarchical B pictures and MCTF, IEEE International Conference on Multimedia and Expo (ICME '06), Toronto, Ontario, Canada, July 2006

DISCLOSURE OF INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0007] In a conventional bi-directional prediction, a value obtained by a prediction formula is always rounded off using the same method. Therefore, a rounding error is propagated if a bi-directionally predicted image is used as a reference image. As a result, the prediction efficiency is decreased. Such problem was not present in the predictive coding schemes prior to H.264/AVC and in H.264/AVC because a bi-directionally predicted image was not used as a reference image.

[0008] The present invention is made to solve the aforementioned problems. For an image that is bi-directionally predicted and referred to by another image, the rounding method for a value, which is obtained by a prediction formula for the bi-directional prediction, is variably controlled. An object of the present invention is to provide devices for video predictive coding and video predictive decoding that can suppress propagation of a rounding error and improve the prediction efficiency.

MEANS FOR SOLVING PROBLEM

[0009] To achieve the aforementioned object, a moving image predictive coding device according to an aspect of the present invention includes: a motion compensation image signal generator that performs motion compensation using at least one reference image and plural pieces of motion vector information to generate motion compensation image signals for a block to be coded, for which bi-directional prediction is applied, the block being included in blocks that are within a unit of coding being bi-directionally predicted; a bi-directional predictor that generates a predicted image signal for the block to be coded using the motion compensation image signals; and a coder that codes a prediction error between an input image signal and the predicted image signal of the block to be coded, wherein the bi-directional predictor selects a rounding method for each unit of coding if a decoded image signal for the unit of coding is allowed to be used as a reference image for another unit of coding.

[0010] In addition, a moving image predictive decoding device according to another aspect of the present invention includes: a decoder that extracts, from input coded data, plural pieces of motion vector information and prediction error information of a block to be decoded, for which bi-directional prediction has been applied, the block being included in blocks that are within a unit of coding that has been bi-directionally predicted; a motion compensation image signal generator that generates motion compensation image signals for the block to be decoded using at least one reference image and the plural pieces of motion vector information; a bi-directional predictor that generates a predicted image signal of the block to be decoded using the motion compensation image signals; and

a reproducer that adds the predicted image signal and the prediction error information to obtain a decoded image signal of the block to be decoded, wherein the bi-directional predictor selects a rounding method for each unit of coding if a decoded image signal for the unit of coding is allowed to be used as a reference image for another unit of coding.

EFFECT OF THE INVENTION

[0011] Since the propagation of the rounding error is suppressed, the coding efficiency is improved.

BRIEF DESCRIPTION OF DRAWINGS

[0012] FIG. 1 is a block diagram of a moving image predictive coding device.

FIG. 2 is a block diagram of a predicted image generator.

FIG. 3 is a block diagram of a bi-directional predictor.

FIG. 4 is a diagram illustrating a syntax of a rounding control signal.

FIG. 5 is a block diagram of a moving image predictive decoding device.

FIG. 6 is a block diagram of a frame memory.

BEST MODES FOR CARRYING OUT THE INVENTION

[0013] First Embodiment

FIG. 1 is a block diagram of a video predictive coding device 300 according to a first embodiment. The video predictive coding device 300 includes a subtractor 302, a transform/quantizer 303, an inverse quantizer/inverse transform 304, an entropy coder 305, an adder 306, a frame memory 308, a predicted image generator 310, a motion vector searcher 312, and a coding controller 314. The video predictive coding device 300 generates coded data 315 from an input video signal 301.

[0014] The input video signal 301 is input to the video predictive coding device 300. Each frame of the input video signal 301 is divided into plural blocks to be coded. The predicted image generator 310 generates a predicted image signal 311 of a block to be coded. The subtractor 302 determines the difference between the predicted image signal 311 of a block to be coded and the input video signal 301 of the block to be coded to generate a prediction error signal of the block to be coded.

[0015] The transform/quantizer 303 orthogonally transforms the prediction error signal to obtain an orthogonal transform coefficient, and quantizes the orthogonal transform coefficient to obtain quantized orthogonal transform coefficient information. The orthogonal transform may be a discrete cosine transform, for example. The quantized orthogonal transform coefficient information is input to the entropy coder 305 and the inverse quantizer/inverse transform 304.

[0016] The inverse quantizer/inverse transform 304 processes the quantized orthogonal transform coefficient information inversely to the processing of the transform/quantizer 303. Specifically, the inverse quantizer/inverse transform 304 inversely quantizes and inversely orthogonally transforms the quantized orthogonal transform coefficient information to reproduce the prediction error signal. The adder 306 adds the locally decoded prediction error signal and the predicted image signal 311 to generate a decoded image signal 307. The decoded image signal 307 is input to the frame memory 308.

[0017] The frame memory 308 filters the decoded image signal 307. The frame memory 308 determines whether to store the filtered decoded image signal 307 based on prediction control information 316. The decoded image signal 307 stored in the frame memory 308 is for use as a reference image signal 309 to be input to the predicted image generator 310.

[0018] The reference image signal 309 is input to the predicted image generator 310 and the motion vector searcher 312. The motion vector searcher 312 generates motion vector information 313 by using the input video signal 301 and the reference image signal 309. The motion vector information 313 is input to the predicted image generator 310 and the entropy coder 305. The predicted image generator 310 generates the predicted image signal 311 by using the reference image signal 309, the prediction control information 316 and the motion vector information 313.

[0019] The coding controller 314 controls the transform/quantizer 303, the predicted image generator 310 and the frame memory 308. The prediction control information 316 generated by the coding controller 314 is input to the predicted image generator 310, the frame memory 308, and the entropy coder 305. The entropy coder 305 entropy-codes coding information including the quantized orthogonal transform coefficient information from the transform/quantizer 303, the prediction control information 316 from the coding controller 314 and the motion vector information 313 from the motion vector searcher 312, and generates the coded data 315 according to a predetermined syntax.

[0020] FIG. 2 is a block diagram of the predicted image generator 310. The predicted image generator 310 includes a switch 203, a bi-directional predictor 204, a uni-directional predictor 205, and an intra predictor 206. The predicted image generator 310 generates the predicted image signal 311 from the reference image signal 309 according to the prediction control information 316 and the motion vector information 313.

[0021] The switch 203 performs switching between the bi-directional predictor 204, the uni-directional predictor 205, and the intra predictor 206. The reference image signal 309 is input to one of the bi-directional predictor 204, the uni-directional predictor 205 and the intra predictor 206 that is selected by the switch 203.

[0022] Each of the bi-directional predictor 204, the uni-directional predictor 205 and the intra predictor 206 generates the predicted image signal 311 from the reference image signal 309. The bi-directional predictor 204 generates the predicted image signal 311 by performing by-directional prediction using the reference image signals 309 of plural reference frames and plural pieces of motion vector information 313. The bi-directional predictor 204 may refer to different regions of the same reference frame according to plural motion vectors.

[0023] The uni-directional predictor 205 generates the predicted image signal 311 by using the reference image signal 309 and the motion vector information 313 from a single reference frame. The intra predictor 206 generates the predicted image signal 311 by using an in-frame reference image signal 309.

[0024] FIG. 3 is a block diagram of the bi-directional predictor 204. The bi-directional predictor 204 includes a motion compensation signal generator 103, a switch 105, a rounding controller 106, a first bi-directional predictor 109, and a second bi-directional predictor 110. The bi-directional predictor 204 generates the predicted image signal 311 by using the reference image signal 309, the prediction control information 316 and the motion vector information 313.

[0025] The motion compensation signal generator 103 generates a motion compensation signal by using the motion vector information 313 and the reference image signal 309. The switch 105 performs switching between the first bi-directional predictor 109 and the second bi-directional predictor 110 according to rounding control information 108. The rounding control information 108 is information that indicates the rounding as an arithmetic method, and designates either one of the first bi-directional predictor 109 and the second bi-directional predictor 110. The motion compensation signal is input to one of the first bi-directional predictor 109 and the second bi-directional predictor 110 to which it is switched. The predicted image signal 311 is generated from the motion compensation signal using the first bi-directional predictor 109 or the second bi-directional predictor 110.

[0026] The motion compensation signal generator 103 generates two motion compensation image signals MC_{L0} and MC_{L1} by using the reference image signal 309 from the frame memory 308 and the motion vector information 313 from the motion vector searcher 312.

[0027] The rounding controller 106 determines whether or not a decoded image signal that corresponds to the input image signal is to be stored in the frame memory 308 as a reference image signal, wherein the input image signal is a signal that is used with a predicted image signal, which is to be generated, to obtain a prediction difference signal. Specifically, the rounding controller 106 determines whether or not the decoded image signal obtained by orthogonally transforming, quantizing, inversely quantizing, inversely orthogonally transforming and motion compensating the prediction difference signal, which is obtained between the predicted image signal to be generated and the input image signal, is to be stored in the frame memory 308 as a reference image signal. The determination is made based on the prediction control information 316. For example, a Stored B-picture in H.264/AVC is allowed to be used as a reference image. The Stored B-picture is stored in the frame memory 308 as the reference image signal. It is also possible to know that the decoded image signal may be used as a reference image signal based on the prediction control information 316. Thus, the prediction control information 316 is information indicating whether or not an image can be used as the reference image signal.

[0028] The rounding controller 106 selects the first bi-directional predictor 109 if the decoded image signal is allowed to be used as a reference image signal for another image to be coded, and selects the second bi-directional predictor 110 if the decoded image signal is not allowed to be used as a reference image signal for another image to be coded.

[0029] The first bi-directional predictor 109 and the second bi-directional predictor 110 generate the predicted image signal 311 from the motion compensated image signals

MC_{L0} and MC_{L1}. It should be noted that the first bi-directional predictor 109 and the second bi-directional predictor 110 perform integer arithmetic operations.

[0030] The first bi-directional predictor 109 and the second bi-directional predictor 110 obtain predicted images by arithmetic operations according to formula (1) and formula (2), respectively. The first bi-directional predictor 109 generates a predicted image signal according to formula (1), and the second bi-directional predictor 110 generates a predicted image signal according to formula (2).

$$\mathrm{Pred} = (MC_{L0} + MC_{L1}) >> 1 \qquad (1)$$

$$\mathrm{Pred} = (MC_{L0} + MC_{L1} + 1) >> 1 \qquad (2)$$

Formulae (1) and (2) are both mathematical formulae expressing the arithmetic operations to generate predicted image signals Pred from the motion compensated image signals MC_{L0} and MC_{L1} generated by the motion compensation signal generator 103. The symbol ">>" in formulae (1) and (2) means an arithmetic right shift.

[0031] Normally, in a hierarchical bi-directional prediction structure or the like in which a bi-directional prediction being referred to is used, the number of B slices that are referred to is the same as that of B slices that are not referred to. Therefore, when the first bi-directional predictor 109 or the second bi-directional predictor 110 is selected based on the prediction control information 316, the rounding error is balanced out.

[0032] In this embodiment, a case in which the first bi-directional predictor 109 uses formula (1) while the second bi-directional predictor 110 uses formula (2) is described. By changing the rounding between a case where the decoded image signal is allowed to be used as a reference image and a case where the decoded image signal is not allowed to be used as a reference image, the propagation of the rounding error can be suppressed. As a result, the prediction efficiency is improved, and thus the coding efficiency is improved.

[0033] Since the rounding controller 106 can suppress the propagation of the rounding error by changing the rounding, the configuration may alternatively be such that the first bi-directional predictor 109 uses formula (2) while the second bi-directional predictor 110 uses formula (1), for example.

[0034] Second Embodiment

A second embodiment will be described focusing on the difference thereof from the first embodiment. In the first embodiment, the rounding controller 106 determines the rounding control information 108 indicating the rounding based on the prediction control information 316. In this embodiment, the rounding control information 108 is explicitly coded in a certain coding unit such as in frame units or in slice units.

[0035] FIG. 4 illustrates an example of a syntax used when the rounding control information 108 is explicitly coded using entropy coding. The prediction control information 316 is information indicating whether or not the decoded image signal in a certain coding unit, such as in frame units or in slice units, is allowed to be used as a reference image signal for another image to be coded for generating a predicted image. If the coding unit is allowed to be used as the reference image signal, the rounding control information is coded and sent, and otherwise, the rounding control information is not coded and is not sent.

[0036] Third Embodiment

A third embodiment will be described focusing on the difference thereof from the first and second embodiments.

In this embodiment, the first bi-directional predictor 109 uses formula (3) and the second bi-directional predictor 110 uses formula (4). Formula (3) represents an arithmetic operation of rounding to the nearest even (RN), and formula (4) represents an arithmetic operation of rounding to the nearest odd.

$$Pred = (((MC_{L0} + MC_{L1})\ \&\ 3) == 3)\ ?\ (MC_{L0} + MC_{L1} + 1) >> 1 : (MC_{L0} + MC_{L1}) >> 1 \quad (3)$$

$$Pred = (((MC_{L0} + MC_{L1})\ \&\ 3) == 1)\ ?\ (MC_{L0} + MC_{L1} + 1) >> 1 : (MC_{L0} + MC_{L1}) >> 1 \quad (4)$$

[0037] In formula (3), the rounding is changed according to a value of the lower two bits of the sum of MC_{L0} and MC_{L1}. If the value of the lower two bits is 3, an operation of adding 1 and then dividing by 2 is performed, and otherwise, an operation of dividing by 2 is performed without any addition. Formula (3) corresponds to a rounding to the nearest even of an integer arithmetic operation.

[0038] In formula (4), the rounding is changed according to a value of the lower two bits of the sum of MC_{L0} and MC_{L1}. If the value of the lower two bits is 1, an operation of adding 1 and then dividing by 2 is performed, and otherwise, an operation of dividing by 2 is performed without any addition. Formula (4) corresponds to a rounding to the nearest odd of an integer arithmetic operation.

[0039] The configuration may alternatively be such that the first bi-directional predictor 109 uses formula (4) while the second bi-directional predictor 110 uses formula (3).

[0040] Fourth Embodiment

A fourth embodiment will be described focusing on the difference thereof from the first to third embodiments. In this embodiment, the first bi-directional predictor 109 uses formula (5). In this embodiment, a stochastic rounding in which a pseudo-random number is generated and an offset value R is used is performed.

$$\mathrm{Pred} = (MC_{L0} + MC_{L1} + R) >> 1 \qquad (5)$$

[0041] In this embodiment, the video predictive coding device 300 and a video predictive decoding device, which will be described later, use a pseudo-random number having the same seed. In this embodiment, a pseudo-random number which is generated in a manner that 0 and 1 are generated in a ratio of 3:1 is used.

[0042] It should be noted that as long as 0 and 1 are generated in a ratio of about 3:1, a random number does not have to be used. For example, a method of generating a periodic or regular sequence may be used. Alternatively, other information in the coded data such as a value of the lower two bits of information indicating the number of frames may be used.

[0043] Fifth Embodiment

A fifth embodiment will be described focusing on the difference thereof from the first to the fourth embodiments. In this embodiment, the first bi-directional predictor 109 uses formula (6).

$$\mathrm{Pred} = (((MC_{L0} + MC_{L1})\ \&\ 1) == 1)\ ?\ (MC_{L0} + MC_{L1} + R) >> 1 : (MC_{L0} + MC_{L1}) >> 1 \qquad (6)$$

In formula (6), the rounding is changed according to a value of the lower one bit of the sum of MC_{L0} and MC_{L1}. If the value of the lower one bit is 1, an operation of adding an offset value R of a pseudo-random number and then dividing by 2 is performed, and otherwise, an operation of dividing by 2 is performed without any addition. That is, the stochastic rounding is performed only when the sum of MC_{L0} and MC_{L1} is an odd in formula (6).

[0044] In this case, the video predictive coding device 300 and the video predictive decoding device, which will be described later, use a pseudo-random number that has the same seed and that is generated in a manner that 0 and 1 are generated in a ratio of 1:1 as the offset value R. As for the pseudo-random number, a random number does not have to be used as long as 0 and 1 are generated in a ratio of about 1:1, and a method of generating a periodic or regular sequence may alternatively be used. Alternatively, other information in the coded data such as a value of the least significant bit of information indicating the number of frames may be used.

[0045] Sixth Embodiment

A sixth embodiment will be described focusing on the difference thereof from the first to the fifth embodiments. In this embodiment, the first bi-directional predictor 109 uses formula (7) and the second bi-directional predictor 110 uses formula (8).

$$Pred = (W_0 \times MC_{L0} + W_1 \times MC_{L1} + 2^L) >> (L + 1) + (O_0 + O_1 + 1) >> 1 \quad (7)$$

$$Pred = (W_0 \times MC_{L0} + W_1 \times MC_{L1} + 2^L - 1) >> (L + 1) + (O_0 + O_1) >> 1 \quad (8)$$

In formulae (7) and (8), W_0 and W_1 represent weighting factors and O_0 and O_1 represent offset factors.

[0046] Formulae (7) and (8) represent weighted bi-directional prediction. In the first term of formula (7), an operation of adding 2^L and then dividing by 2^{L+1} is performed. In formula (7), a fraction equal to or larger than 1/2 is rounded up and a fraction smaller than 1/2 is rounded down. That is, the rounding corresponding to rounding 1 to 4 down and 5 to 9 up in the case of a decimal number is performed. In the first term of formula (8), an operation of adding (2^L-1) and then dividing by 2^{L+1} is performed. In formula (8), a fraction larger than 1/2 is rounded up and a fraction equal to or smaller than 1/2 is rounded down. That is, the rounding corresponding to rounding 1 to 5 down and 6 to 9 up in the case of a decimal number is performed. In the weighted bi-directional prediction according to H.264/AVC, the rounding corresponding to rounding 1 to 4 down and 5 to 9 up is always used. According to this embodiment, since it is switched between formulae (7) and (8), the rounding error is less likely to be propagated.

[0047] The rounding to the nearest even and the rounding to the nearest odd as in formulae (3) and (4) or the stochastic rounding as in formulae (5) and (6) may be combined with the prediction formulae of this embodiment.

[0048] The configuration may alternatively be such that the first bi-directional predictor 109 uses formula (8) while the second bi-directional predictor 110 uses formula (7).

[0049] Seventh Embodiment

FIG. 5 is a block diagram of a video predictive decoding device 400 associated with the video predictive coding device 300 of the first to sixth embodiments. The video predictive decoding device 400 includes an entropy decoder 402, an inverse quantizer/inverse transform 403, an adder 404, a frame memory 406 and a predicted image generator 409. The video predictive decoding device 400 generates a display video signal 407 from coded data 401.

[0050] The entropy decoder 402 entropy-decodes the coded data 401 according to a predetermined syntax. The entropy decoder 402 obtains quantized orthogonal transform coefficient information, prediction control information 411 and motion vector information 412. The decoded quantized orthogonal transform coefficient information is input to the inverse quantizer/inverse transform 403. The decoded prediction control information 411 and the decoded motion vector information 412 are input to the predicted image generator 409. If an image to be decoded is allowed to be used as a reference image for another image to be decoded, the coded data 401 includes rounding control information. In such case, the entropy decoder 402 also extracts the rounding control information by decoding the coded data 401.

[0051] The inverse quantizer/inverse transform 403 performs inverse quantization and inverse orthogonal transform to reproduce a prediction error signal. The adder 404 adds the prediction error signal and a predicted image signal 410 to generate a decoded image signal 405.

[0052] The decoded image signal 405 is input to the frame memory 406. The frame memory 406 filters the decoded image signal 405 and outputs the resulting signal as the display video signal 407. The frame memory 406 determines whether to store the filtered decoded image signal 405 based on the prediction control information 411. The stored decoded image signal 405 is input to the predicted image generator 409 as a reference image signal 408.

[0053] The predicted image generator 409 generates the predicted image signal 410 by using the reference image signal 408, the prediction control information 411 and the motion vector information 412. The configuration of the predicted image generator 409 is the same as that of the predicted image generator 310 of the video predictive coding device 300 described with reference to FIGS. 2 and 3. Specifically, the predicted image generator 409 obtains a predicted image by using the operation of either formula (1) or formula (2) in the same manner as the predicted image generator 310. If the rounding control information is obtained from the coded data 401, the predicted image generator 409 further uses the rounding control information to generate the predicted image signal 410.

[0054] FIG. 6 is a block diagram of the frame memory 406. The configuration of the frame memory 308 shown in FIG. 1 is the same as that of the frame memory 406 shown in FIG. 6. The frame memory 406 includes a loop filter 503, a switch 504 and a reference image buffer 506. The frame memory 406 uses the prediction control information 411 and the decoded image signal 405 to generate the reference image signal 408 and the display video signal 407. The loop filter 503 applies a deblocking filter or an image restoration filter to the decoded image signal 405.

[0055] The switch 504 performs switching between storing and not storing the decoded image signal, to which the loop filter 503 has been applied, in the reference image buffer 506 based on the prediction control information 411. If the decoded image signal is allowed to be used as the reference image signal, the decoded image signal is input to the reference image buffer 506. If the decoded image signal is not allowed to be used as the reference image signal, the decoded image signal is not input to the reference image buffer 506.

[0056] In the case where the frame memory 406 is arranged on the side of the video predictive decoding device, the decoded image signal, to which the loop filter 503 has been applied, is output as the display video signal 407 both when it is input to the reference image buffer 506 and when it is not input to the reference image buffer 506.

[0057] Eighth Embodiment

An eighth embodiment will be described focusing on the difference thereof from the first to the seventh embodiments. In this embodiment, the rounding controller 106 performs switching between the first bi-directional predictor 109 and the second bi-directional predictor 110 when a decoded image signal corresponding to an input image signal is used as a reference image signal. In this embodiment, the rounding controller 106 selects the second bi-directional predictor 110 if a decoded image signal corresponding to an input image signal is not used as a reference image signal. Thus, when a decoded image signal corresponding to an input image signal is used as a reference image signal, the rounding controller 106 switches plural rounding methods while performing bi-directional prediction. The rounding may be switched in a round-robin fashion or randomly, for example.

[0058] The video predictive coding device explicitly entropy-codes the rounding control information indicating the selected rounding. The video predictive decoding device switches the rounding according to the rounding control information extracted from the coded data.

[0059] Incidentally, the rounding control information may be coded implicitly. The rounding may be switched based on other information in the coded data such as a value of the least significant bit of information indicating the number of frames.

[0060] The video predictive coding device and the video predictive decoding device can also be implemented by using a general-purpose computer as basic hardware. Specifically, the video predictive coding device and the video predictive decoding device can be implemented by making a processor installed in the computer execute a program. In such case, the video predictive coding device or the video predictive decoding device may be implemented by installing the program in the computer in advance, or by storing the program in a storage medium such as a CD-ROM or distributing the program via a network and installing the program in the computer as necessary. Alternatively, the video predictive coding device and the video predictive decoding device can be implemented by appropriately utilizing storage media such as a memory, a hard disk or an optical disc, provided in or externally to the computer.

[0061] The present invention is not limited to the embodiments presented above, but may be embodied with various modified components in implementation thereof without departing from the scope of the present invention. Further, the present invention can be embodied in various forms by appropriately combining plural components disclosed in the embodiments. For example, some of the components presented in the embodiments may be omitted. Further, some components in different embodiments may be appropriately combined.

EXPLANATIONS OF LETTERS OR NUMERALS

[0062] 103 Motion compensation signal generator

105 Switch

106 Rounding controller

109 First bi-directional predictor

110 Second bi-directional predictor

203 Switch

204 Bi-directional predictor

205 Uni-directional predictor

206 Intra predictor

300 Video predictive coding device

302 Subtractor

303 Transform/quantizer

304 Inverse quantizer/inverse transform

305 Entropy coder

306 Adder

308 Frame memory

310 Predicted image generator

312 Motion vector searcher

314 Coding controller

400 Video predictive decoding device

402 Entropy decoder

403 Inverse quantizer/inverse transform

404 Adder

406 Frame memory

409 Predicted image generator

FIG.1

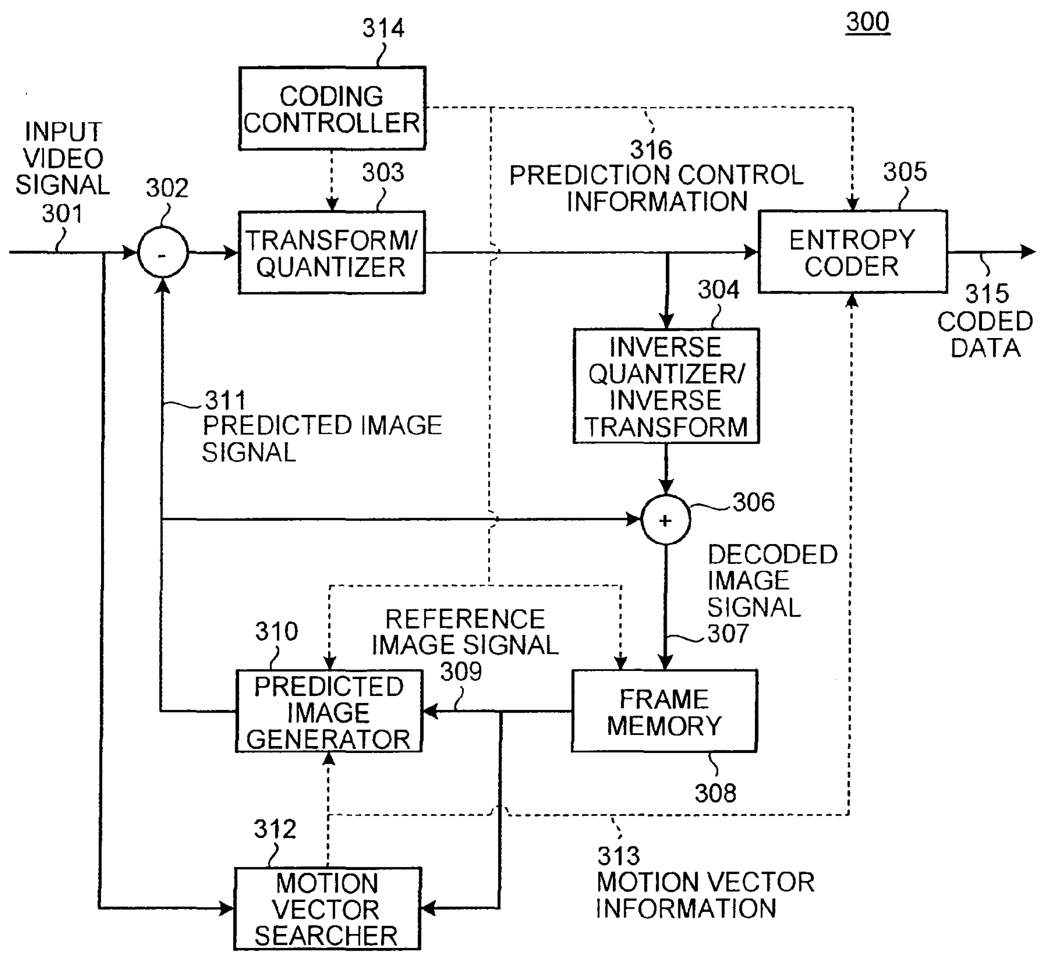

300
314
CODING CONTROLLER
INPUT VIDEO SIGNAL 301
302
303
TRANSFORM/ QUANTIZER
316 PREDICTION CONTROL INFORMATION
305
ENTROPY CODER
315 CODED DATA
304
INVERSE QUANTIZER/ INVERSE TRANSFORM
311 PREDICTED IMAGE SIGNAL
306
DECODED IMAGE SIGNAL 307
REFERENCE IMAGE SIGNAL
310
309
PREDICTED IMAGE GENERATOR
FRAME MEMORY
308
312
MOTION VECTOR SEARCHER
313 MOTION VECTOR INFORMATION

FIG.2

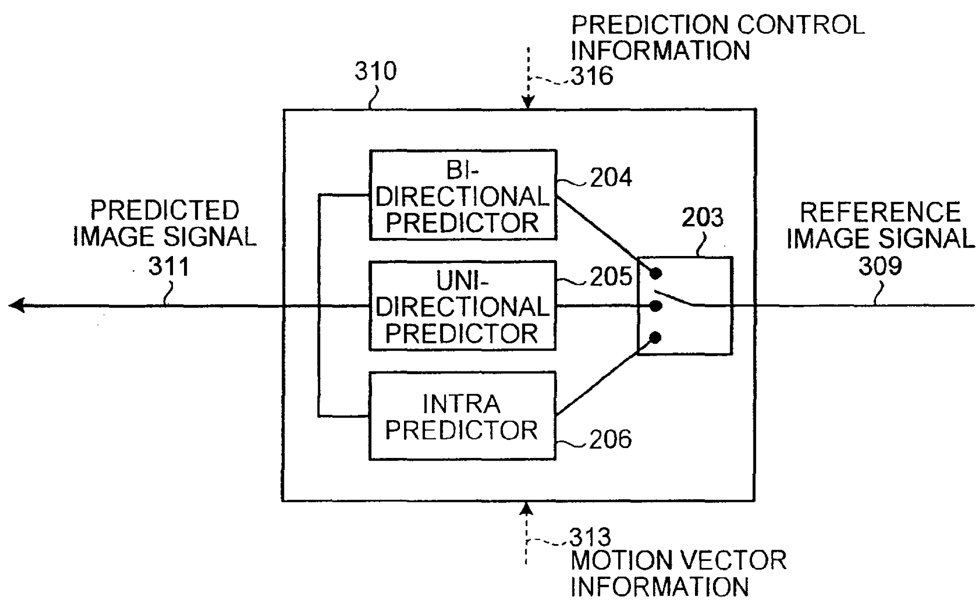

PREDICTION CONTROL
INFORMATION
316
310
BI-
DIRECTIONAL
PREDICTOR
204
UNI-
DIRECTIONAL
PREDICTOR
205
INTRA
PREDICTOR
206
203
PREDICTED
IMAGE SIGNAL
311
REFERENCE
IMAGE SIGNAL
309
313
MOTION VECTOR
INFORMATION

FIG.3

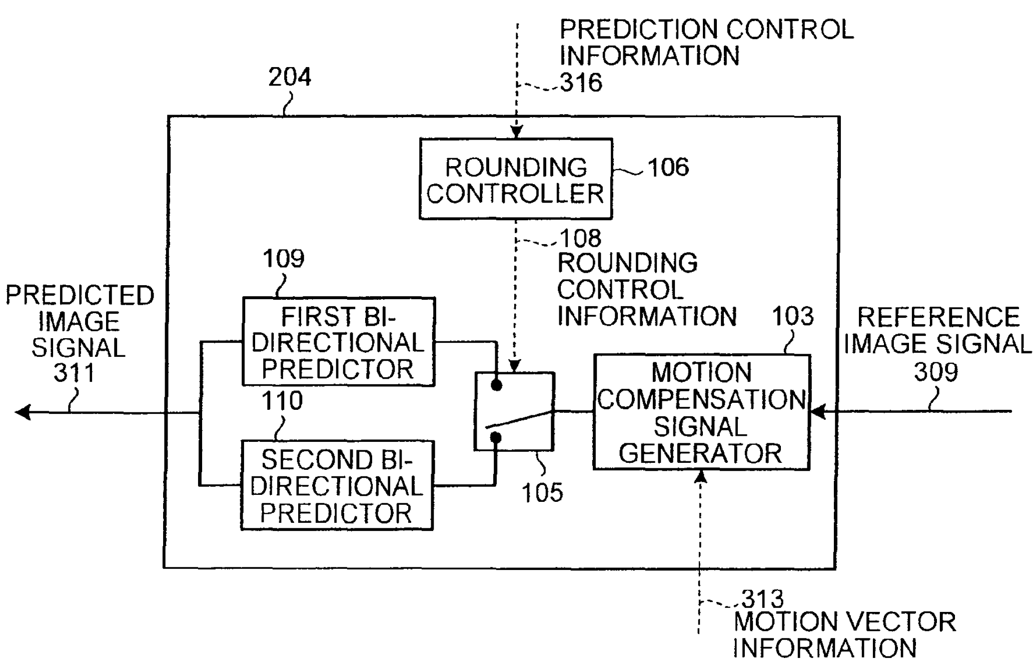

PREDICTION CONTROL
INFORMATION
316
204
ROUNDING
CONTROLLER
106
108
ROUNDING
CONTROL
INFORMATION
109
FIRST BI-
DIRECTIONAL
PREDICTOR
110
SECOND BI-
DIRECTIONAL
PREDICTOR
105
103
MOTION
COMPENSATION
SIGNAL
GENERATOR
PREDICTED
IMAGE
SIGNAL
311
REFERENCE
IMAGE SIGNAL
309
313
MOTION VECTOR
INFORMATION

FIG.4

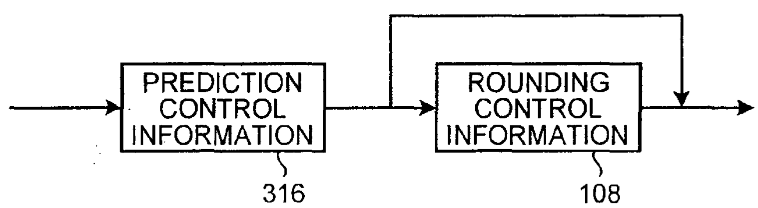

PREDICTION CONTROL INFORMATION
ROUNDING CONTROL INFORMATION
316
108

FIG.5

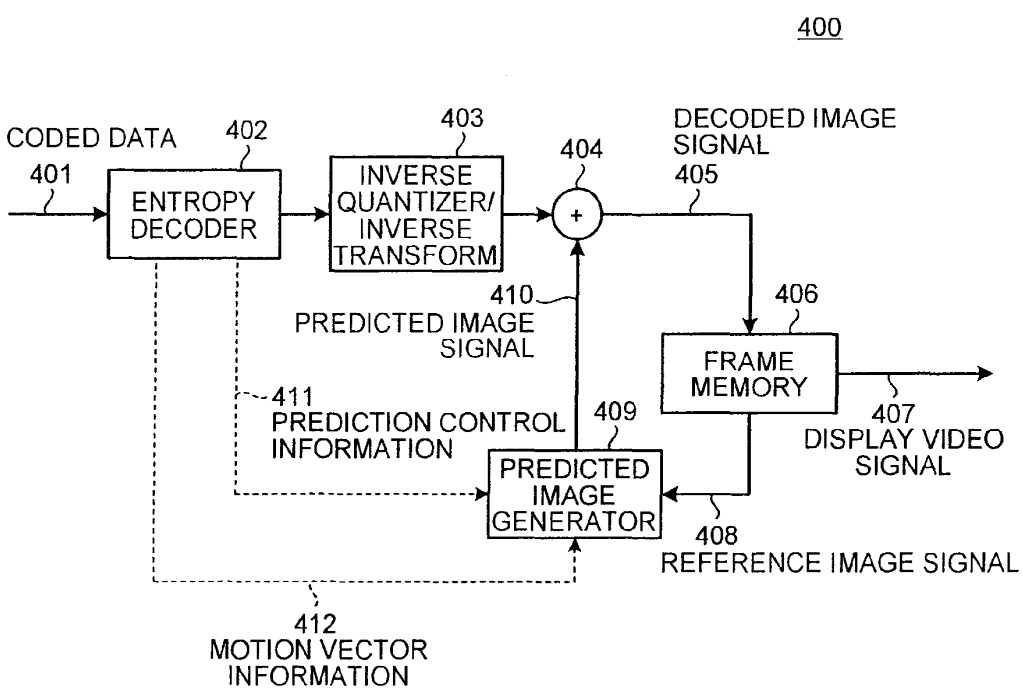
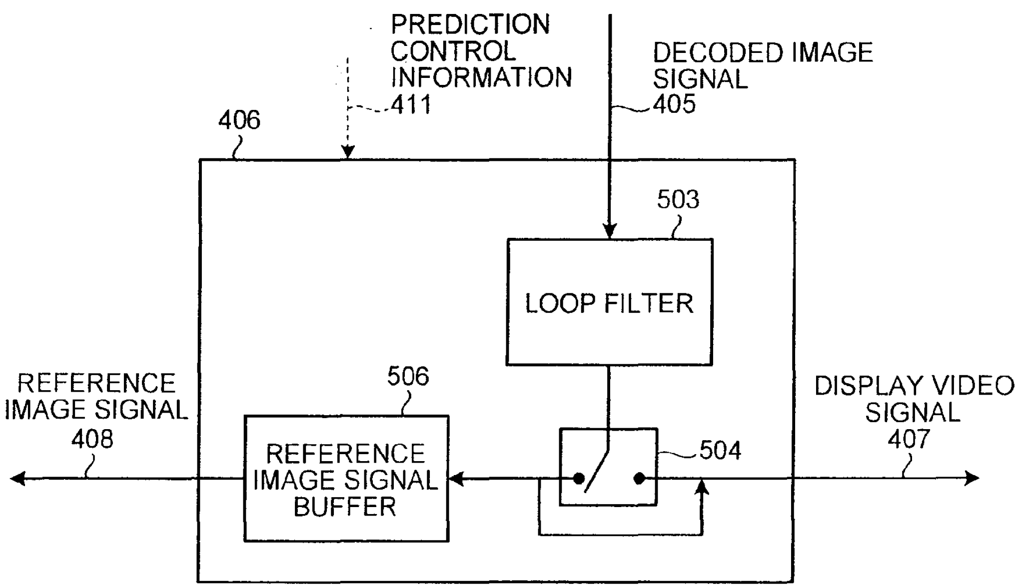
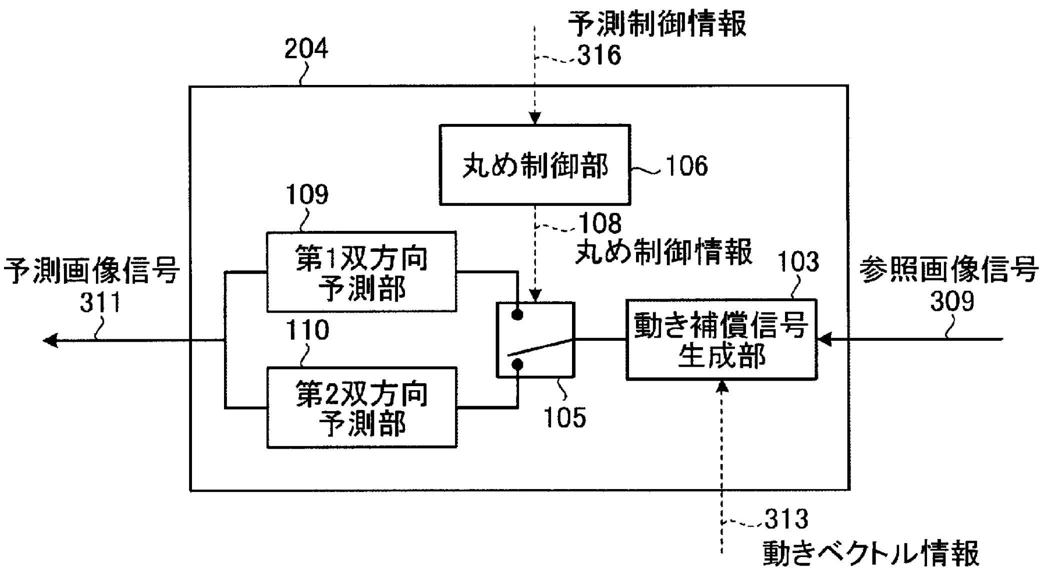

400
CODED DATA
401
402
ENTROPY DECODER
403
INVERSE QUANTIZER/ INVERSE TRANSFORM
404
+
DECODED IMAGE SIGNAL
405
406
FRAME MEMORY
407
DISPLAY VIDEO SIGNAL
410
PREDICTED IMAGE SIGNAL
411
PREDICTION CONTROL INFORMATION
409
PREDICTED IMAGE GENERATOR
408
REFERENCE IMAGE SIGNAL
412
MOTION VECTOR INFORMATION

FIG.6


PREDICTION
CONTROL
INFORMATION
411
DECODED IMAGE
SIGNAL
405
406
503
LOOP FILTER
REFERENCE
IMAGE SIGNAL
408
506
REFERENCE
IMAGE SIGNAL
BUFFER
504
DISPLAY VIDEO
SIGNAL
407

[図3]



311 PREDICTED IMAGE SIGNAL
316 PREDICTION CONTROL INFORMATION
106 ROUNDING CONTROL UNIT
109 FIRST BIDIRECTIONAL PREDICTION UNIT
110 SECOND BIDIRECTIONAL PREDICTION UNIT
103 MOTION COMPENSATION SIGNAL GENERATION UNIT
309 REFERENCE IMAGE SIGNAL
313 MOTION VECTOR INFORMATION
108 ROUNDING CONTROL INFORMATION

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BARAZESH, ELLYAR Y	
ART UNIT	**PAPER NUMBER**
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07/16/2014	ELECTRONIC

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The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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sunny.oh@nokia.com

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No. 13/344,893	Applicant(s) UGUR ET AL.	
	Examiner ELLYAR Y. BARAZESH	Art Unit 2483	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

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- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *06 January 2012*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-19* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-19* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

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Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *06 January 2012* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date *06/19/2012*.

3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

1. This Office Action is sent in response to Applicant's Communication received 06 January 2012 for application number 13/344893.

2. Claims 1-19 are presented for examination.

Priority

3. Applicant's claim for the benefit of a prior-filed application under 35 U.S.C. 119(e) or under 35 U.S.C. 120, 121, or 365(c) is acknowledged.

Information Disclosure Statement

4. The information disclosure statement (IDS) was submitted on 19 June 2012. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Claim Objections

5. **Claims 5 and 9** are objected to because of the following informalities:

6. In Claim 5, line 1, "the method according to any of the claims 1" should apparently be -- the method according to claim 1 --.

7. In Claim 9, line 1, "An apparatus comprises" should apparently be -- An apparatus comprising --.

Appropriate correction is required.

Claim Rejections - 35 USC § 101

8. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

9. **Claim 17** is rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.

10. **Claim 17** recites an embodiment of the applicants' invention directed towards a "computer readable storage medium stored with code thereon." It is noted, however, the recitation of the "computer readable storage medium" in the specification is not exclusory with respect to non-statutory medium types as no specific and limiting definition of "computer readable storage medium" is provided. Thus, under the broadest reasonable interpretation, the full claim scope of "computer readable storage medium" would include non-statutory mediums such as carrier waves.

As per the USPTO notice signed by director David Kappos on 1/26/2010: "The United States Patent and Trademark Office (USPTO) is obliged to give claims their broadest reasonable interpretation consistent with the specification during proceedings before the USPTO. See In re Zletz, 893 F.2d 319(Fed. Cir. 1989) (during patent examination the pending claims must be interpreted as broadly as their terms reasonably allow). The broadest reasonable interpretation of a claim drawn to a computer readable medium (also called machine readable medium and other such variations such as memory units) typically covers forms of non-transitory tangible media and transitory propagating signals per se in view of the ordinary and customary meaning of computer readable media, particularly when the specification is silent. See MPEP 2111.01. When the broadest reasonable interpretation of a claim covers a signal per se, the claim must be rejected under 35 U.S.C. 101 as covering non-statutory subject matter. See In re Nuijten, 500 F.3d 1346, 1356-57 (Fed. Cir. 2007) (transitory embodiments are not directed to statutory subject matter) and Interim Examination Instructions for Evaluating Subject Matter Eligibility Under 35 U.S.C.j101, Aug. 24,2009; p. 2."

The claim as a whole is directed to signal-based mediums. A signal does not fall within one of the four statutory categories of invention *(i.e., process, machine, manufacture, or composition of matter)* because it is an ephemeral, transient signal and thus is non-statutory. Since the claim as a whole is directed towards these non-statutory instances, claim 17 is directed to non-statutory subject matter.

Claim Rejections - 35 USC § 112

11. The following is a quotation of 35 U.S.C. 112(b):

(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

12. **Claim 3** is rejected under 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

13. **Claim 3** recites the limitation "said first rounding offset" in line 3. There is insufficient antecedent basis for this limitation in the claim.

Remarks

14. **Claims 9, 18, and 19** recite the claim limitations **"computer code configured to: determine, use, combine, decrease; an input to determine a block of pixels; a**

determinator to determine a type of the block; a first predictor to use said first reference pixel location; a second predictor to use said second reference pixel location; a combiner to combine; a shifter to decrease precision; means for: determining, using, combining, decreasing" These claim limitations have been interpreted under 35 U.S.C. 112, sixth paragraph, because they use non-structural terms "**computer code configured to**; **an input to; a determinator to; a first predictor to; a second predictor to; a combiner to; a shifter to; means for**" coupled with functional language "**determine, use, combine, decrease; determine a block of pixels; determine a type of the block; use said first reference pixel location; use said second reference pixel location; combine; decrease precision; determining, using, combining, decreasing**" without reciting sufficient structure to achieve the function. Furthermore, the non-structural term is not preceded by a structural modifier.

Since these claim limitations invoke 35 U.S.C. 112, sixth paragraph, **claims 9, 18, and 19** are interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112, sixth paragraph limitation:

[00120] In general, the various embodiments of the invention may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. For example, some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the invention is not limited thereto. While various aspects of the invention may be illustrated and described as block diagrams, flow charts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[00121] The embodiments of this invention may be implemented by computer software executable by a data processor of the mobile device, such as in the processor entity, or by hardware, or by a combination of software and hardware. Further in this regard it should be noted that any blocks of the logic flow as in the Figures may represent program steps, or interconnected logic circuits, blocks and functions, or a combination of program steps and logic circuits, blocks and functions. The software may be stored on such physical media as memory chips, or memory blocks implemented within the processor, magnetic media such as hard disk or floppy disks, and optical media such as for example DVD and the data variants thereof, CD.

[00122] The memory may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor-based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory. The data processors may be of any type suitable to the local technical environment, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multi-core processor architecture, as non-limiting examples.

[00123] Embodiments of the inventions may be practiced in various components such as integrated circuit modules. The design of integrated circuits is by and large a highly automated process. Complex and powerful software tools are available for converting a logic level design into a semiconductor circuit design ready to be etched and formed on a semiconductor substrate.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does **not** wish to have the claim limitations treated under 35 U.S.C. 112, sixth paragraph, applicant may amend the claim so that it will clearly not invoke 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites sufficient structure, material, or acts for performing the claimed function to preclude application of 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and *Supplementary Examination Guidelines for Determining Compliance with 35 U.S.C. § 112 and for Treatment of Related Issues in Patent Applications*, 76 FR 7162, 7167 (Feb. 9, 2011).

Claim Rejections - 35 USC § 103

15. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

16. **Claim 1, 5, 7-9, 13, and 15-19** are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over **Ye et al. (US 2013/0142262 A1) (hereinafter Ye)** in view of **Noda et al. (US 2009/0087111 A1) (hereinafter Noda)**.

17. **Regarding claim 1**, Ye discloses a method comprising:

determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision **[Input frames are made up of blocks in the bitstream which hold pixels of full integer pixel precision because in later motion prediction, fractional pixel precision may be applied to the integer pixel values of input frames to predict a current frame. Paragraphs 0022-0023, 0028]**;

determining a type of the block **[For each input video block, it is determined whether a block is to be encoded temporally using neighboring reference frames or spatially using intra frame prediction. Paragraphs 0022-0024]**;

if the determining indicates that the block is a block predicted by using two or more reference blocks **[When a multi-directional block is input, multi-hypothesis prediction may be provided, such as bi-prediction temporal prediction, where two**

prediction signals from two reference blocks in two neighboring frames are combined to form the prediction for the current frame block. Paragraphs 0024-0025],

determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block **[In bi-directional prediction, a reference pixel location (x,y) is determined for reference picture 0 and another reference pixel location (x,y) is determined for reference picture 1 to form the prediction values P0(x,y) and P1(x,y). Paragraphs 0023-0028]**;

using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision **[First reference pixel location (x,y) for reference picture 0 is used to obtain prediction P0(x,y). 1/2, 1/4, and 1/8 fractional pixel precision may be used in motion prediction by interpolating integer pixel values. It is known in the art that such fractional pixel precision (sub-pixel precision) produces a finer and more precise motion tracking and prediction compared to integer pixel precision. Thus, the fractional precision used in motion prediction is a second precision higher than the first integer pixel precision that the input pixels have. Paragraphs 0025, 0028, Fig. 3]**;

using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision **[Second reference pixel location (x,y) for reference picture 1 is used to obtain prediction P1(x,y). 1/2, 1/4, and 1/8 fractional pixel precision may be used in**

motion prediction by interpolating integer pixel values. It is known in the art that such fractional pixel precision (sub-pixel precision) produces a finer and more precise motion tracking and prediction compared to integer pixel precision. Thus, the fractional precision used in motion prediction is a second precision higher than the first integer pixel precision that the input pixels have, and when used in bi-directional prediction, may be of the same second precision as the other reference frame P0. Paragraphs 0025, 0028, Fig. 3];

combining said first prediction and said second prediction to obtain a combined prediction **[The prediction signals P0(x,y) and P1(x,y) are combined in the paragraph 0025 equations to form the final bi-prediction signal P(x,y). Paragraph 0025]**; and

decreasing the precision of said combined prediction **[The sum of P0(x,y) and P1(x,y) is bit shifted to the right (either by 1 or by a value "S" in weighted prediction) in the paragraph 0025 equations. Bit shifting to the right reduces the number of bits and thereby causes a reduction of bit precision. Thus, the prediction P(x,y), which is formed by the combination of P0(x,y) and P1(x,y), has its precision decreased. Paragraph 0025].**

Ye does not explicitly disclose decreasing precision to said first precision.

However, Noda, in the same field of video compression, teaches decreasing the precision to said first precision **[The input image signal has a first precision bit depth of N. During encoding, the bit depth is increased by M and the predicted image has a second higher precision bit depth of N+M. After motion prediction**

and decoding, the decoded image also has a bit depth of N+M and is subject to bit depth reduction to decrease each pixel by M bits so the final image has a bit depth of N. Thus the decoded image has a decrease of precision from the second precision to the first precision. Paragraphs 0129-0131].

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of invention to modify the invention disclosed by Ye to add the teachings of Noda as above, in order to improve precision of the filter in motion compensation, reduce prediction error, and improve coding efficiency **[Noda; Paragraph 0131]**.

18. **Regarding claim 5**, Ye and Noda teach the method according to any of the claims 1.

Furthermore, Ye discloses wherein said type of the block is a bi-directional block or a multidirectional block **[Multi-hypothesis prediction may be provided, such as bi-prediction temporal prediction (used by a bi-direcitonal block), where two prediction signals from two reference blocks in two neighboring frames are combined to form the prediction for the current frame block. Paragraphs 0022-0025]**.

19. **Regarding claim 7**, Ye and Noda teach the method according to any of the claims 1.

Furthermore, Noda teaches wherein the first precision is 8 bits **[The input pixel values may have a precision of 8 bits. Paragraphs 0302-0303]**.

Ye teaches a prior art video encoding method where an input pixel value is a pixel value with a first integer bit precision **[Ye: Paragaphs 0024-0028]**, but differs from the claimed method in that it is not specified that the first precision is an 8 bit precision.

Noda teaches that the integer pixel value is an 8 bit integer pixel.

The substitution of one known element (first integer precision of Ye) for another (input 8 bit precision of Noda) would have been obvious to one of ordinary skill in the art at the time of invention because the substitution would have yielded predictable results, namely, the encoding and prediction of an input pixel value with a first integer bit precision of 8 bits.

20. **Regarding claim 8**, Ye and Noda teach the method according to any of the claims 1.

Furthermore, Ye discloses the method further comprising: obtaining said first prediction and said second prediction by filtering pixel values of said reference blocks **[For bi-prediction, the current frame uses prediction signal P(x,y), which is formed by P0(x,y) and P1(x,y) from reference frames 0 and 1. Motion prediction is used to produce first prediction P0(x,y) for reference frame 0 and second prediction P1(x,y) for reference frame 1. In the motion prediction, a 6 tap interpolation filter may be applied to reference pictures 0 and 1 to obtain fractional pixel precision for prediction signals P0(x,y) and P1(x,y). Paragraphs 0024-0028]**.

21. **Regarding claim 9**, Ye discloses an apparatus comprises:

a processor; and a memory unit operatively connected to the processor **[Video encoder system may be embodied in a microcontroller processor which performs a process from instructions stored on a computer readable storage media (memory). Paragraph 0244]** and including:

computer code **[Computer code instructions for performing the video encoding may be stored on the media. Paragraph 0244].**

Claim 9 further recites the same elements as claim 1. Therefore, claim 9 is rejected in the same manner as claim 1.

22. **Regarding claim 13**, the same elements as claim 5 are recited. Therefore, claim 13 is rejected in the same manner as claim 5.

23. **Regarding claim 15**, the same elements as claim 7 are recited. Therefore, claim 15 is rejected in the same manner as claim 7.

24. **Regarding claim 16**, the same elements as claim 8 are recited. Therefore, claim 16 is rejected in the same manner as claim 8.

25. **Regarding claim 17**, Ye discloses a computer readable storage medium stored with code thereon for use by an apparatus **Video encoder system may be embodied in a microcontroller processor which performs a process from instructions stored on a computer readable storage media (memory). Paragraph 0244].**

Claim 17 further recites the same elements as claim 1. Therefore, claim 17 is rejected in the same manner as claim 1.

26. **Regarding claim 18**, Ye discloses an apparatus **[Video encoder. Paragraph 0022]** comprising: an input, a determinator, a first predictor, a second predictor, and a shifter **[Encoder has the structure of figure 1A, where input video is input into the system and the motion prediction unit determines kinds of blocks for inter and intra coding, and also provides for right bit shifting of the prediction P(x,y) for the current block based on predictions from reference frames according to the equation in paragraph 0025. Paragraph 0025, Fig. 1A]**.

Furthermore, claim 18 recites the same elements as claim 1. Thus, claim 18 is rejected in the same manner as claim 1.

27. **Regarding claim 19**, the same elements as claim 1 are recited. Therefore, claim 19 is rejected in the same manner as claim 1.

28. **Claims 2-4, 6, 10-12, and 14** are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over **Ye et al. (US 2013/0142262 A1) (hereinafter Ye)** in view of **Noda et al. (US 2009/0087111 A1) (hereinafter Noda)**, further in view of **Panchal et al. (US 2010/0086027 A1) (hereinafter Panchal).**

29. **Regarding claim 2**, Ye and Noda teach the method according to claim 1.

Ye and Noda do not explicitly teach the method further comprising: inserting a first rounding offset to said first prediction and said second prediction.

However, Panchal, in the same field of video coding, teaches the method further comprising: inserting a first rounding offset to said first prediction and said second prediction **[When algorithm 2 is used, the first rounding offset 2^r (equivalent to 2^y) is inserted to the sum of the prediction Pred0 for a first reference frame and the prediction Pred1 for a second reference frame. The first rounding offset may alternatively be equal to 32 if prediction algorithm 3 is used. Paragraphs 0060-0064]**.

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of invention to modify the invention disclosed by Ye and Noda to add the teachings of Panchal as above, in order to ensure that an integer number is provided in the prediction calculation and promote efficiency in the video coding **[Panchal; Paragraphs 0021, 0061]**.

30. **Regarding claim 3**, Ye and Noda teach the method according to claim 1.

Furthermore, Ye discloses the method further comprising: reducing the precision of said first prediction and said second prediction **[The sum of P0(x,y) and P1(x,y) is bit shifted to the right (either by 1 or by a value "S" in weighted prediction) in the paragraph 0025 equations. Bit shifting to the right reduces the number of bits and thereby causes a reduction of bit precision. Thus, the prediction P(x,y), which is formed by the combination of P0(x,y) and P1(x,y), has its precision decreased, and therefore, the precision of P0 and P1 is decreased. Paragraph 0025]**

Ye does not explicitly teach reducing precision to an intermediate prediction after adding said first rounding offset, said intermediate prediction being higher than said first precision

However**,** Noda teaches reducing precision to an intermediate prediction, said intermediate prediction being higher than said first precision **[Input pixel precision of N bits is increased to a second pixel precision of N+M bits. The N+M bit precision is then lowered to an intermediate N+M-L precision, where L<=M. Thus, the N+M-L precision is an intermediate precision higher than the N precision but lower than the N+M precision when L is less than M. Paragraphs 0133-0136]**.

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of invention to modify the invention disclosed by Ye to add the teachings of Noda as above, in order to improve precision of the filter in motion compensation, reduce prediction error, and improve coding efficiency **[Noda; Paragraph 0131]**.

Ye and Noda do not teach reducing precision after adding said first rounding offset.

However, Panchal teaches reducing precision after adding said first rounding offset **[When algorithm 2 is used, the first rounding offset 2^r (equivalent to 2^y) is inserted to the sum of the prediction Pred0 for a first reference frame and the prediction Pred1 for a second reference frame. The first rounding offset may alternatively be equal to 32 if prediction algorithm 3 is used. In both algorithms, after the rounding offset is added to the first and second predictions, the**

precision is reduced by right bit shifting the overall prediction pred(i,j) which consists of the summed first and second predictions. Paragraphs 0060-0064].

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of invention to modify the invention disclosed by Ye and Noda to add the teachings of Panchal as above, in order to ensure that an integer number is provided in the prediction calculation and promote efficiency in the video coding **[Panchal; Paragraphs 0021, 0061]**.

31. **Regarding claim 4**, Ye, Noda, and Panchal teach the method according to claim 2.

Furthermore, Panchal teaches the method further comprising: inserting a second rounding offset to the combined prediction before said decreasing **[When algorithm 2 is used, second rounding offsets o1 and o2 (recall first rounding offset is 2^r for algorithm 2) are applied to the overall prediction pred(i,j) before a decrease of precision by pixel shifting 1 bit to the right. Paragraph 0061]**.

See the Panchal motivation of claim 1.

32. **Regarding claim 6**, Ye, Noda, and Panchal teach the method according to claim 2.

Furthermore, Panchal teaches wherein the first rounding offset is 2^y **[When algorithm 3 is used for prediction, the first rounding offset is equal to 32. This value is equal to 2^y when y is equal to 5 i.e. (2^5=32). Paragraph 0062]**, and said decreasing comprises right shifting the combined prediction y+1 bit **[When algorithm 3**

is used, the rounding offset is equal to 32, which is equal to 2^y when y=5. When y=5, y plus 1 is equal to 6 i.e. (y+1=6). In algorithm 3, a right shift of 6 is applied to the combined prediction pred (i,j). Thus, the right shift of y+1 bits is present in algorithm 3. It is known in the art that bit shifting to the right reduces the number of bits and thereby causes a decrease of bit precision. Paragraph 0062].

See the Panchal motivation of claim 2.

33. **Regarding claim 10**, the same elements as claim 2 are recited. Therefore, claim 10 is rejected in the same manner as claim 2.

34. **Regarding claim 11**, the same elements as claim 3 are recited. Therefore, claim 11 is rejected in the same manner as claim 3.

35. **Regarding claim 12**, the same elements as claim 4 are recited. Therefore, claim 12 is rejected in the same manner as claim 4.

36. **Regarding claim 14**, the same elements as claim 6 are recited. Therefore, claim 14 is rejected in the same manner as claim 6.

Conclusion

37. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

a. Motta et al. (US 2010/0002770 A1)

b. Bao et al. (US 2008/0089417 A1)

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ELLYAR Y. BARAZESH whose telephone number is

(571)272-5226. The examiner can normally be reached on Monday through Friday 7:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Joseph Ustaris can be reached on (571)272-7383. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Joseph Ustaris/
Supervisory Patent Examiner, Art Unit 2483

/ELLYAR Y BARAZESH/
Examiner, Art Unit 2483

Notice of References Cited	Application/Control No. 13/344,893	Applicant(s)/Patent Under Reexamination UGUR ET AL.	
	Examiner ELLYAR Y. BARAZESH	Art Unit 2483	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2013/0142262 A1	06-2013	Ye et al.	375/240.16
*	B	US-2009/0087111 A1	04-2009	NODA et al.	382/238
*	C	US-2010/0086027 A1	04-2010	Panchal et al.	375/240.12
*	D	US-2010/0002770 A1	01-2010	Motta et al.	375/240.16
*	E	US-2008/0089417 A1	04-2008	Bao et al.	375/240.16
	F	US-			
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Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13344893
	Filing Date	2012-01-06
	First Named Inventor	Kemal Ugur
	Art Unit	2482
	Examiner Name	TBD
	Attorney Docket Number	NC74925-US-NP

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Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6512523		2003-01-28	Gross	
	2	6539058		2003-03-25	Pearlstein et al.	

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	1	20100086027	A1	2010-04-08	Panchal et al.	
	2	20090257503	A1	2010-10-15	Ye et al.	

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	1	2729615	CA	A1	2010-01-07	Kabushiki kaisha toshiba		☐

 ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.B./

Receipt date: 06/19/2012	Application Number	13344893 13344893 - GAU: 2483
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)	Filing Date	2012-01-06
	First Named Inventor	Kemal Ugur
	Art Unit	2482
	Examiner Name	TBD
	Attorney Docket Number	NC74925-US-NP

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	1	UGUR et al., "High precision bi-directional averaging", Joint CollaborativeTeam on Video Coding (JCT.VC) of ITV-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 4th Meeting, January 20-28, 2011, pp. 1-3.	☐
	2	UGUR et al., "On clipping in bi-directional averaging", Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 5th Meeting, March 16-23, 2011, pp. 1-4.	☐
	3	"Advanced Video Coding for Generic Audiovisual Services", Series H: Audiovisual And Multimedia Systems, Infrastructure of audiovisual services – Coding of moving video, ITU-T Recommendation H.264, November, 2007, 564 pages.	☐
	4	International Search Report and Written Opinion received for corresponding Patent Cooperation Treaty Application No. PCT/IB2012/050089, dated May 09, 2012, 14 pages.	☐

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Examiner Signature	/Ellyar Barazesh/	Date Considered	07/10/2014

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Receipt date: 06/19/2012	Application Number		13344893 13344893 - GAU: 2483
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Filing Date		2012-01-06
	First Named Inventor	Kemal Ugur	
	Art Unit		2482
	Examiner Name	TBD	
	Attorney Docket Number		NC74925-US-NP

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Thomas J. Arria/	Date (YYYY-MM-DD)	2012-06-19
Name/Print	Thomas J. Arria	Registration Number	60223

 ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.B./

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.B./

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	38	"6512523" "6539058"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 17:30
S1	1459	375/240.15.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 15:32
S2	187426	("375").CLAS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	OFF	2014/07/09 15:32
S3	7950	(block macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) SAME (reference referenc$3) SAME ((pixel) with (location locale position placement coordinate))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 15:36
S4	7988	(block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) SAME (reference referenc$3) SAME ((pixel) with (location locale position placement coordinate))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 15:39
S5	621	((reference referenc$3) with (block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) with (forward future)) AND S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 15:39
S6	282	((reference referenc$3) with (block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) with (previous$3 behind)) AND S5	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 15:40
S7	8	"20100086027"	US-	OR	ON	2014/07/09

			PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT			15:45
S8	2	"20090257503"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 15:45
S9	52	(estimat$3 predict$3) with ("GOP"(group near2 (picture frame image))) AND S6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 15:50
S10	233	((reference referenc$3) with (block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) with (bidirection$3 bi$1direction$3 (bi adj directiona$3))) AND S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 15:57
S11	65	((reference referenc$3) with (block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) with pixel with (bidirection$3 bi$1direction$3 (bi adj directiona$3))) AND S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 15:58
S12	24	S11 AND ((estimat$3 predict$3) with (pixel)) with (accuracy accurat$3 precision precis$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 15:59
S13	260	((reference referenc$3) with (block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) with (bidirection$3 biprediction bi$1prediction (bi adj prediction) bi$1direction$3 (bi adj directiona$3))) AND S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 16:19
S14	24	S13 AND (shift$3 near2 bit)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 16:27
S15	2	S14 AND (bit near2 depth)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2014/07/09 16:27

			DERWENT			
S16	9	S14 AND (bit near2 (depth precision))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 16:27
S17	43	(block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) SAME (reference referenc$3) SAME (bidirection$3 biprediction bi$1prediction (bi adj prediction) bi$1direction$3 (bi adj directiona$3)) AND (pixel with tap$4) AND (pixel with (shift$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 16:48
S18	27	((forward future) with (predict$3 estimat$4)) AND ((previous$3 behind) with (predict$3 estimat$4)) AND S17	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 16:51
S19	19	S17 AND ((combin$4 sum$4 merg$3 mix$3 multiply$3) near6 (predict$4 estimat$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 16:53
S20	15	S19 AND (pixel near2 (precision accuracy))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 16:59
S21	66	(block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) SAME (reference referenc$3) SAME (bidirection$3 biprediction bi$1prediction (bi adj prediction) bi$1direction$3 (bi adj directiona$3)) AND (filter with tap$4) AND (pixel with (shift$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 17:00
S22	29	S21 AND ((combin$4 sum$4 merg$3 mix$3 multiply$3) near6 (predict$4 estimat$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 17:01
S23	21	S22 AND (pixel near2 (precision accuracy))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 17:01
S24	13	S22 AND (pixel near2 (precision accuracy)) SAME (tap)	US-PGPUB;	OR	ON	2014/07/09 17:01

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT			
S25	106	(block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) SAME (reference referenc$3) SAME (bidirection$3 biprediction bi$1prediction (bi adj prediction) bi$1direction$3 (bi adj directiona$3)) AND (filter with tap$4) AND (bit with (shift$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 17:20
S26	44	S25 AND ((combin$4 sum$4 merg$3 mix$3 multiply$3) near6 (predict$4 estimat$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 17:21
S27	13	S26 AND (pixel near2 (precision accuracy)) SAME (tap)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 17:21
S28	12	S27 AND (round$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/09 17:27
S29	106	(block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) SAME (reference referenc$3) SAME (bidirection$3 biprediction bi$1prediction (bi adj prediction) bi$1direction$3 (bi adj directiona$3) (multi$1hypothesis (multi adj hypothesis) multihypothesis)) AND (filter with tap$4) AND (bit with (shift$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 08:57
S31	44	S29 AND ((combin$4 sum$4 merg$3 mix$3 multiply$3) near6 (predict$4 estimat$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 08:59
S33	450	(block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) SAME (bidirection$3 biprediction bi$1prediction (bi adj prediction) bi$1direction$3 (bi adj directiona$3) (multi$1hypothesis (multi adj hypothesis) multihypothesis)) AND (filter with tap$4) AND (bit with (shift$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:00
S34	453	(block "MB" macroblock (macro adj	US-	OR	ON	2014/07/10

		block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) SAME (bidirection$3 biprediction bi$1prediction (bi adj prediction) bi$1direction$3 multi$1direction$3 (bi adj directiona$3) (multi adj direction$3) multidirection$3 (multi$1hypothesis (multi adj hypothesis) multihypothesis)) AND (filter with tap$4) AND (bit with (shift$3))	PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT			09:01
S35	245	(block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) SAME (bidirection$3 biprediction bi$1prediction (bi adj prediction) bi$1direction$3 multi$1direction$3 (bi adj directiona$3) (multi adj direction$3) multidirection$3 (multi$1hypothesis (multi adj hypothesis) multihypothesis)) AND (pixel near2 (accuracy precision accurat$3 precis$4)) AND (bit with (shift$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:04
S36	115	S35 AND ((combin$4 sum$4 merg$3 mix$3 multiply$3) near6 (predict$4 estimat$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:05
S38	18	S36 AND ((round$3) near6 (predict$4 estimat$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:05
S39	1264	(block "MB" macroblock (macro adj block) macro$1block ("CTU")("C.T.U.") (coding near2 tree near2 unit)) SAME (bidirection$3 biprediction bi$1prediction (bi adj prediction) bi$1direction$3 multi$1direction$3 (bi adj directiona$3) (multi adj direction$3) multidirection$3 (multi$1hypothesis (multi adj hypothesis) multihypothesis)) AND (pixel near2 (accuracy precision accurat$3 precis$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:18
S40	655	S39 AND ((combin$4 sum$4 merg$3 mix$3 multiply$3) near6 (predict$4 estimat$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:19
S41	8	S40 AND ((round$3) near4 (predict$4 estimat$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:19
S42	8	S40 AND ((round$3) near4 (predict$4 estimat$4 "P1" "P2"))	US-PGPUB; USPAT; USOCR;	OR	ON	2014/07/10 09:20

			FPRS; EPO; JPO; DERWENT			
S43	48	S40 AND ((round$3) near4 (offset off$1set (off adj set)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:30
S44	1	((round$3) with ("2y" "2x" "2n")) AND ((shift$3) with ("y+1" "x+1"))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:44
S48	431	((round$3) near4 (offset off$1set (off adj set))) with ("2")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:48
S49	27	S48 AND ((predict$4 estimat$4) with (shift$4) with (right))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:49
S50	27	S48 AND ((predict$4 estimat$4) with bit with (shift$4) with (right))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:49
S51	25	S50 AND (bidirection$3 biprediction bi$1prediction (bi adj prediction) bi$1direction$3 multi$1direction$3 (bi adj directiona$3) (multi adj direction$3) multidirection$3 (multi$1hypothesis (multi adj hypothesis) multihypothesis))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 09:50
S52	3243	(original first earlier) with (pixel) with (precision accuracy)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 11:55
S53	120	S52 AND (shift$3 with right with bit)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT	OR	ON	2014/07/10 11:56
S54	40	S53 AND (bidirection$3 biprediction bi$1prediction (bi adj prediction)	US-PGPUB;	OR	ON	2014/07/10 11:57

			bi$1direction$3 multi$1direction$3 (bi adj directiona$3) (multi adj direction$3) multidirection$3 (multi$1hypothesis (multi adj hypothesis) multihypothesis))	USPAT; USOCR; FPRS; EPO; JPO; DERWENT			

7/10/2014 5:32:49 PM
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BIB DATA SHEET

CONFIRMATION NO. 2120

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/344,893	01/06/2012 **RULE**	375	2483	NC74925US-NP

APPLICANTS

INVENTORS

Kemal UGUR, Tampere, FINLAND;
Jani LAINEMA, Tampere, FINLAND;
Antti HALLAPURO, Tampere, FINLAND;

** **CONTINUING DATA** *************************

This appln claims benefit of 61/430,694 01/07/2011

** **FOREIGN APPLICATIONS** *************************

** **IF REQUIRED, FOREIGN FILING LICENSE GRANTED** **

01/19/2012

Foreign Priority claimed ❑ Yes ☑ No 35 USC 119(a-d) conditions met ❑ Yes ☑ No Verified and Acknowledged /ELLYAR Y BARAZESH/ Examiner's Signature	❑ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		FINLAND	11	19	5

ADDRESS

Nokia USA Inc.
Attn: Intellectual Property Rights Docketing
200 South Mathilda Ave
Sunnyvale, CA 94086
UNITED STATES

TITLE

Motion Prediction in Video Coding

FILING FEE RECEIVED		
1880	FEES: Authority has been given in Paper No.____________ to charge/credit DEPOSIT ACCOUNT No.____________ for following:	❑ All Fees ❑ 1.16 Fees (Filing) ❑ 1.17 Fees (Processing Ext. of time) ❑ 1.18 Fees (Issue) ❑ Other ________________ ❑ Credit

BIB (Rev. 05/07).

Search Notes	Application/Control No. 13344893	Applicant(s)/Patent Under Reexamination UGUR ET AL.
	Examiner ELLYAR Y BARAZESH	Art Unit 2483

CPC- SEARCHED		
Symbol	**Date**	**Examiner**

CPC COMBINATION SETS - SEARCHED		
Symbol	**Date**	**Examiner**

US CLASSIFICATION SEARCHED			
Class	**Subclass**	**Date**	**Examiner**

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
Palm inventor search	7/10/2014	EYB
East search	7/10/2014	EYB
Consulted Primary Examiner Tung Vo about limitations of claim 1	7/10/2014	EYB

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**

/ELLYAR Y BARAZESH/ Examiner.Art Unit 2483	

Index of Claims	Application/Control No. 13344893	Applicant(s)/Patent Under Reexamination UGUR ET AL.
	Examiner ELLYAR Y BARAZESH	Art Unit 2483

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/10/2014								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								
	19	✓								

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby appoint:

☒ Practitioners associated with the Customer Number: **10949**

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) and are authorized to act on behalf of the Assignee in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Assignee Name and Address:

NOKIA CORPORATION
Keilalahdentie 4
FIN-02150 Espoo, Finland

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record
The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Name: Virpi Tognetty	
Signature:	Date: 20 December 2012
Title: Director, Patenting Operations Legal and Intellectual Property	Telephone:
Name: Jukka Nihtilä	
Signature:	Date: 20 December 2012
Title: Head, Business Development Legal & IP	Telephone:

PTO/SB/96 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Ugur et al.

Application No./Patent No.: 13/344,893 (Conf. No. 2120) Filed/Issue Date: January 6, 2012

Titled: Motion Prediction in Video Coding

Nokia Corporation, a corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. ☒ the assignee of the entire right, title, and interest in;

2. ☐ an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is ________ %); or

3. ☐ the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A. ☒ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel 028009, Frame 0259, or for which a copy therefore is attached.

OR

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: ________________ To: ________________
The document was recorded in the United States Patent and Trademark Office at
Reel ________, Frame ________, or for which a copy thereof is attached.

2. From: ________________ To: ________________
The document was recorded in the United States Patent and Trademark Office at
Reel ________, Frame ________, or for which a copy thereof is attached.

3. From: ________________ To: ________________
The document was recorded in the United States Patent and Trademark Office at
Reel ________, Frame ________, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☐ As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Guy R. Gosnell/ — Signature
10/01/2014 — Date

Guy R. Gosnell — Printed or Typed Name
Reg. No. 34,610 — Title

Privacy Act Statement

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CHANGE OF CORRESPONDENCE ADDRESS

Application

Address to:
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	13/344,893 (Conf. No. 2120)
Filing Date	January 6, 2012
First Named Inventor	Ugur et al.
Art Unit	2483
Examiner Name	Ellyar Y. Barazesh
Attorney Docket Number	042933/452410

Please change the Correspondence Address for the above-identified patent application to:

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I am the:

☐ Applicant/Inventor

☐ Assignee of record of the entire interest.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96).

☑ Attorney or agent of record. Registration Number 34,610.

☐ Registered practitioner named in the application transmittal letter in an application without an executed oath or declaration. See 37 CFR 1.33(a)(1). Registration Number______________________.

Signature	/Guy R. Gosnell/
Typed or Printed Name	Guy R. Gosnell
Date 10/01/2014	Telephone 704-444-1000

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☐ *Total of ___________forms are submitted.

Electronic Acknowledgement Receipt

EFS ID:	20297169
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	73658
Filer:	Robert Flynt Strean/RIEKO WELCH
Filer Authorized By:	Robert Flynt Strean
Attorney Docket Number:	NC74925US-NP
Receipt Date:	01-OCT-2014
Filing Date:	06-JAN-2012
Time Stamp:	12:25:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	452410_POA_10-01-2014.PDF	61638 f5c851427e101b46c4a2442745b5740e4c215591	no	1

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2	Assignee showing of ownership per 37 CFR 3.73.	452410_373b_Statement_10-01-2014.PDF	826969 bdc51a13693ced85252e5758f1c8d8ab167863b5	no	2
Warnings:					
Information:					
3	Change of Address	452410_ChangeCorrespondence_10-01-2014.PDF	281288 75cfd87b5752181c6b84abff52b8b34c932b962e	no	1
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Information:					
		Total Files Size (in bytes):	1169895		

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National Stage of an International Application under 35 U.S.C. 371
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New International Application Filed with the USPTO as a Receiving Office
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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/344,893	01/06/2012	Kemal UGUR	042933/452410

CONFIRMATION NO. 2120

POA ACCEPTANCE LETTER

OC000000071126029

10949
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

Date Mailed: 10/07/2014

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 10/01/2014.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/qtran/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/344,893	01/06/2012	Kemal UGUR	NC74925US-NP

CONFIRMATION NO. 2120

POWER OF ATTORNEY NOTICE

OC000000071126008

73658
Nokia USA Inc.
Attn: Intellectual Property Rights Docketing
200 South Mathilda Ave
Sunnyvale, CA 94086

Date Mailed: 10/07/2014

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 10/01/2014.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/qtran/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.:	13/344,893	Confirmation No.: 2120
Applicant(s):	Ugur et al.	
Filed:	January 6, 2012	
Art Unit:	2483	
Examiner:	Ellyar Y. Barazesh	
Title:	MOTION PREDICTION IN VIDEO CODING	

Docket No.: 042933/452410
Customer No.: 10949

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT UNDER 37 C.F.R. § 1.111

Sir:

In response to the Office Action dated July 16, 2014, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims beginning on page 2 of this paper.

Remarks begin on page 7 of this paper.

Amendments to the Claims:

1. (Original) A method comprising:

determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

determining a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combining said first prediction and said second prediction to obtain a combined prediction; and

decreasing the precision of said combined prediction to said first precision.

2. (Original) The method according to claim 1 further comprising:

inserting a first rounding offset to said first prediction and said second prediction.

3. (Currently Amended) The method according to claim 1 further comprising:

reducing the precision of said first prediction and said second prediction to an intermediate prediction after adding ~~said~~ a first rounding offset, said intermediate prediction being higher than said first precision.

4. (Original) The method according to claim 2 further comprising:

inserting a second rounding offset to the combined prediction before said decreasing.

5. (Currently Amended) The method according to ~~any of the claims~~claim 1, wherein said type of the block is a bi-directional block or a multidirectional block.

6. (Original) The method according to claim 2, wherein the first rounding offset is 2^y, and said decreasing comprises right shifting the combined prediction y+1 bit.

7. (Currently Amended) The method according to ~~any of the claims~~claim 1, wherein the first precision is 8 bits.

8. (Currently Amended) The method according to ~~any of the claims~~claim 1 further comprising:

obtaining said first prediction and said second prediction by filtering pixel values of said reference blocks.

9. (Currently Amended) An apparatus ~~comprises~~comprising:

at least one ~~a~~ processor~~;~~ and at least one ~~a~~ memory ~~unit operatively connected to the processor and~~ including computer program code, the at least one memory and computer program code configured to, with the processor, cause the apparatus to:

~~computer code configured to~~ determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

~~computer code configured to~~ determine a type of the block;

~~computer code configured to,~~ wherein if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

10. (Currently Amended) The apparatus according to claim 9, wherein the at least one memory and computer code ~~is~~ are further configured to:

insert a first rounding offset to said first prediction and said second prediction.

11. (Currently Amended) The apparatus according to claim 9, wherein the at least one memory and computer code ~~is~~ are further configured to:

reduce the precision of said first prediction and said second prediction to an intermediate prediction after adding said first rounding offset, said intermediate prediction being higher than said first precision.

12. (Currently Amended) The apparatus according to claim 10, wherein the at least one memory and computer code ~~is~~ are further configured to:

insert a second rounding offset to the combined prediction before said decreasing.

13. (Original) The apparatus according to any of the claims 9, wherein said type of the block is a bi-directional block or a multidirectional block.

14. (Original) The apparatus according to claim 10, wherein the first rounding offset is 2^y, and said decreasing comprises right shifting the combined prediction y+1 bits.

15. (Original) The apparatus according to any of the claims 9, wherein the first precision is 8 bits.

16. (Currently Amended) The apparatus according to any of the claims 9, wherein the at least one memory and computer code ~~is~~ are further configured to:

obtain said first prediction and said second prediction by filtering pixel values of said reference blocks.

17. (Currently Amended) A computer program product comprising at least one non-transitory computer readable storage medium having computer executable program code portions stored therein, the computer executable program code portions ~~with~~ comprising program code instructions ~~thereon for use by an apparatus, which when executed by a processor, causes the apparatus~~configured to:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

determine a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

18. (Original) An apparatus comprising:

an input to determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

a determinator to determine a type of the block; wherein if the determining indicates that the block is a block predicted by using two or more reference blocks, said determinator further to determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

a first predictor to use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

a second predictor to use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

a combiner to combine said first prediction and said second prediction to obtain a combined prediction; and

a shifter to decrease the precision of said combined prediction to said first precision.

19. (Original) An apparatus comprising:

means for determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision;

means for determining a type of the block;

means for determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block, if the determining indicates that the block is a block predicted by using two or more reference blocks;

means for using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision;

means for using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

means for combining said first prediction and said second prediction to obtain a combined prediction; and

means for decreasing the precision of said combined prediction to said first precision.

REMARKS

The present application includes Claims 1-19. Claims 1-19 were rejected. By this Amendment, Claims 3, 5, 7-12, 16, and 17 have been amended to further clarify the claims. The amendments to Claims 9 and 17 may find support in at least Paragraphs 56 and 167-169. As such these amendments do not constitute new matter.

Claim Objections

Claims 5 and 9 were objected to because of informalities. Claim 5 has been amended to recite "The method according to Claim 1" and Claim 9 has been amended to recite "An apparatus comprising." As such, the informalities of Claims 5 and 9 have been corrected and the applicant respectfully requests that the objections be withdrawn.

Claim Rejections - 35 USC § 112

Claim 3 was rejected under 35 USC § 112(pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 3 has been amended to recite "a first rounding offset," correcting the antecedent basis. As such, Claim 3 is definite and particularly points out the subject matter which the inventor regards as the invention. The Applicant respectfully requests that the rejection of Claim 3 under 35 USC § 112 be withdrawn.

Claim Rejections - 35 USC § 101

Claim 17 was rejected under 35 USC § 101 because the is directed to non-statutory subject matter.

Claim 17 has been amended to recite "A computer program product comprising at least one non-transitory computer readable storage medium." As such Claim 17 is directed toward statutory subject matter and the Applicant respectfully requests that the rejection be withdrawn.

<u>Claim interpretation under 35 USC § 112 Paragraph 6</u>

Claims 9, 18, and 19 have been interpreted under 35 USC § 112, paragraph 6. Claim 9 has been amended to recite "an apparatus comprising: at least one processor and at least one memory including computer program code, the at least one memory and computer program code configured to, with the processor, cause the apparatus to." As such, Claim 9, as amended, recites structural elements to achieve the claimed functions. The Applicant asserts that Claim 9, as amended, should not be interpreted under 35 USC § 112, paragraph 6.

<u>Claim Rejections - 35 USC § 103</u>

Claims 1, 5, 7-9, 13, and 15-19 were rejected under pre-AIA 35 USC § 103(a) as being unpatentable over Ye et al. (US 2013/0142262 A1) in view of Noda et al. (US 2009/0087111 A1).

Claims 2-4, 6, 10-12, and 14 were rejected under pre-AIA 35 USC § 103(a) as being unpatentable over Ye et al. in view of Noda et al. further in view of Panchal et al. (US 2010/0086027 A1).

The rejection asserts that "determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision," is taught by Ye. (Office Action mailed July 16, 2014; Pg. 7.) The rejection states "input frames are made of blocks in a bitstream which hold pixels of full interger pixel precision, because in later motion prediction, *fractional pixel precision may be applied to the interger pixel values of the input frames to predict a current frame*." *Id.* However, Paragraph 28 actually discloses "when a motion vector points to a fractional picture position, motion interpolation is used to obtain the fractional pixel values by interprolating from interger pixel values **in the reference picture**." (Paragraph 28.) The disclosure relied on for teaching the first precision is not related to determining a block of pixels of a video representation encoded in a bit stream, or input video block, but instead a reference picture.

The independent claims specify that the block of pixels of video encoded in a bitstream, or the input video blocks are predicted using reference pixels of reference blocks. Since Ye discloses precision in relation to reference pictures, but is silent as to the precision of the input video block, Ye cannot teach or suggest "using said first reference pixel location to obtain a first prediction, **said first prediction having a second precision, which is higher than said first precision**" and "using said second reference pixel location to obtain a second prediction, **said second prediction having the second precision, which is higher than said first precision**."

Noda is directed toward image encoding and decoding and contains no teaching or suggestion of the above described elements of the rejected claims. Indeed, Noda was not cited for this proposition.

Panchal is directed toward efficient prediction mode selection and contains no teaching or suggestion of the above described elements of the rejected claims. Indeed, Panchal was not cited for this proposition.

Since none of the cited references teaches or suggests "using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision" and "using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision," as set forth in various forms by the independent claims, it logically follows that no proper combination of the cited references teaches or suggests these same recitations.

For at least the reasons discussed above, Applicant respectfully submits that independent Claims 1, 9, 17, 18, and 19 are patentable over Ye alone or in combination with Noda and/or Panchal. Applicant therefore respectfully requests that the rejections of independent Claims 1, 9, 17, 18, and 19, as well as the claims which depend therefrom, be withdrawn.

The patentability of the independent claims has been argued as set forth above and thus the Applicant will not take this opportunity to argue the merits of the rejection with regard to the dependent claims. However, the Applicant does not concede that the dependent claims are not independently patentable and reserve the right to argue the patentability of the dependent claims at a later date if necessary.

CONCLUSION

In light of the remarks above, Applicant respectfully submits that the application is in condition for allowance and respectfully requests that a Notice of Allowance be issued. The

Examiner is encouraged to contact Applicant's undersigned attorney to resolve any remaining issues in order to expedite examination of the present application.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefor (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,

Grant A. Gildehaus
Registration No. 68,805

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101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
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Electronic Patent Application Fee Transmittal

Application Number:	13344893
Filing Date:	06-Jan-2012
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Filer:	Grant Allen Gildehaus/Emma Pham
Attorney Docket Number:	042933/452410

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 1 month with $0 paid	1251	1	200	200

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
	Total in USD ($)			**200**

Electronic Acknowledgement Receipt

EFS ID:	20497609
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	10949
Filer:	Grant Allen Gildehaus/Emma Pham
Filer Authorized By:	Grant Allen Gildehaus
Attorney Docket Number:	042933/452410
Receipt Date:	23-OCT-2014
Filing Date:	06-JAN-2012
Time Stamp:	13:57:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

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Payment Type	Deposit Account
Payment was successfully received in RAM	$200
RAM confirmation Number	172
Deposit Account	160605
Authorized User	

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1		Response.pdf	359083 c991c0debcf0de28bf0d7fcfc8b523d73d96fdc4	yes	10

Multipart Description/PDF files in .zip description

Document Description	Start	End
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Claims	2	6
Applicant Arguments/Remarks Made in an Amendment	7	10

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Fee Worksheet (SB06)	fee-info.pdf	30078 509aea2bdf167cc095b9b88bd453b9d517fca834	no	2

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<u>National Stage of an International Application under 35 U.S.C. 371</u>
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<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/344,893	Filing Date 01/06/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	10/23/2014	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 19	Minus	** 20	= 0	x $80 =	0
	Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	x $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	**0**

AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/ROCHELLE GETER/

Substitute for form 1449/PTO (Revised 07/2007)				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Application Number	13/344,893
				Filing Date	01/06/2012
				First Named Inventor	Kemal Ugur
				Art Unit	2483
				Examiner Name	Ellyar Y. Barazesh
Sheet	*1*	of	1	Attorney Docket Number	042933/452410

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action from Korean Patent Application No. 2013-7020731, dated July 31, 2014	

Examiner Signature		Date Considered	

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#35174831v1

Submitted October 30, 2014

Electronic Acknowledgement Receipt

EFS ID:	20561802
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/452410
Receipt Date:	30-OCT-2014
Filing Date:	06-JAN-2012
Time Stamp:	14:19:32
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		452410-IDS.PDF	356310 f31c085381b38e12d7894941f43043078d725534	yes	10

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Transmittal Letter	1	1
Information Disclosure Statement (IDS) Form (SB08)	2	2
Non Patent Literature	3	10

Warnings:

Information:

Total Files Size (in bytes):	356310

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/452410

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Kemal Ugur	Confirmation No.:	2120
Appl. No.:	13/344,893	Group Art Unit:	2483
Filed:	01/06/2012	Examiner:	Ellyar Y. Barazesh
For:	MOTION PREDICTION IN VIDEO CODING		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(c)

Attached is a list of documents on form PTO-1449 along with a copy of any cited foreign patent documents and non-patent literature document in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

It is requested that the Examiner consider these documents and officially make them of record in accordance with the provisions of 37 C.F.R. § 1.97 and Section 609 of the MPEP. By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

This Information Disclosure Statement is submitted in accordance with 37 C.F.R. § 1.97(c), before final Office Action or Allowance, whichever is earlier.

In accordance with the requirements of 37 C.F.R. § 1.97(c), the following statement as specified in 37 C.F.R. § 1.97(e) is made:

Each item of information contained in this statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this statement.

Respectfully submitted,

Grant Gildehaus
Registration No. 68,605

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UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/344,893	01/06/2012	Kemal UGUR	042933/452410	2120

10949 7590 01/23/2015
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
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EXAMINER	
BARAZESH, ELLYAR Y	

ART UNIT	PAPER NUMBER
2483	

NOTIFICATION DATE	DELIVERY MODE
01/23/2015	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No. 13/344,893	Applicant(s) UGUR ET AL.	
	Examiner ELLYAR Y. BARAZESH	Art Unit 2483	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 October 2014*.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-19* is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-19* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *06 January 2012* is/are: a)☒ accepted or b)☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b)
Paper No(s)/Mail Date *10/30/2014*.

3) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

1. The applicants have filed a response to the First Action on the Merits (FAOM).

2. Claims 3, 5, 7-12, 16, and 17 have been amended. Claims 1-19 are pending.

Response to Amendment

3. In light of the amendments made to claims 5 and 9, the objections directed to those claims are withdrawn.

4. In light of the amendment made to claim 3, the 35 USC 112, second paragraph, rejection directed to that claim has been withdrawn.

5. In light of the amendment made to claim 17, the 35 USC 101 rejection directed to that claim has been withdrawn.

6. In light of the amendment made to claim 9, claim 9 no longer invokes 35 USC 112, sixth paragraph.

Response to Arguments

7. Applicant's arguments filed 23 October 2014 have been fully considered but are not persuasive.

8. Applicant asserts that the prior art Ye et al. (US 2013/0142262 A1) (hereinafter Ye) does not disclose "determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision" as recited in the independent claims. Applicant states that paragraph 0028 of Ye teaches pixel precision related to a reference picture, and not related to a block of pixels of a video representation encoded in a bitstream. The Examiner respectfully disagrees with the Applicant's characterization of Ye.

Turning to Ye at paragraph 0022, it is disclosed that video blocks are input into the encoder 100, and that the encoder 100 processes video signal 102 block by block. Paragraph 0023 of Ye discloses that prediction during encoding can be performed on input video blocks of various integer pixel sizes, such as 16x16, 16x8, and 8x8, to name a few. For example, a 16x16 video block refers to a block of video data in a video frame that measures 16 pixels by 16 pixels. It follows that such a block has <u>full pixel precision</u> rather than a fractional pixel precision because the pixel values contained in each block are located at <u>integer</u> pixel locations. This full pixel precision is read to be a “first precision” in terms of the language in the independent claims. For an input video stream, integer sized pixel blocks (such as 16x16 sized blocks) encoded in an input bitstream are determined and predicted using motion compensation, where the pixel values at each integer location in each input pixel block provide for full pixel integer precision. Therefore, Ye indeed discloses "<u>determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision”</u> as recited in the independent claims.

Paragraph 0028 of Ye, as the Applicant points out, states that reference pictures may be provided with ½ pixel or ¼ pixel precision. However, the rejection of "a first precision" does not rely on these fractional pixel precisions of reference picture. Rather, as stated above, the rejection reads the integer full pixel precision of the 16x16, 16x8, etc. blocks of paragraphs 0022-0023 to be the “first precision.” The rejection utilizes the reference picture fractional pixel precision of paragraph 0028 to be the “second precision" as recited in the claims. In the rejection, Examiner cited paragraph 0028 in the citation to the “first precision” to show that for an input video block with full pixel precision, motion prediction and compensation may be performed using a reference picture block which has fractional pixel precision. Prediction using such fractional pixel precision in the reference block corresponds to a “second precision” that is higher than the “first precision” because pixel values at fractional pixel locations are used for prediction. Prediction using pixel values at fractional pixel locations allows for more accurate motion vectors during prediction, and therefore provides a higher prediction precision versus prediction that uses integer full pixel locations.

9. The prior art rejections of claims 1-19 are maintained.

Information Disclosure Statement

10. The information disclosure statement (IDS) was submitted on 30 October 2014. The submission is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Remarks

11. **Claims 18 and 19** recite the claim limitations **“an input to determine a block of pixels; a determinator to determine a type of the block; a first predictor to use said first reference pixel location; a second predictor to use said second reference pixel location; a combiner to combine; a shifter to decrease precision; means for: determining, using, combining, decreasing"** These claim limitations have been interpreted under 35 U.S.C. 112, sixth paragraph, because they use non-structural terms “**an input to; a determinator to; a first predictor to; a second predictor to; a combiner to; a shifter to; means for**” coupled with functional language

"**determine a block of pixels; determine a type of the block; use said first reference pixel location; use said second reference pixel location; combine; decrease precision; determining, using, combining, decreasing**" without reciting sufficient structure to achieve the function. Furthermore, the non-structural term is not preceded by a structural modifier.

Since these claim limitations invoke 35 U.S.C. 112, sixth paragraph, **claims 18 and 19** are interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112, sixth paragraph limitation:

[00120] In general, the various embodiments of the invention may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. For example, some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the invention is not limited thereto. While various aspects of the invention may be illustrated and described as block diagrams, flow charts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[00121] The embodiments of this invention may be implemented by computer software executable by a data processor of the mobile device, such as in the processor entity, or by hardware, or by a combination of software and hardware. Further in this regard it should be noted that any blocks of the logic flow as in the Figures may represent program steps, or interconnected logic circuits, blocks and functions, or a combination of program steps and logic circuits, blocks and functions. The software may be stored on such physical media as memory chips, or memory blocks implemented within the processor, magnetic media such as hard disk or floppy disks, and optical media such as for example DVD and the data variants thereof, CD.

[00122] The memory may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor-based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory. The data processors may be of any type suitable to the local technical environment, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multi-core processor architecture, as non-limiting examples.

[00123] Embodiments of the inventions may be practiced in various components such as integrated circuit modules. The design of integrated circuits is by and large a highly automated process. Complex and powerful software tools are available for converting a logic level design into a semiconductor circuit design ready to be etched and formed on a semiconductor substrate.

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

If applicant does **not** wish to have the claim limitations treated under 35 U.S.C. 112, sixth paragraph, applicant may amend the claim so that it will clearly not invoke 35 U.S.C. 112, sixth paragraph, or present a sufficient showing that the claim recites sufficient structure, material, or acts for performing the claimed function to preclude application of 35 U.S.C. 112, sixth paragraph.

For more information, see MPEP § 2173 et seq. and *Supplementary Examination Guidelines for Determining Compliance with 35 U.S.C. § 112 and for Treatment of Related Issues in Patent Applications*, 76 FR 7162, 7167 (Feb. 9, 2011).

Claim Rejections - 35 USC § 103

12. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

13. **Claim 1, 5, 7-9, 13, and 15-19** are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over **Ye et al. (US 2013/0142262 A1) (hereinafter Ye)** in view of **Noda et al. (US 2009/0087111 A1) (hereinafter Noda)**.

14. **Regarding claim 1**, Ye discloses a method comprising:

determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision **[Input frames are made up of blocks in the bitstream which hold pixels of full integer pixel precision because in later motion prediction, fractional pixel precision may be applied to the integer pixel values of input frames to predict a current frame. Paragraphs 0022-0023, 0028]**;

determining a type of the block **[For each input video block, it is determined whether a block is to be encoded temporally using neighboring reference frames or spatially using intra frame prediction. Paragraphs 0022-0024]**;

if the determining indicates that the block is a block predicted by using two or more reference blocks **[When a multi-directional block is input, multi-hypothesis prediction may be provided, such as bi-prediction temporal prediction, where two prediction signals from two reference blocks in two neighboring frames are combined to form the prediction for the current frame block. Paragraphs 0024-0025]**,

determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block **[In bi-directional prediction, a reference pixel location (x,y) is determined for reference picture 0 and another**

reference pixel location (x,y) is determined for reference picture 1 to form the prediction values P0(x,y) and P1(x,y). Paragraphs 0023-0028];

using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision **[First reference pixel location (x,y) for reference picture 0 is used to obtain prediction P0(x,y). 1/2, 1/4, and 1/8 fractional pixel precision may be used in motion prediction by interpolating integer pixel values. It is known in the art that such fractional pixel precision (sub-pixel precision) produces a finer and more precise motion tracking and prediction compared to integer pixel precision. Thus, the fractional precision used in motion prediction is a second precision higher than the first integer pixel precision that the input pixels have. Paragraphs 0025, 0028, Fig. 3]**;

using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision **[Second reference pixel location (x,y) for reference picture 1 is used to obtain prediction P1(x,y). 1/2, 1/4, and 1/8 fractional pixel precision may be used in motion prediction by interpolating integer pixel values. It is known in the art that such fractional pixel precision (sub-pixel precision) produces a finer and more precise motion tracking and prediction compared to integer pixel precision. Thus, the fractional precision used in motion prediction is a second precision higher than the first integer pixel precision that the input pixels have, and when used in**

bi-directional prediction, may be of the same second precision as the other reference frame P0. Paragraphs 0025, 0028, Fig. 3];

combining said first prediction and said second prediction to obtain a combined prediction **[The prediction signals P0(x,y) and P1(x,y) are combined in the paragraph 0025 equations to form the final bi-prediction signal P(x,y). Paragraph 0025]**; and

decreasing the precision of said combined prediction **[The sum of P0(x,y) and P1(x,y) is bit shifted to the right (either by 1 or by a value "S" in weighted prediction) in the paragraph 0025 equations. Bit shifting to the right reduces the number of bits and thereby causes a reduction of bit precision. Thus, the prediction P(x,y), which is formed by the combination of P0(x,y) and P1(x,y), has its precision decreased. Paragraph 0025].**

Ye does not explicitly disclose decreasing precision to said first precision.

However, Noda, in the same field of video compression, teaches decreasing the precision to said first precision **[The input image signal has a first precision bit depth of N. During encoding, the bit depth is increased by M and the predicted image has a second higher precision bit depth of N+M. After motion prediction and decoding, the decoded image also has a bit depth of N+M and is subject to bit depth reduction to decrease each pixel by M bits so the final image has a bit depth of N. Thus the decoded image has a decrease of precision from the second precision to the first precision. Paragraphs 0129-0131]**.

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of invention to modify the invention disclosed by Ye to add the teachings of Noda as above, in order to improve precision of the filter in motion compensation, reduce prediction error, and improve coding efficiency **[Noda; Paragraph 0131]**.

15. **Regarding claim 5**, Ye and Noda teach the method according to claim 1.

Furthermore, Ye discloses wherein said type of the block is a bi-directional block or a multidirectional block **[Multi-hypothesis prediction may be provided, such as bi-prediction temporal prediction (used by a bi-direcitonal block), where two prediction signals from two reference blocks in two neighboring frames are combined to form the prediction for the current frame block. Paragraphs 0022-0025]**.

16. **Regarding claim 7**, Ye and Noda teach the method according to claim 1.

Furthermore, Noda teaches wherein the first precision is 8 bits **[The input pixel values may have a precision of 8 bits. Paragraphs 0302-0303]**.

Ye teaches a prior art video encoding method where an input pixel value is a pixel value with a first integer bit precision **[Ye: Paragaphs 0024-0028]**, but differs from the claimed method in that it is not specified that the first precision is an 8 bit precision.

Noda teaches that the integer pixel value is an 8 bit integer pixel.

The substitution of one known element (first integer precision of Ye) for another (input 8 bit precision of Noda) would have been obvious to one of ordinary skill in the art at the time of invention because the substitution would have yielded predictable results, namely, the encoding and prediction of an input pixel value with a first integer bit precision of 8 bits.

17. **Regarding claim 8**, Ye and Noda teach the method according to claim 1.

Furthermore, Ye discloses the method further comprising: obtaining said first prediction and said second prediction by filtering pixel values of said reference blocks **[For bi-prediction, the current frame uses prediction signal P(x,y), which is formed by P0(x,y) and P1(x,y) from reference frames 0 and 1. Motion prediction is used to produce first prediction P0(x,y) for reference frame 0 and second prediction P1(x,y) for reference frame 1. In the motion prediction, a 6 tap interpolation filter may be applied to reference pictures 0 and 1 to obtain fractional pixel precision for prediction signals P0(x,y) and P1(x,y). Paragraphs 0024-0028]**.

18. **Regarding claim 9**, Ye discloses an apparatus comprising:

at least one processor and at least one memory **[Video encoder system may be embodied in a microcontroller processor which performs a process from instructions stored on a computer readable storage media (memory). Paragraph 0244]** including computer program code **[Computer code instructions for performing the video encoding may be stored on the media. Paragraph 0244].**

Claim 9 further recites the same elements as claim 1. Therefore, claim 9 is rejected in the same manner as claim 1.

19. **Regarding claim 13**, the same elements as claim 5 are recited. Therefore, claim 13 is rejected in the same manner as claim 5.

20. **Regarding claim 15**, the same elements as claim 7 are recited. Therefore, claim 15 is rejected in the same manner as claim 7.

21. **Regarding claim 16**, the same elements as claim 8 are recited. Therefore, claim 16 is rejected in the same manner as claim 8.

22. **Regarding claim 17**, Ye discloses a computer program product comprising at least one non-transitory computer readable storage medium having computer executable program code portions stored thereon **[Video encoder system may be embodied in a microcontroller processor which performs a process from instructions (code) stored on a computer readable storage media (memory). Paragraph 0244].**

Claim 17 further recites the same elements as claim 1. Therefore, claim 17 is rejected in the same manner as claim 1.

23. **Regarding claim 18**, Ye discloses an apparatus **[Video encoder. Paragraph 0022]** comprising: an input, a determinator, a first predictor, a second predictor, and a shifter **[Encoder has the structure of figure 1A, where input video is input into the system and the motion prediction unit determines kinds of blocks for inter and intra coding, and also provides for right bit shifting of the prediction P(x,y) for the**

current block based on predictions from reference frames according to the equation in paragraph 0025. Paragraph 0025, Fig. 1A].

Furthermore, claim 18 recites the same elements as claim 1. Thus, claim 18 is rejected in the same manner as claim 1.

24. **Regarding claim 19**, the same elements as claim 1 are recited. Therefore, claim 19 is rejected in the same manner as claim 1.

25. **Claims 2-4, 6, 10-12, and 14** are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over **Ye et al. (US 2013/0142262 A1) (hereinafter Ye)** in view of **Noda et al. (US 2009/0087111 A1) (hereinafter Noda)**, further in view of **Panchal et al. (US 2010/0086027 A1) (hereinafter Panchal).**

26. **Regarding claim 2**, Ye and Noda teach the method according to claim 1.

Ye and Noda do not explicitly teach the method further comprising: inserting a first rounding offset to said first prediction and said second prediction.

However, Panchal, in the same field of video coding, teaches the method further comprising: inserting a first rounding offset to said first prediction and said second prediction **[When algorithm 2 is used, the first rounding offset 2^r (equivalent to 2^y) is inserted to the sum of the prediction Pred0 for a first reference frame and the prediction Pred1 for a second reference frame. The first rounding offset may alternatively be equal to 32 if prediction algorithm 3 is used. Paragraphs 0060-0064]**.

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of invention to modify the invention disclosed by Ye and Noda to add the teachings of Panchal as above, in order to ensure that an integer number is provided in the prediction calculation and promote efficiency in the video coding **[Panchal; Paragraphs 0021, 0061]**.

27. **Regarding claim 3**, Ye and Noda teach the method according to claim 1.

Furthermore, Ye discloses the method further comprising: reducing the precision of said first prediction and said second prediction **[The sum of P0(x,y) and P1(x,y) is bit shifted to the right (either by 1 or by a value "S" in weighted prediction) in the paragraph 0025 equations. Bit shifting to the right reduces the number of bits and thereby causes a reduction of bit precision. Thus, the prediction P(x,y), which is formed by the combination of P0(x,y) and P1(x,y), has its precision decreased, and therefore, the precision of P0 and P1 is decreased. Paragraph 0025]**

Ye does not explicitly teach reducing precision to an intermediate prediction after adding a first rounding offset, said intermediate prediction being higher than said first precision

However**,** Noda teaches reducing precision to an intermediate prediction, said intermediate prediction being higher than said first precision **[Input pixel precision of N bits is increased to a second pixel precision of N+M bits. The N+M bit precision is then lowered to an intermediate N+M-L precision, where L<=M. Thus, the N+M-L**

precision is an intermediate precision higher than the N precision but lower than the N+M precision when L is less than M. Paragraphs 0133-0136].

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of invention to modify the invention disclosed by Ye to add the teachings of Noda as above, in order to improve precision of the filter in motion compensation, reduce prediction error, and improve coding efficiency **[Noda; Paragraph 0131]**.

Ye and Noda do not teach reducing precision after adding a first rounding offset.

However, Panchal teaches reducing precision after adding a first rounding offset **[When algorithm 2 is used, the first rounding offset 2^r (equivalent to 2^y) is inserted to the sum of the prediction Pred0 for a first reference frame and the prediction Pred1 for a second reference frame. The first rounding offset may alternatively be equal to 32 if prediction algorithm 3 is used. In both algorithms, after the rounding offset is added to the first and second predictions, the precision is reduced by right bit shifting the overall prediction pred(i,j) which consists of the summed first and second predictions. Paragraphs 0060-0064]**.

Therefore, it would have been obvious to a person of ordinary skill in the art at the time of invention to modify the invention disclosed by Ye and Noda to add the teachings of Panchal as above, in order to ensure that an integer number is provided in the prediction calculation and promote efficiency in the video coding **[Panchal; Paragraphs 0021, 0061]**.

28. **Regarding claim 4**, Ye, Noda, and Panchal teach the method according to claim 2.

Furthermore, Panchal teaches the method further comprising: inserting a second rounding offset to the combined prediction before said decreasing **[When algorithm 2 is used, second rounding offsets o1 and o2 (recall first rounding offset is 2^r for algorithm 2) are applied to the overall prediction pred(i,j) before a decrease of precision by pixel shifting 1 bit to the right. Paragraph 0061]**.

See the Panchal motivation of claim 1.

29. **Regarding claim 6**, Ye, Noda, and Panchal teach the method according to claim 2.

Furthermore, Panchal teaches wherein the first rounding offset is 2^y **[When algorithm 3 is used for prediction, the first rounding offset is equal to 32. This value is equal to 2^y when y is equal to 5 i.e. (2^5=32). Paragraph 0062]**, and said decreasing comprises right shifting the combined prediction y+1 bit **[When algorithm 3 is used, the rounding offset is equal to 32, which is equal to 2^y when y=5. When y=5, y plus 1 is equal to 6 i.e. (y+1=6). In algorithm 3, a right shift of 6 is applied to the combined prediction pred (i,j). Thus, the right shift of y+1 bits is present in algorithm 3. It is known in the art that bit shifting to the right reduces the number of bits and thereby causes a decrease of bit precision. Paragraph 0062]**.

See the Panchal motivation of claim 2.

30. **Regarding claim 10**, the same elements as claim 2 are recited. Therefore, claim 10 is rejected in the same manner as claim 2.

31. **Regarding claim 11**, the same elements as claim 3 are recited. Therefore, claim 11 is rejected in the same manner as claim 3.

32. **Regarding claim 12**, the same elements as claim 4 are recited. Therefore, claim 12 is rejected in the same manner as claim 4.

33. **Regarding claim 14**, the same elements as claim 6 are recited. Therefore, claim 14 is rejected in the same manner as claim 6.

Conclusion

34. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ELLYAR Y. BARAZESH whose telephone number is

(571)272-5226. The examiner can normally be reached on Monday through Friday 7:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Joseph Ustaris can be reached on (571)272-7383. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/ELLYAR Y BARAZESH/
Examiner, Art Unit 2483

/ANNER HOLDER/
Primary Examiner, Art Unit 2483

Substitute for form 1449/PTO (Revised 07/2007) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*	Complete if Known	
	Application Number	13/344,893
	Filing Date	01/06/2012
	First Named Inventor	Kemal Ugur
	Art Unit	2483
	Examiner Name	Ellyar Y. Barazesh
Sheet 1 of 1	Attorney Docket Number	042933/452410

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action from Korean Patent Application No. 2013-7020731, dated July 31, 2014	

Examiner Signature	/Ellyar Barazesh/	Date Considered	01/13/2015

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#35174831v1

Submitted October 30, 2014

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.B./

Search Notes	Application/Control No. 13344893	Applicant(s)/Patent Under Reexamination UGUR ET AL.
	Examiner ELLYAR Y BARAZESH	**Art Unit** 2483

CPC- SEARCHED

Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED

Symbol	Date	Examiner

US CLASSIFICATION SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES

Search Notes	Date	Examiner
Palm inventor search	7/10/2014	EYB
East search	7/10/2014	EYB
Consulted Primary Examiner Tung Vo about limitations of claim 1	7/10/2014	EYB
Updated East seach	1/13/2015	EYB

INTERFERENCE SEARCH

US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/ELLYAR Y BARAZESH/ Examiner.Art Unit 2483	

Index of Claims	Application/Control No. 13344893	Applicant(s)/Patent Under Reexamination UGUR ET AL.
	Examiner ELLYAR Y BARAZESH	Art Unit 2483

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/10/2014	01/13/2015							
	1	✓	✓							
	2	✓	✓							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
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	15	✓	✓							
	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19	✓	✓							

<table>
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(Revised 07/2007)

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Use as many sheets as necessary)</td><td colspan="2">Complete if Known</td></tr>
<tr><td>Application Number</td><td>13/344,893</td></tr>
<tr><td>Filing Date</td><td>01/06/2012</td></tr>
<tr><td>First Named Inventor</td><td>Kemal Ugur</td></tr>
<tr><td>Art Unit</td><td>2483</td></tr>
<tr><td>Examiner Name</td><td>Ellyar Y. Barazesh</td></tr>
<tr><td>Sheet</td><td>1</td><td>of</td><td>1</td><td>Attorney Docket Number</td><td>042933/452410</td></tr>
</table>

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action from Russian Patent Application No. 2013136693, dated November 28, 2014	NO

Examiner Signature		Date Considered	

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#35391232v1

Submitted February 26, 2015

Electronic Patent Application Fee Transmittal

Application Number:	13344893
Filing Date:	06-Jan-2012
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Filer:	Jonathan Abbott Thomas/Lisa Rone
Attorney Docket Number:	042933/452410

Filed as Large Entity

Filing Fees for **Utility under 35 USC 111(a)**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
	Total in USD ($)			**180**

Electronic Acknowledgement Receipt

EFS ID:	21609444
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/452410
Receipt Date:	26-FEB-2015
Filing Date:	06-JAN-2012
Time Stamp:	14:46:19
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	836
Deposit Account	160605
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	452410-RU_OA.pdf	81747 b6b8ad90487bb24a13e52f9d76194447b1d8291d	no	3

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2		452410-IDS.pdf	195524 1021b7088376eb57b26e858e11e60bfa433ca31d	yes	2

Multipart Description/PDF files in .zip description

Document Description	Start	End
Transmittal Letter	1	1
Information Disclosure Statement (IDS) Form (SB08)	2	2

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
3	Fee Worksheet (SB06)	fee-info.pdf	30403 524f24857d22ad3370eeb5113ece591992c363db	no	2

Warnings:

Information:

Total Files Size (in bytes): 307674

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/452410

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Kemal Ugur	Confirmation No.:	2120
Appl. No.:	13/344,893	Group Art Unit:	2483
Filed:	01/06/2012	Examiner:	Ellyar Y. Barazesh
For:	MOTION PREDICTION IN VIDEO CODING		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(d)

This Information Disclosure Statement is being filed after a Final Office Action under 37 C.F.R. § 1.113 or a Notice of Allowance under 37 C.F.R. § 1.311, but before payment of the Issue Fee. The Final Office Action or Notice of Allowance was mailed on January 23, 2015.

Attached is a list of documents on form PTO-1449 along with any cited foreign patent documents and non-patent literature documents in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

In accordance with the requirements of 37 C.F.R. § 1.97(d)(2), the following statement as specified in 37 C.F.R. § 1.97(e) is made:

Each item of information contained in this statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this statement.

The $180.00 fee specified in 37 C.F.R. § 1.17(p) is being paid at the time of e-filing. The Commissioner is authorized to charge any additional fee, or credit any refund, to our Deposit Account No. 16-0605.

Respectfully submitted,

/Grant Gildehaus/

Grant Gildehaus
Registration No. 68,805

CUSTOMER NO. 10949
ALSTON & BIRD LLP
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101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
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PTO/SB/30 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	13/344,893
Filing Date	January 6, 2012
First Named Inventor	Ugur et al.
Art Unit	2483
Examiner Name	Ellyar Y. Barazesh
Attorney Docket Number	042933/452410

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
      i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on ____________
      ii. ☐ Other ____________

   b. ☑ Enclosed
      i. ☑ Amendment/Reply
      ii. ☐ Affidavit(s)/ Declaration(s)
      iii. ☐ Information Disclosure Statement (IDS)
      iv. ☐ Other ____________

2. Miscellaneous
   a. ☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of ________ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)
   b. ☐ Other ____________

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.
   a. ☑ The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. 160605.
      i. ☑ RCE fee required under 37 CFR 1.17(e)
      ii. ☐ Extension of time fee (37 CFR 1.136 and 1.17)
      iii. ☐ Other ____________
   b. ☐ Check in the amount of $ ____________ enclosed
   c. ☐ Payment by credit card (Form PTO-2038 enclosed)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	/Grant A. Gildehaus/	Date	March 27, 2015
Name (Print/Type)	Grant A. Gildehaus	Registration No.	68,805

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

Signature			
Name (Print/Type)		Date	

Electronic Patent Application Fee Transmittal

Application Number:	13344893
Filing Date:	06-Jan-2012
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Filer:	Grant Allen Gildehaus/Emma Pham
Attorney Docket Number:	042933/452410

Filed as Large Entity

Filing Fees for **Utility under 35 USC 111(a)**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for Continued Examination	1801	1	1200	1200
		Total in USD ($)		**1200**

Electronic Acknowledgement Receipt

EFS ID:	21899216
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	10949
Filer:	Grant Allen Gildehaus/Emma Pham
Filer Authorized By:	Grant Allen Gildehaus
Attorney Docket Number:	042933/452410
Receipt Date:	27-MAR-2015
Filing Date:	06-JAN-2012
Time Stamp:	13:40:33
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1200
RAM confirmation Number	10487
Deposit Account	160605
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		Response.pdf	619198 26c4b6e7b15eeb67314d80ed61a0d1793babbffa	yes	10

Multipart Description/PDF files in .zip description

Document Description	Start	End
Amendment Submitted/Entered with Filing of CPA/RCE	1	1
Claims	2	7
Applicant Arguments/Remarks Made in an Amendment	8	10

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Request for Continued Examination (RCE)	RCE.pdf	148659 b83fcf2643e5e8d0815c1fd9f9d87f30b6d786a7	no	1

Warnings:

This is not a USPTO supplied RCE SB30 form.

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
3	Fee Worksheet (SB06)	fee-info.pdf	30163 10a1206d7075c84977804517eb28acddf22bf8de	no	2

Warnings:

Information:

Total Files Size (in bytes): 798020

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.:	13/344,893	Confirmation No.: 2120
Applicant(s):	Ugur et al.	
Filed:	January 6, 2012	
Art Unit:	2483	
Examiner:	Ellyar Y. Barazesh	
Title:	MOTION PREDICTION IN VIDEO CODING	

Docket No.:	042933/452410
Customer No.:	10949

Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT AFTER FINAL UNDER 37 CFR § 1.116

Sir:

In response to the Final Office Action dated January 23, 2015, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims beginning on page 2 of this paper.

Remarks/Arguments begin on page 8 of this paper.

Amendments to the Claims:

1. (Currently Amended) A method comprising:

determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

determining a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combining said first prediction and said second prediction to obtain a combined prediction; and

decreasing the precision of said combined prediction to said first precision.

2. (Original) The method according to claim 1 further comprising:

inserting a first rounding offset to said first prediction and said second prediction.

3. (Previously Presented) The method according to claim 1 further comprising:

reducing the precision of said first prediction and said second prediction to an intermediate prediction after adding a first rounding offset, said intermediate prediction being higher than said first precision.

4. (Original) The method according to claim 2 further comprising:

inserting a second rounding offset to the combined prediction before said decreasing.

5. (Previously Presented) The method according to claim 1, wherein said type of the block is a bi-directional block or a multidirectional block.

6. (Original) The method according to claim 2, wherein the first rounding offset is 2^y, and said decreasing comprises right shifting the combined prediction y+1 bit.

7. (Previously Presented) The method according to claim 1, wherein the first precision is 8 bits.

8. (Previously Presented) The method according to claim 1 further comprising:

obtaining said first prediction and said second prediction by filtering pixel values of said reference blocks.

9. (Currently Amended) An apparatus comprising:

at least one processor and at least one memory including computer program code, the at least one memory and computer program code configured to, with the processor, cause the apparatus to:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

determine a type of the block;

wherein if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

10. (Previously Presented) The apparatus according to claim 9, wherein the at least one memory and computer code are further configured to:

insert a first rounding offset to said first prediction and said second prediction.

11. (Previously Presented) The apparatus according to claim 9, wherein the at least one memory and computer code are further configured to:

reduce the precision of said first prediction and said second prediction to an intermediate prediction after adding said first rounding offset, said intermediate prediction being higher than said first precision.

12. (Previously Presented) The apparatus according to claim 10, wherein the at least one memory and computer code are further configured to:

insert a second rounding offset to the combined prediction before said decreasing.

13. (Original) The apparatus according to any of the claims 9, wherein said type of the block is a bi-directional block or a multidirectional block.

14. (Original) The apparatus according to claim 10, wherein the first rounding offset is 2^y, and said decreasing comprises right shifting the combined prediction y+1 bits.

15. (Original) The apparatus according to any of the claims 9, wherein the first precision is 8 bits.

16. (Previously Presented) The apparatus according to any of the claims 9, wherein the at least one memory and computer code are further configured to:

obtain said first prediction and said second prediction by filtering pixel values of said reference blocks.

17. (Currently Amended) A computer program product comprising at least one non-transitory computer readable storage medium having computer executable program code portions stored therein, the computer executable program code portions comprising program code instructions configured to:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

determine a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks,

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

combine said first prediction and said second prediction to obtain a combined prediction; and

decrease the precision of said combined prediction to said first precision.

18. (Currently Amended) An apparatus comprising:

an input to determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

a determinator to determine a type of the block; wherein if the determining indicates that the block is a block predicted by using two or more reference blocks, said determinator further to determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

a first predictor to use said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

a second predictor to use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

a combiner to combine said first prediction and said second prediction to obtain a combined prediction; and

a shifter to decrease the precision of said combined prediction to said first precision.

19. (Currently Amended) An apparatus comprising:

means for determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

means for determining a type of the block;

means for determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block, if the determining indicates that the block is a block predicted by using two or more reference blocks;

means for using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

means for using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision;

means for combining said first prediction and said second prediction to obtain a combined prediction; and

means for decreasing the precision of said combined prediction to said first precision.

REMARKS/ARGUMENTS

The present application includes Claims 1-19. Claims 1-19 were rejected. By this Amendment, Claims 1, 9, 17, 18, and 19 have been amended. Support for the amendment to Claims 1, 9, 17, 18, and 19 may be found in at least paragraph 134. As such these amendments do not introduce new matter.

Claim Rejections - 35 USC § 103

Claims 1, 5, 7-9, 13, and 15-19 were rejected under pre-AIA 35 USC § 103(a) as being unpatentable over Ye et al. (US 2013/0142262 A1) in view of Noda et al. (US 2009/0087111 A1).

Claims 2-4, 6, 10-12, and 14 were rejected under pre-AIA 35 USC § 103(a) as being unpatentable over Ye et al. in view of Noda et al. further in view of Panchal et al. (US 2010/0086027 A1).

Applicant respectfully asserts that Ye does not teach or suggest each of the elements recited in independent Claim 1, 9, 17, 18, or 19. In particular, independent Claims 1, 9, 17, 18, and 19, as amended, each recite, albeit in somewhat different language, "wherein the first precision indicates the number of bits needed to represent values of said pixels" and "wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction." Applicant respectfully asserts that Ye fails to teach or suggest at least this recitation of the independent Claims 1, 9, 17, 18, and 19.

The rejection asserts that "Ye discloses that prediction during encoding can be performed on input video blocks of various integer pixel sizes, such as 16x16, 16x8, and 8x8, to name a few." See office action mailed January 23, 2015; pg. 3. "For example, a 16x16 video block refers to a block of video data in a video frame that measures 16 pixels by 16 pixels." *Id.* "It follows that such as block has full pixel precision rather that a fractional pixel precision because the pixel values contained in each block are located at integer pixel locations." *Id* (Emphasis in the original). "The rejection reads the integer full pixel precision of the 16x16, 16x8, etc. blocks of paragraphs 0022-0023 to be the 'first precision.'" *Id.* In other words, the rejection construes the precision of a pixel as a location of a pixel, e.g. integer-pel, half-pel, quarter-pel.

Applicant has amendment the independent claims to clarify that the first precision indicates the number of bits required to represent values of said pixels and the second precision indicates the number of bits need to represent values of said first prediction and values of said second prediction, neither of which is taught or suggested by Ye.

Noda is directed toward image encoding and decoding of moving images and contains no teaching or suggestion of the above described elements of the rejected claims. Indeed, Noda was not cited for this proposition.

Panchal is directed toward efficient prediction mode selection and contains no teaching or suggestion of the above described elements of the rejected claims. Indeed, Panchal was not cited for this proposition.

Since none of the cited references teaches or suggests "wherein the first precision indicates the number of bits needed to represent values of said pixels" or "wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction," as set forth in various forms by the independent claims, it logically follows that no proper combination of the cited references teaches or suggests these same recitations.

For at least the reasons discussed above, Applicant respectfully submits that independent Claims 1, 9, 17, 18, and 19 are patentable over Ye alone or in combination with Noda and/or Panchal. Applicant therefore respectfully requests that the rejections of independent Claims 1, 9, 17, 18, and 19, as well as the claims which depend therefrom, be withdrawn.

The patentability of the independent claims has been argued as set forth above and thus the Applicant will not take this opportunity to argue the merits of the rejection with regard to the dependent claims. However, the Applicant does not concede that the dependent claims are not independently patentable and reserves the right to argue the patentability of the dependent claims at a later date if necessary.

CONCLUSION

In light of the remarks above, Applicant respectfully submits that the application is in condition for allowance and respectfully requests that a Notice of Allowance be issued. The

Examiner is encouraged to contact Applicant's undersigned attorney to resolve any remaining issues in order to expedite examination of the present application.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefor (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/344,893	Filing Date 01/06/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT

03/27/2015	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 19	Minus	** 20	= 0	x $80 =	0
Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	x $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	**0**

AMENDMENT

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/GAIL WOOTEN/

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/344,893	01/06/2012	Kemal UGUR	042933/452410	2120

10949 7590 07/28/2015
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EXAMINER	
LE, PETER D	
ART UNIT	**PAPER NUMBER**
2488	
NOTIFICATION DATE	**DELIVERY MODE**
07/28/2015	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No. 13/344,893	Applicant(s) UGUR ET AL.	
	Examiner PETER D. LE	Art Unit 2488	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *03/27/2015*.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.
2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.
3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-19* is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.
6)☐ Claim(s) _____ is/are allowed.
7)☒ Claim(s) *1-19* is/are rejected.
8)☐ Claim(s) _____ is/are objected to.
9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.
11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a)☐ All b)☐ Some** c)☐ None of the:
1.☐ Certified copies of the priority documents have been received.
2.☐ Certified copies of the priority documents have been received in Application No. _____.
3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *02/26/2015*.
3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
4) ☐ Other: _____.

DETAILED ACTION

The present application is being examined under the pre-AIA first to invent provisions.

Amendment, filed on 03/27/2015, has been entered.

Claims 1-19 are pending with claims 1, 9, and 17 – 19 being amended.

Continued Examination Under 37 CFR 1.114

1) A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114.

Examiner's Note

The instant application has a lengthy prosecution history and the examiner encourages the applicant to have an interview (telephonic or personal) with the examiner prior to filing a response to the instant office action. Also, prior to the interview the examiner encourages the applicant to present multiple possible claim amendments, so as to enable the examiner to identify claim amendments that will advance prosecution in a meaningful manner.

Response to Arguments/Amendments

Presented arguments have been fully considered, but some are rendered moot in view of the new ground(s) of rejection necessitated by amendment(s) initiated by the applicant(s).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

1. **Claims 1-19** rejected under 35 U.S.C. 103(a) as being unpatentable over Ye et al ("Ye") [U.S Patent Application Pub. 2013/0142262 A1] in view of Noda et al. [U.S Patent Application Pub. 2009/0087111 A1]

Regarding claim 1, Ye meets the claim limitations as follows:

A method comprising:

determining a block of pixels of a video representation *(i.e. input video 102 block by block) [Fig. 1A; para. 0022: 'A typically used video block unit 16x16 pixels']* encoded in a bitstream *[Fig. 1A: video block being transformed (104), quantized*

(106) and entropy encoded (108) to become bitstream (120)], values of said pixels having a first precision *(i.e. values of said pixels are quantized (106). So a first precision (bit-depth) is inherent) [para. 0051: r^{adapt} represents the number of bits needed to code the filter coefficient]*, wherein the first precision indicates the number of bits needed to represent values of said pixels;

determining a type of the block *(i.e. inherent in MPEG4; H.264/AVC) [Fig. 1A: Ref. 180, 160, 162: Coding mode, prediction mode; para. 0022-0025: Spatial prediction, inter prediction (e.g. Bi-prediction)]*;

if the determining indicates that the block is a block predicted by using two or more reference blocks *(i.e. Bi-prediction)*, determining *(i.e. it is inherent for B—prediction)* a first reference pixel location in a first reference block and a second reference pixel location in a second reference block *[para. 0025: 'Bi-prediction essentially combines two prediction signals', the equation $P(x,y) = (w.P_0 (x,y)+(W-w).P_1 (x,y)+W/2) >> S$]*;

using said first reference pixel location *(i.e. $P_0 (x,y)$)* to obtain a first prediction *[para. 0025: '**P_0 (x,y)** and $P_1 (x,y)$ are the prediction signals for the location (x, y) from **each reference picture**, and P(x, y) is the final bi-prediction signal', the equation $P(x,y) = (w.P_0 (x,y)+(W-w).P_1 (x,y)+W/2) >> S$]*, said first prediction having a second precision, which is higher than said first precision *(i.e. $w.P_0 (x,y)$).*

Like $W=2^S$ ($W= 1<<S$), ***w is understood to be an integer*** *($w=2^N$)* ***to increase the precision of P_0 (x,y)****) [Fig. 3; para. 0028: 'Motion prediction or motion compensation (i.e. inter-prediction) at unit 162 may be performed with fractional-pixel precision (i.e. higher precision);'motion precision of full-pixel, ½-pixel, and ¼ pixel is allowed']*, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

using said second reference pixel location *(i.e. P_1 (x,y))* to obtain a second prediction *(($W-w$).P_1(x,y)) [para. 0025: '**P_0 (x,y)** and P_1(x,y) are the prediction signals for the location (x, y) from **each reference picture**, and P(x, y) is the final bi-prediction signal', the equation $P(x,y) = (w.P_0(x,y)+(W-w).P_1(x,y)+W/2) >> S$]*, said second prediction having the second precision, which is higher than said first precision *(($W-w$).P_1(x,y) where* ***$W = 1 << S$ (i.e. $W = 2^S$)*** *) [Fig. 3; para. 0028: 'Motion prediction or motion compensation (i.e. inter-prediction) at unit 162 may be performed with fractional-pixel precision (i.e. higher precision);'motion precision of full-pixel, ½-pixel, and ¼ pixel is allowed']*;

combining said first prediction and said second prediction to obtain a combined prediction *[para. 0025: 'Bi-prediction essentially combines two prediction signals', the equation $P(x,y) = (w.P_0(x,y)+(W-w).P_1(x,y)+W/2) >> S$]*; and decreasing the precision of said combined prediction to said first precision *[para. 0025:, the equation* $P(x,y) = (w.P_0(x,y)+(W-w).P_1(x,y)+W/2) >> S$ *where S is a bit shift to the right (Note: a binary number which is shifted to the right by S bits is equivalent to division of the binary number by* 2^S *(i.e. decreasing the bit-depth (Least Significant Bits (LSB) or the precision)].*

Ye does not disclose explicitly the following claim limitations (emphasis added):

using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is <u>higher than said first precision</u>, wherein the second precision indicates <u>the number of bits needed to represent values of said first prediction and values of said second prediction</u>;

using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is <u>higher than said first precision</u>;

decreasing the precision of said combined prediction <u>to said first precision</u>;

However in the same field of endeavor Noda discloses the deficient claim as follows:

using said first reference pixel location to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision *(i.e. (N+M) bit depth) [Fig. 1B: Increase pixel bit depth S13; para. 0012: 'convert bit depth of each pixel having an N bit depth to an (N+M) bit depth' to generate a prediction image of the (N+M) bit depth; para. 0078, 0081: Eq. (1) shows a pixel* *value is left-shifted by M bits]*, wherein the second precision indicates the number of bits needed to represent values of said first prediction *(i.e. N bit depth)* and values of said second prediction *(i.e. (M+N) bit depth)*;

using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision *(i.e. (N+M) bit depth) [Fig. 1B: Increase pixel bit depth S13; para. 0012: 'convert bit depth of each pixel having an N bit depth to an (N+M) bit depth' to generate a prediction image of the (N+M) bit depth; para. 0078, 0081: Eq. (1) shows a pixel value is left-shifted by M bits]*;

decreasing the precision of said combined prediction to said first precision *[para. 0109, 0129-0131: Eq.2 shows decreasing by M bits as obviousness. Note: The input image signal has a first precision bit depth of N. During encoding, the bit depth is increased by M and the predicted image has a second higher precision bit depth of N+M. After motion prediction and decoding, the decoded image also has a bit depth of N+M and is subject to bit depth reduction to decrease each pixel by M bits so the final image has a bit depth of N. Thus the decoded image has a decrease of precision from the second precision to the first precision].*

Ye and Noda are combinable because they are from the same field of video compression.

It would have been obvious to one with ordinary skill in the art at the same time of invention to combine teachings of Ye and Noda as motivation to convert bit depth of each pixel of an input image to be higher so as to reduce the prediction error.

Regarding claim 2, Ye meets the claim limitations as follows:

The method according to claim 1 further comprising: inserting a first rounding offset *(i.e. W/2) [para. 0025: the equation* $P(x,y) = (w.P_0 (x,y)+(W-w).P_1 (x,y)+W/2) >> S$*]* to said first prediction *(i.e.* $w.P_0 (x,y)$*)* and said second prediction *(*$(W-w).P_1 (x,y)$*).*

Regarding claim 3, Ye meets the claim limitations as follows:

The method according to claim 1 further comprising:

reducing *(i.e. right-shift of S bits)* the precision of said first prediction *(i.e.* $w.P_0 (x,y)$*) [para. 0025: '**P_0 (x,y)** and P_1 (x,y) are the prediction signals for the location (x, y) from **each reference picture**, and P(x, y) is the final bi-prediction signal', the equation* $P(x,y) = (w.P_0 (x,y)+(W-w).P_1 (x,y)+W/2) >> S$*]* and said second prediction *(*$(W-w).P_1 (x,y)$*) [para. 0025: '**P_0 (x,y)** and P_1 (x,y) are the prediction signals for the location (x, y) from **each reference picture**, and P(x, y) is the final bi-prediction signal', the equation* $P(x,y) = (w.P_0 (x,y)+(W-w).P_1 (x,y)+W/2) >> S$*]* to an intermediate prediction *(i.e. interpolation or fraction* *pixels) [para. 0028]* after adding a first rounding offset *(i.e. W/2)*, said intermediate prediction *[Fig. 3; para. 0028: 'Motion prediction or motion compensation (i.e. inter-prediction) at unit 162 may be performed with fractional-pixel precision (i.e. higher precision);'motion precision of full-pixel, ½-pixel, and ¼ pixel is allowed']* being higher than said first precision *(i.e. the intermediate prediction from the* 1^{st} *reference is* $w.P_0$ *(x,y) being higher than said first precision* P_0 *(x,y) because of integer coefficient w; the intermediate prediction from the 2nd reference is (W-w)* P_1 *(x,y) being higher than said first precision* P_1 *(x,y) because of integer coefficient (W-w) where* $W = 1 << S = 2^S$*)* .

Ye does not disclose explicitly the following claim limitations (emphasis added):

said intermediate prediction being <u>higher than said first precision.</u>

However in the same field of endeavor Noda discloses the deficient claim as follows:

said intermediate prediction being higher than said first precision *(i.e. (N+M) bit depth) [Fig. 1B: Increase pixel bit depth S13; para. 0012: 'convert bit depth of each pixel having an N bit depth to an (N+M) bit depth (i.e. intermediate step of prediction)' to generate a prediction image of the (N+M) bit depth; para. 0078, 0081: Eq. (1 or 1-1 or 1-2) shows a pixel value is left-shifted by M bits].*

Ye and Noda are combinable because they are from the same field of video compression. It would have been obvious to one with ordinary skill in the art at the same time of invention to combine teachings of Ye and Noda as motivation to convert bit depth of each pixel of an input image to be higher so as to reduce the prediction error.

Regarding claim 4, Ye meets the claim limitations as follows:

The method according to claim 2 further comprising: inserting a second rounding offset *(i.e. inserting scale w to P_0 (x,y) and scale (W-w) to P_1 (x,y)) [para. 0025: the equation $P(x,y) = (w.P_0(x,y)+(W-w).P_1(x,y)+W/2) >> S$]* to the combined prediction before said decreasing.

Ye does not disclose explicitly the following claim limitations (emphasis added):

The method according to claim 2 further comprising: inserting <u>a second rounding offset</u> to the combined prediction before said decreasing.

However in the same field of endeavor Noda discloses the deficient claim as follows:

inserting a second rounding offset *(i.e. offset) [para. 0078: Eq. 1-1 or Eq. 1-2: increase bit depth of the input image signal K to become K' by addition of offset]* to the combined prediction before said decreasing.

Ye and Noda are combinable because they are from the same field of video compression. It would have been obvious to one with ordinary skill in the art at the same time of invention to combine teachings of Ye and Noda as motivation to convert bit depth of each pixel of an input image to be higher so as to reduce the prediction error.

Regarding claim 5, Ye meets the claim limitations as follows:

The method according to claim 1, wherein said type of the block is a bi-directional block *[Fig. 2; para. 0024: bi-prediction]* or a multidirectional block.

Regarding claim 6, Ye meets the claim limitations as follows:

The method according to claim 2, wherein the first rounding offset is 2^y *(i.e. W/2. Note:* $W = 1<<S$ *or* $W/2 = 2^{(S-1)}$*) [para. 0025: "wherein W and S respectively represent a weighting factor and bit shift for fixed-pointg operation and W=1<<S]*, and said decreasing comprises right shifting *(i.e. >>S)* the combined prediction y+ 1 bit *(i.e. S bits) [para. 0025: the equation* $P(x,y) = (w.P_0(x,y)+(W-w).P_1(x,y)+W/2) >> S$*]*.

Regarding claim 7, Ye meets the claim limitations set forth in claim 1.

Ye does not disclose explicitly the following claim limitations (emphasis added):

The method according to claim 1, wherein the first precision is 8 bits.

However in the same field of endeavor Noda discloses the deficient claim as follows:

wherein the first precision is 8 bits *[Fig. 41 shows Input Pixel Value (8bit); para. 302-303]*.

Ye and Noda are combinable because they are from the same field of video compression. It would have been obvious to one with ordinary skill in the art at the same time of invention to combine teachings of Ye and Noda as motivation to use either 8bit or 12bit video input because it is video standard.

Regarding claim 8, Ye meets the claim limitations as follows:

> The method according to claim 1 further comprising: obtaining said first prediction and said second prediction by filtering pixel values of said reference blocks *[Fig. 5, 8 depict adaptive filters for each reference picture separately; para. 0024-0029 disclosing 6-tap interpolation filter]*.

Regarding claim 9, Ye meets the claim limitations as follows (emphasis added):

> An apparatus comprising: at least one processor *(e.g. computer systems, FPGA or ASIC) [para. 0224]* and at least one memory *(i.e. a CRM) [para. 0254]* including computer program code, the at least one memory and computer program code configured to, with the processor, cause the apparatus to: **the same limitations set forth in claim 1**. Therefore claim 9 is rejected in the same manner as claim 1.

Regarding claim 10, all claim limitations are set forth as claim 2 in the apparatus form and rejected as per discussion for claim 2.

Regarding claim 11, all claim limitations are set forth as claim 3 in the apparatus form and rejected as per discussion for claim 3.

Regarding claim 12, all claim limitations are set forth as claim 4 in the apparatus form and rejected as per discussion for claim 4.

Regarding claim 13, all claim limitations are set forth as claim 5 in the apparatus form and rejected as per discussion for claim 5.

Regarding claim 14, all claim limitations are set forth as claim 6 in the apparatus form and rejected as per discussion for claim 6.

Regarding claim 15, all claim limitations are set forth as claim 7 in the apparatus form and rejected as per discussion for claim 7.

Regarding claim 16, all claim limitations are set forth as claim 8 in the apparatus form and rejected as per discussion for claim 8.

Regarding claim 17, all claim limitations are set forth as claim 9 in the form of computer program product comprising at least one non-transitory computer readable storage medium and rejected as per discussion for claim 9.

Regarding claim 18, all claim limitations are set forth as claim 1 in the form of an apparatus and rejected as per discussion for claim 1.

Regarding claim 19, all claim limitations are set forth as claim 1 in the form of an apparatus and rejected as per discussion for claim 1.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. See form 892.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to PETER D. LE whose telephone number is (571)270-5382. The examiner can normally be reached on Monday - (Alternate) Friday from 7:30AM-5PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, SATH PERUNGAVOOR can be reached on 571-272-7455. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/PETER D LE/
Examiner, Art Unit 2488

Substitute for form 1449/PTO (Revised 07/2007) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				**Complete if Known**	
				Application Number	13/344,893
				Filing Date	01/06/2012
				First Named Inventor	Kemal Ugur
				Art Unit	2483
				Examiner Name	~~Ellyar Y. Barazesh~~ Peter D. Le
Sheet	*1*	of	1	Attorney Docket Number	042933/452410

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action from Russian Patent Application No. 2013136693, dated November 28, 2014	NO

Examiner Signature	/Peter Le/	Date Considered	07/21/2015

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#35391232v1

Submitted February 26, 2015

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.L./

Index of Claims	Application/Control No. 13344893	Applicant(s)/Patent Under Reexamination UGUR ET AL.
	Examiner PETER D. LE	Art Unit 2488

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE									
Final	Original	07/10/2014	01/13/2015	07/21/2015							
	1	✓	✓	✓							
	2	✓	✓	✓							
	3	✓	✓	✓							
	4	✓	✓	✓							
	5	✓	✓	✓							
	6	✓	✓	✓							
	7	✓	✓	✓							
	8	✓	✓	✓							
	9	✓	✓	✓							
	10	✓	✓	✓							
	11	✓	✓	✓							
	12	✓	✓	✓							
	13	✓	✓	✓							
	14	✓	✓	✓							
	15	✓	✓	✓							
	16	✓	✓	✓							
	17	✓	✓	✓							
	18	✓	✓	✓							
	19	✓	✓	✓							

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S2	1	13/344893.app.	US-PGPUB; USPAT	OR	ON	2015/07/15 21:24
S3	6190	(H04N19/42 OR H04N19/523 OR H04N19/577).CPC.	US-PGPUB; USPAT	OR	ON	2015/07/15 21:26
S4	38055	(bit NEAR2 pixel)	US-PGPUB; USPAT	OR	ON	2015/07/15 21:48
S5	4413	(bit NEAR2 pixel) WITH (resolution)	US-PGPUB; USPAT	OR	ON	2015/07/15 21:49
S6	4897	(bit NEAR2 pixel) WITH (resolution precision)	US-PGPUB; USPAT	OR	ON	2015/07/15 21:49
S7	7265	((bit NEAR2 pixel) (bit NEAR2 depth)) WITH (resolution precision)	US-PGPUB; USPAT	OR	ON	2015/07/15 22:35
S8	160	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits)) WITH (resolution precision) WITH (predict$3))	US-PGPUB; USPAT	OR	ON	2015/07/15 22:37
S9	8	("6512523" | "20100002770" | "20100086027" | "20090087111" | "6539058" | "20090257503" | "20080089417" | "20100086027" | "20130142262").PN.	US-PGPUB; USPAT	OR	ON	2015/07/15 22:48
S10	1	S9 and S7	US-PGPUB; USPAT	OR	ON	2015/07/15 22:59
S11	100132	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits) (bit NEAR2 length)) WITH (determin$3 conver$5 increas$3 increment$3 decreas$3 decrement$3))	US-PGPUB; USPAT	OR	ON	2015/07/15 23:31
S12	2914	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits) (bit NEAR2 length)) WITH (determin$3 conver$5 increas$3 increment$3 decreas$3 decrement$3) WITH (predict$3 precision))	US-PGPUB; USPAT	OR	ON	2015/07/15 23:32
S13	1	13/344893.app. AND (predict$3 WITH precision)	US-PGPUB; USPAT	OR	ON	2015/07/15 23:51
S14	90	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits) (bit NEAR2 length)) WITH (determin$3 conver$5 increas$3 increment$3 decreas$3 decrement$3) WITH (predict$3 precision)) SAME (inter$2predict$3 intra$2predict$3 inter$2frame intra$2frame)	US-PGPUB; USPAT	OR	ON	2015/07/15 23:56

S15	806	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits) (bit NEAR2 length)) WITH (predict$3 precision)) SAME (inter$2predict$3 intra$2predict$3 inter$2frame intra$2frame)	US-PGPUB; USPAT	OR	ON	2015/07/16 00:44
S16	716	S15 not S14	US-PGPUB; USPAT	OR	ON	2015/07/16 00:44
S17	546	(((bit NEAR2 pixel) (bit NEAR2 depth) (bit NEAR2 length)) WITH (predict$3 precision)) SAME (inter$2predict$3 intra$2predict$3 inter$2frame intra$2frame)	US-PGPUB; USPAT	OR	ON	2015/07/16 00:46
S18	509	(((bit NEAR2 pixel) (bit NEAR2 depth) (bit NEAR2 length)) WITH (determin$3 calculat$3 conver$5 precision)) SAME (inter$2predict$3 intra$2predict$3 inter$2frame intra$2frame) SAME (predict$3)	US-PGPUB; USPAT	OR	ON	2015/07/16 01:42
S19	14	(((bit NEAR2 pixel) (bit NEAR2 depth) (bit NEAR2 length)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME (inter$2predict$3 intra$2predict$3 inter$2frame intra$2frame) SAME (predict$3)	US-PGPUB; USPAT	OR	ON	2015/07/16 01:43
S20	5180	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision))	US-PGPUB; USPAT	OR	ON	2015/07/16 01:53
S21	219	(((bit NEAR2 pixel) (bit NEAR2 depth) (bit NEAR2 length)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME (predict$3)	US-PGPUB; USPAT	OR	ON	2015/07/16 01:54
S22	580	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME precision	US-PGPUB; USPAT	OR	ON	2015/07/16 01:54
S23	539	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) WITH precision	US-PGPUB; USPAT	OR	ON	2015/07/16 01:55
S24	2	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) WITH precision WITH offset WITH shift$5	US-PGPUB; USPAT	OR	ON	2015/07/16 02:02
S25	1	"20100086027".pn.	US-PGPUB; USPAT	OR	ON	2015/07/20 18:36

7/21/2015 2:45:27 AM
C:\Users\ple1\Documents\EAST\Workspaces\13344893.wsp

Search Notes	Application/Control No. 13344893	Applicant(s)/Patent Under Reexamination UGUR ET AL.
	Examiner PETER D. LE	Art Unit 2488

CPC- SEARCHED

Symbol	Date	Examiner
H04N19/42 OR H04N19/523 OR H04N19/577	7/21/2015	PL

CPC COMBINATION SETS - SEARCHED

Symbol	Date	Examiner

US CLASSIFICATION SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES

Search Notes	Date	Examiner
See EAST Search History	7/21/2015	PL

INTERFERENCE SEARCH

US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/ELLYAR Y BARAZESH/ Examiner.Art Unit 2483	

Substitute for form SB08 (Revised 07/09) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				**Complete if Known**	
				Application Number	13/344,893
				Filing Date	01/06/2012
				First Named Inventor	Kemal Ugur
				Art Unit	2488
				Examiner Name	Peter D. Le
Sheet	*1*	of	1	Attorney Docket Number	042933/452410

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action from Korean Patent Application No. 2013-7020731, dated August 26, 2015	YES

Examiner Signature		Date Considered	

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#35877281v1

Submitted September 21, 2015

Electronic Acknowledgement Receipt

EFS ID:	23549279
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/452410
Receipt Date:	21-SEP-2015
Filing Date:	06-JAN-2012
Time Stamp:	12:43:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		452410-IDS.pdf	245003 441c27ae003e7817402fe0dc58fb3d31c2f2663c	yes	2

	Multipart Description/PDF files in .zip description				
	Document Description		**Start**		**End**
	Transmittal Letter		1		1
	Information Disclosure Statement (IDS) Form (SB08)		2		2
Warnings:					
Information:					
2	Non Patent Literature	452410-KR_Office_Action.pdf	770894 c79060ff4cc1151ce8250dd415fe053f1d84f72c	no	7
Warnings:					
Information:					
		Total Files Size (in bytes):	1015897		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/452410

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Kemal Ugur	Confirmation No.:	2120
Appl. No.:	13/344,893	Group Art Unit:	2488
Filed:	01/06/2012	Examiner:	Peter D. Le
For:	MOTION PREDICTION IN VIDEO CODING		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(c)

Attached is a list of documents on form PTO-1449 along with a copy of any cited foreign patent documents and non-patent literature document in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

It is requested that the Examiner consider these documents and officially make them of record in accordance with the provisions of 37 C.F.R. § 1.97 and Section 609 of the MPEP. By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

This Information Disclosure Statement is submitted in accordance with 37 C.F.R. § 1.97(c), before final Office Action or Allowance, whichever is earlier.

In accordance with the requirements of 37 C.F.R. § 1.97(c), the following statement as specified in 37 C.F.R. § 1.97(e) is made:

Each item of information contained in this statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this statement. In this regard, Applicants note that the communication from the foreign patent office was not received by any individual designated by 37 CFR 1.56(c) more than thirty (30) days prior to the filing of this Information Disclosure Statement.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.:	13/344,893	Confirmation No.: 2120
Applicant(s):	Ugur et al.	
Filed:	January 6, 2012	
Art Unit:	2488	
Examiner:	Peter D. Le	
Title:	MOTION PREDICTION IN VIDEO CODING	

Docket No.:	042933/452410
Customer No.:	10949

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT

Sir:

In response to the Official Action dated July 28, 2015, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims beginning on page 2 of this paper.

Remarks begin on page 9 of this paper.

Amendments to the Claims:

1. (Currently Amended) A method comprising:

determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

determining a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks, the reference blocks having said first precision:

determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

using said first reference pixel location to obtain a first prediction by a fractional pixel sample interpolation process, said first prediction having a second precision, which is higher than said first precision~~, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction~~;

using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

~~combining~~ adding said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction; and

after adding the first predication and the second prediction and the rounding value, decreasing the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right.

2. (Original) The method according to claim 1 further comprising:

inserting a first rounding offset to said first prediction and said second prediction.

3. (Previously Presented) The method according to claim 1 further comprising:

reducing the precision of said first prediction and said second prediction to an intermediate prediction after adding a first rounding offset, said intermediate prediction being higher than said first precision.

4. (Original) The method according to claim 2 further comprising:

inserting a second rounding offset to the combined prediction before said decreasing.

5. (Previously Presented) The method according to claim 1, wherein said type of the block is a bi-directional block or a multidirectional block.

6. (Original) The method according to claim 2, wherein the first rounding offset is 2^y, and said decreasing comprises right shifting the combined prediction y+1 bit.

7. (Previously Presented) The method according to claim 1, wherein the first precision is 8 bits.

8. (Previously Presented) The method according to claim 1 further comprising:

obtaining said first prediction and said second prediction by filtering pixel values of said reference blocks.

9. (Currently Amended) An apparatus comprising:

at least one processor and at least one memory including computer program code, the at least one memory and computer program code configured to, with the processor, cause the apparatus to:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

determine a type of the block;

wherein if the determining indicates that the block is a block predicted by using two or more reference blocks, the reference blocks having said first precision:

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction by a fractional pixel sample interpolation process, said first prediction having a second precision, which is higher than said first precision~~, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction~~;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

~~combine~~ add said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction; and

after adding the first predication and the second prediction and the rounding value, decrease the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right.

10. (Previously Presented) The apparatus according to claim 9, wherein the at least one memory and computer code are further configured to:

insert a first rounding offset to said first prediction and said second prediction.

11. (Previously Presented) The apparatus according to claim 9, wherein the at least one memory and computer code are further configured to:

reduce the precision of said first prediction and said second prediction to an intermediate prediction after adding said first rounding offset, said intermediate prediction being higher than said first precision.

12. (Previously Presented) The apparatus according to claim 10, wherein the at least one memory and computer code are further configured to:

insert a second rounding offset to the combined prediction before said decreasing.

13. (Original) The apparatus according to any of the claims 9, wherein said type of the block is a bi-directional block or a multidirectional block.

14. (Original) The apparatus according to claim 10, wherein the first rounding offset is 2^y, and said decreasing comprises right shifting the combined prediction y+1 bits.

15. (Original) The apparatus according to any of the claims 9, wherein the first precision is 8 bits.

16. (Previously Presented) The apparatus according to any of the claims 9, wherein the at least one memory and computer code are further configured to:

obtain said first prediction and said second prediction by filtering pixel values of said reference blocks.

17. (Currently Amended) A computer program product comprising at least one non-transitory computer readable storage medium having computer executable program code portions stored therein, the computer executable program code portions comprising program code instructions configured to:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

determine a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks, the reference blocks having said first precision:

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction by a fractional pixel sample interpolation process, said first prediction having a second precision, which is higher than said first precision~~, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction~~;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

~~combine~~ add said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction; and

after adding the first predication and the second prediction and the rounding value, decrease the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right.

18. (Currently Amended) An apparatus comprising:

an input to determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

a determinator to determine a type of the block; wherein if the determining indicates that the block is a block predicted by using two or more reference blocks with the reference blocks having said first precision, said determinator further to determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

a first predictor to use said first reference pixel location to obtain a first prediction by a fractional pixel sample interpolation process, said first prediction having a second precision, which is higher than said first precision~~, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction~~;

a second predictor to use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

a combiner to ~~combine~~ add said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction; and

after adding the first predication and the second prediction and the rounding value, a shifter to decrease the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right.

19. (Currently Amended) An apparatus comprising:

means for determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

means for determining a type of the block;

means for determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block, if the determining indicates that the block is a block predicted by using two or more reference blocks with the reference blocks having said first precision;

means for using said first reference pixel location to obtain a first prediction by a fractional pixel sample interpolation process, said first prediction having a second precision, which is higher than said first precision~~, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction~~;

means for using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

means for ~~combining~~ adding said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction; and

after adding the first predication and the second prediction and the rounding value, means for decreasing the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right.

REMARKS

Claims 1-19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over US Patent Application Publication No. US 2013/0142262 to Ye, et al. ("Ye") in view of US Patent Application Publication No. US 2009/0087111 to Noda, et al. ("Noda"). As described below, the independent claims have been amended in order to be further patentably distinct from the cited references, taken either individually or in any proper combination. Support for the amendments is provided at least by paragraphs [0108], [0136], [0158] and [0159] of the published application. Based on the foregoing amendments and the following remarks, reconsideration of the present application and allowance of the amended sets of claims are respectfully requested.

At the outset, Applicant's undersigned representative wishes to thank the Examiner for his preparation and his helpful comments during the telephonic interview on January 21, 2016. In this interview, some amendments to independent Claim 1, including some of those relating to the first and second precisions, were discussed in relation to the cited references. The independent claims have now been amended to include the amendments discussed during the interview. Toward the conclusion of the interview, the Examiner indicated that the amendments that had been discussed and are now included in the independent claims overcome the current rejection. However, in an effort to advance the examination of the present application, the independent claims have now been additionally amended so as to include further amendments that extend beyond discussed during the interview to further distinguish the cited references. As discussed below, these additional amendments include, for example, amendments that further define the addition of the first and second predictions to obtain the combined prediction and the subsequent decrease of the precision of the combined prediction to said first precision.

By way of example of the independent claims, independent Claim 1 is drawn to a method that includes determining a block of pixels of a video representation encoded in a bitstream. The values of the pixels have a first precision. The first precision indicates the number of bits needed to represent values of said pixels. The method also includes determining a type of the block. If the determining indicates that the block is a block predicted by using two or more reference blocks, the method determines a first reference pixel location in a first reference block and a second reference pixel location in a second reference block. As discussed during the interview, the reference blocks have the first precision. The method of independent Claim 1 uses the first reference pixel location to obtain a first prediction by a fractional pixel sample interpolation process. The first prediction has a second precision, which is higher than said first precision. The method also uses the second reference pixel location to obtain a second prediction. The second prediction also has the second precision, which is higher than said first precision. The second precision indicates the number of bits needed to represent values of the first prediction and values of the second prediction. As now amended, the method of independent Claim 1 also includes adding said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction. After adding the first predication and the second prediction and the rounding value, the method of amended independent Claim 1 decreases the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right.

Independent Claims 9, 18 and 19 are drawn to an apparatus and independent Claim 17 is drawn to a computer program product. As such, independent Claims 9 and 17-19 have a different scope than independent method Claim 1. However, independent Claims 9 and 17-19 have been amended in a comparable manner to that described above in conjunction with independent Claim 1 such that independent Claims 9 and 17-19 are patentably distinct from the cited references, taken either individually or in any proper combination, for at least the same reasons as described below with respect to independent Claim 1.

Neither of the cited references and, therefore, no proper combination of the cited references teaches or suggests using a first reference pixel location in a first reference block and a second reference pixel location in a second reference block to obtain first and second predictions, respectively, in which <u>the reference blocks are at a first precision and the first and</u>

second predictions are at a second precision, as now more clearly set forth by the amended independent claims. Although the Official Action on page 5 appears to take the position that Ye discloses such an increase in precision from the reference blocks to the first and second predictions and contends that $w \cdot P_0(x,y)$ increases the precision of $P_0(x,y)$ and that $(W-w) \cdot P_1(x,y)$ increases the precision of $P_1(x,y)$. As discussed during the interview, however, $w \cdot P_0(x,y)$ and $(W-w) \cdot P_1(x,y)$ do not have increase precision relative to $P_0(x,y)$ and $P_1(x,y)$, respectively, and, instead, simply serve to change the range of values, such as by increasing the range of values in instances in which $W>w>1$. Such an increase in the range of values as in Ye does not teach or suggest that the precision increases such that Ye fails to teach or suggest any increase in precision from the reference blocks to the first and second predictions.

As to Noda, the Official Action contends on page 6 that Noda also discloses an increase in precision from the reference blocks to the first and second predictions. Noda discloses a system having a pixel bit depth converter to convert bit depth of each pixel of an input image formed of a plurality of pixels (each having an N bit depth) to a reference image having an (N+M) bit depth. Following the conversion, each pixel has a depth that is larger than the original N bit depth by M bits. The Noda system also includes a prediction image generator to generate a prediction image of the (N+M) bit depth from a reference image that also has the (N+M) bit depth. The Noda system further includes a subtracter to obtain a differential signal between the input image of the (N+M) bit depth and the prediction image of the (N+M) bit depth, an encoder to encode the differential signal and output encoded image information, a decoder to output a decoded difference picture based on the image encoding information, an adder to add the prediction image of the (N+M) depth to the decoded difference picture of the (N+M) bit depth and output a decoded image of the (N+M) bit depth, and a reference image storing memory to store the decoded image as the reference image.

In other words, Noda discloses increasing the bit depth of each pixel of an input image having an N bit depth to a reference image of (N+M) bit depth, and only then generating a prediction image of the (N+M) bit depth from the reference image of the (N+M) bit depth. In comparison to the independent claims, it is initially noted that Noda does not teach or suggest "a block predicted by using two or more reference blocks". Moreover, like Ye, Noda fails to teach or suggest any increase in precision from the reference blocks to the first and second predictions. Instead, both the reference block from which the prediction image is generated as well as the prediction image itself have the same precision, that is, a (N+M) bit depth. Consequently, neither of the cited references and, therefore, no proper combination of the cited references teaches or suggests <u>using reference blocks that are at a first precision to generate first and second predictions that are at a second precision</u>, as now more clearly set forth by the amended independent claims.

Additionally, neither of the cited references and, therefore, no proper combination of the cited references teaches or suggests adding the first prediction having the second precision and the second prediction having the second precision and a rounding value to obtain a combined prediction and the, after adding the first predication and the second prediction and the rounding value, decreasing the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right, as now set forth by the amended independent claims. As to the adding claim element, Ye discloses the combination of $w \cdot P_0(x,y)$ and $(W-w) \cdot P_1(x,y)$ with a rounding offset. However, as described above, $w \cdot P_0(x,y)$ and $(W-w) \cdot P_1(x,y)$ both have the same original precision, such as the first precision, with which the input pixels are represented and do not have a second precision that is higher than the first precision of the initial block of pixels, as now set forth by the amended independent claims. Additionally, Noda fails to teach or suggest any such addition of the first predication and the second prediction and the rounding value. Thus, neither cited reference and, therefore, no combination of the cited references teaches or suggests adding the first prediction having the second precision and the second prediction having the second precision and a rounding value to obtain a combined prediction, as set forth by the amended independent claims.

As to the decreasing claim element, Ye discloses a combination of values having the same precision as the combined result. Since the precision does not change, Ye has no need to decrease the precision and, as a result, does not teach or suggest decreasing the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right, as now set forth by the amended independent claims. Although Noda discloses the shifting of bits, it is noted that since Noda fails to teach or suggest adding the first and second predictions to obtain a combined predication, Noda also necessarily fails to teach or suggest shifting bits of a combined prediction to the right in order to decrease its precision. Thus, neither cited reference and, therefore, no combination of the cited references teaches or suggests decreasing the precision of said combined prediction to the first precision by shifting bits of the combined prediction to the right, as now set forth by the amended independent claims.

For each of the foregoing reasons, neither of the cited references and, therefore, no proper combination of the cited references teaches or suggests the independent claims, as amended. Thus, the rejection of the independent claims, as amended, as well as the claims which depend therefrom, is overcome.

CONCLUSION

In view of the remarks and amendment presented above, Applicant respectfully submits that the present application is in condition for allowance. As such, the issuance of a Notice of Allowance is therefore respectfully requested. In order to expedite the examination of the present application, the Examiner is encouraged to contact Applicant' undersigned attorney in order to resolve any remaining issues.

The patentability of the independent claims has been argued as set forth above and thus Applicant will not take this opportunity to argue the merits of the rejection with regard to specific dependent claims. However, Applicant does not concede that the dependent claims are not independently patentable and reserves the right to argue the patentability of dependent claims at a later date if necessary.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefor (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,

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ELECTRONICALLY FILED USING THE EFS-WEB ELECTRONIC FILING SYSTEM OF THE UNITED STATES PATENT & TRADEMARK OFFICE ON January 28, 2016.

Electronic Patent Application Fee Transmittal

Application Number:	13344893
Filing Date:	06-Jan-2012
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Filer:	Guy Randall Gosnell/Lauren Martin
Attorney Docket Number:	042933/452410

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $0 paid	1253	1	1400	1400
Miscellaneous:				
		Total in USD ($)		**1400**

Electronic Acknowledgement Receipt

EFS ID:	24756315
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	Motion Prediction in Video Coding
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	10949
Filer:	Guy Randall Gosnell/Lauren Martin
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/452410
Receipt Date:	28-JAN-2016
Filing Date:	06-JAN-2012
Time Stamp:	16:49:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1400
RAM confirmation Number	3922
Deposit Account	160605
Authorized User	ALSTON & BIRD, LLP

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 CFR 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 CFR 1.17 (Patent application and reexamination processing fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		2016-01-28-452410-AmendAsFiled.PDF	812139 87612317288b4e14ec870c9f0e785ba749d53103	yes	14

Multipart Description/PDF files in .zip description

Document Description	Start	End
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Claims	2	8
Applicant Arguments/Remarks Made in an Amendment	9	14

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Fee Worksheet (SB06)	fee-info.pdf	30319 a28907f589359e173103f7c34cb2bac1f17bfa91	no	2

Warnings:

Information:

Total Files Size (in bytes): 842458

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/344,893	Filing Date 01/06/2012	☒ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 01/28/2016	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 19	Minus	** 20	= 0	x $80 =	0
Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	x $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	**0**

AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/Katrina Harling/

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/344,893	01/06/2012	Kemal UGUR	042933/452410	2120

10949 7590 02/01/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER	
LE, PETER D	

ART UNIT	PAPER NUMBER
2488	

NOTIFICATION DATE	DELIVERY MODE
02/01/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

PTOL-90A (Rev. 04/07)

Applicant-Initiated Interview Summary	**Application No.** 13/344,893	**Applicant(s)** UGUR ET AL.	
	Examiner PETER D. LE	**Art Unit** 2488	

All participants (applicant, applicant's representative, PTO personnel):

(1) PETER D. LE.

(2) _____.

(3) GUY GOSNELL (Reg. #34,610).

(4) RAGIP KURCEREN (Patent Agent).

Date of Interview: 21 January 2016.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☒103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: Claim 1.

Identification of prior art discussed: Noda [US 2009/0087111].

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

The proposed amendment of claim 1: "if the determining indicates that the block is a block predicted by using two or more reference blocks having said first precision" specifies that the current block and the reference blocks have the same first precision prior to a prediction having a second precision which is higher than said first precision. Noda teaches [para. 0012] that a conversion of pixels having N-bit depth (i.e.low precision) to (N+M) bit depth (i.e. higher precision) for prediction. Examiner insisted that mathmetically there is no significant difference between "using the same precision prior to the prediction and increasing the precision during the prediction" and "increasing the precision for prediction". Note: Both claim 1 and Noda are slient about whether the current block and the reference blocks have the same precision or higher precision after the prediction. No agreement is reached..

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/PETER D LE/ Examiner, Art Unit 2488	

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/344,893	Filing Date 01/06/2012	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	04/22/2016	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 19	Minus	** 20	= 0	x $80 =	0
	Independent (37 CFR 1.16(h))	* 5	Minus	***5	= 0	x $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	**0**

AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/VIOLA ROGERS/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

10949 7590 04/27/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER	
LE, PETER D	
ART UNIT	PAPER NUMBER
2488	

DATE MAILED: 04/27/2016

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/344,893	01/06/2012	Kemal UGUR	042933/452410	2120

TITLE OF INVENTION: MOTION PREDICTION IN VIDEO CODING

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	07/27/2016

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

10949 7590 04/27/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/344,893	01/06/2012	Kemal UGUR	042933/452410	2120

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nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	07/27/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
LE, PETER D	2488	375-240150

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
   - ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
   - ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
   (1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
   (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

   1 ____________________
   2 ____________________
   3 ____________________

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies ____________

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number ____________ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ❑ Applicant certifying micro entity status. See 37 CFR 1.29 — NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
- ❑ Applicant asserting small entity status. See 37 CFR 1.27 — NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
- ❑ Applicant changing to regular undiscounted fee status. — NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature ______________________ Date ______________________

Typed or printed name ______________________ Registration No. ______________________

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/344,893	01/06/2012	Kemal UGUR	042933/452410	2120

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EXAMINER	
LE, PETER D	
ART UNIT	**PAPER NUMBER**
2488	

DATE MAILED: 04/27/2016

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

PTOL-85 (Rev. 02/11)

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Examiner-Initiated Interview Summary	**Application No.** 13/344,893	**Applicant(s)** UGUR ET AL.	
	Examiner PETER D. LE	**Art Unit** 2488	

All participants (applicant, applicant's representative, PTO personnel):

(1) *PETER D. LE*.

(2) _____.

(3) *GUY R. GOSNELL (Reg. #34,610)*.

(4) _____.

Date of Interview: *20 April 2016*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☐103 ☒Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *1 and other independent claims*.

Identification of prior art discussed: *N/A*.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

The Representative authorized Examiner's Amendment to correct a typo-error "predication" to "prediction" in claim 1 and other independent claims.

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/PETER D LE/
Examiner, Art Unit 2488

Notice of Allowability	**Application No.** 13/344,893	**Applicant(s)** UGUR ET AL.	
	Examiner PETER D. LE	**Art Unit** 2488	**AIA (First Inventor to File) Status** No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *01/28/2016*.

   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on______.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are *1-19*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.

   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 09/21/2015
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☒ Interview Summary (PTO-413), Paper No./Mail Date *4/20/2016* .
5. ☒ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/PETER D LE/ Examiner, Art Unit 2488	/SATH V PERUNGAVOOR/ Supervisory Patent Examiner, Art Unit 2488

DETAILED ACTION

The present application is being examined under the pre-AIA first to invent provisions.

The response filed on 01/28/2016 has been entered and made of record.

The application has been amended as follows:

Claims 1-19 are pending with **independent claims 1, 9, 17, 18 and 19** being amended.

EXAMINER'S AMENDMENT

[1] An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

[2] Authorization for this examiner's amendment was given in a telephone interview initiated by the Examiner with Mr. Guy Gosnell (Reg. No. 34,610) on 4/20/2016.

[3] **The application has been amended as follows:**

Claims 1, 9, 17, 18 and 19 are replaced by the following amendments respectively

1. (Currently Amended) A method comprising: determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels; determining a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks, the reference blocks having said first precision;

determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

using said first reference pixel location to obtain a first prediction by a fractional pixel sample interpolation process, said first prediction having a second precision, which is higher than said first precision ~~wherein the second precision indicates the number of bits needed to represent dues of said first prediction and values of said second prediction~~;

using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

~~combining~~ adding said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction; and after adding the first prediction and the second prediction and the rounding value, decreasing the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right.

9. (Currently Amended) An apparatus comprising:

at least one processor and at least one memory including computer program code, the at least one memory and computer program code configured to, with the processor, cause the apparatus to:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

determine a type of the block;

wherein if the determining indicates that the block is a block predicted by using two or more reference blocks, the reference blocks having said first precision;

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction by a fractional pixel sample interpolation process, said first prediction having a second precision, which is higher than said first precision~~, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction~~;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

~~combine~~ add said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction; and

after adding the first prediction and the second prediction and the rounding value, decrease the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right.

17. (Currently Amended) A computer program product comprising at least one non- transitory computer readable storage medium having computer executable program code portions stored therein, the computer executable program code portions comprising program code instructions configured to:

determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

determine a type of the block;

if the determining indicates that the block is a block predicted by using two or more reference blocks, the reference blocks having said first precision:

determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

use said first reference pixel location to obtain a first prediction by a fractional pixel sample interpolation process, said first prediction having a second precision, which is higher than said first precision~~, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction~~;

use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

~~combine~~ add said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction; and

after adding the first prediction and the second prediction and the roundin^{g} value, decrease the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right.

18. (Currently Amended) An apparatus comprising:

an input to determine a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

a determinator to determine a type of the block; wherein if the determining indicates that the block is a block predicted by using two or more reference blocks with the reference blocks having said first precision, said determinator further to determine a first reference pixel location in a first reference block and a second reference pixel location in a second reference block;

a first predictor to use said first reference pixel location to obtain a first prediction by a fractional pixel sample interpolation process, said first prediction having a second precision, which is higher than said first precision~~, wherein the second precision indicates4he number of bits needed to represent values of said first prediction and values of said second prediction~~;

a second predictor to use said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

a combiner to ~~combine~~ add said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction; and

after adding the first prediction and the second prediction and the rounding value, a shifter to decrease the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right.

19. (Currently Amended) An apparatus comprising:

means for determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels;

means for determining a type of the block;

means for determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block, if the determining indicates that the block is a block predicted by using two or more reference blocks with the reference blocks having said first precision;

means for using said first reference pixel location to obtain a first prediction by a fractional pixel sample interpolation process, said first prediction having a second precision, which is higher than said first precision~~, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction~~;

means for using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction;

means for ~~combining~~ adding said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction; and

after adding the first prediction and the second prediction and the rounding value, means for decreasing the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right.

EXAMINER'S NOTES

Claim Interpretation - 35 USC § 112

Use of the word “means” (or “step for”) in a claim with functional language creates a rebuttable presumption that the claim element is to be treated in accordance with 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph). The presumption that 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph) is invoked is rebutted when the function is recited with sufficient structure, material, or acts within the claim itself to entirely perform the recited function.

Absence of the word “means” (or “step for”) in a claim creates a rebuttable presumption that the claim element **is not** to be treated in accordance with 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph). The presumption that 35 U.S.C. 112(f) (pre-AIA 35 U.S.C. 112, sixth paragraph) is not invoked is rebutted when the claim element recites function but fails to recite sufficiently definite structure, material or acts to perform that function.

Claim elements in this application that use the word “means” (or “step for”) are presumed to invoke 35 U.S.C. 112(f) except as otherwise indicated in an Office action. Similarly, claim elements that do not use the word “means” (or “step for”) are presumed not to invoke 35 U.S.C. 112(f) except as otherwise indicated in an Office action.

Claim 19 is interpreted under 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph.

Since the claim limitation(s) invokes 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, claims been interpreted to cover the corresponding structure described in the specification that achieves the claimed function, and equivalents thereof.

A review of the specification shows that the following appears to be the corresponding structure described in the specification for the 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph limitation: mobile terminal or user equipment of a wireless communication system [Fig. 1, 2; para. 0096]

If applicant wishes to provide further explanation or dispute the examiner's interpretation of the corresponding structure, applicant must identify the corresponding structure with reference to the specification by page and line number, and to the drawing, if any, by reference characters in response to this Office action.

REASON FOR ALLOWANCE

[1] The following is an examiner's statement of reasons for allowance: The claimed invention is a method/an apparatus for bi-directional prediction using rounding with the distinct limitation (emphasis added) "determining a block of pixels of a video representation encoded in a bitstream, values of said pixels having a first precision, wherein the first precision indicates the number of bits needed to represent values of said pixels; determining a type of the block; if the determining indicates that the block is a block predicted by using two or more reference blocks, **the reference blocks having said first precision:** determining a first reference pixel location in

a first reference block and a second reference pixel location in a second reference block; using said first reference pixel location to obtain a first prediction **by a fractional pixel sample interpolation process**, said first prediction having a second precision, which is higher than said first precision; using said second reference pixel location to obtain a second prediction, said second prediction having the second precision, which is higher than said first precision, **wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction; adding said first prediction having the second precision and said second prediction having the second precision and a rounding value to obtain a combined prediction**; and **after adding the first prediction and the second prediction and the rounding value, decreasing the precision of said combined prediction to said first precision by shifting bits of the combined prediction to the right**.".

[2] Prior arts were found and applied in the prior action. *See* the last Office Action (mailed on 07/28/2015). None of the prior arts in the prior action or in the list of references cited explicitly teach the said limitations.

[3] Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

[4] Claims 1-19 are allowed.

CONTACT

Any inquiry concerning this communication or earlier communications from the examiner should be directed to PETER D. LE whose telephone number is (571)270-5382. The examiner can normally be reached on Monday - (Alternate) Friday from 7:30AM-5PM (EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, SATH PERUNGAVOOR can be reached on 571-272-7455. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/PETER D LE/
Examiner, Art Unit 2488

/SATH V PERUNGAVOOR/
Supervisory Patent Examiner, Art Unit 2488

Examiner-Initiated Interview Summary	Application No.	Applicant(s)	
	13/344,893	UGUR ET AL.	
	Examiner	**Art Unit**	
	PETER D. LE	2488	

All participants (applicant, applicant's representative, PTO personnel):

(1) PETER D. LE.

(3) GUY R. GOSNELL (Reg. #34,610).

(2) ______.

(4) ______.

Date of Interview: 20 April 2016.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☒ No.
If Yes, brief description: ______.

Issues Discussed ☐101 ☐112 ☐102 ☐103 ☒Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: 1 and other independent claims.

Identification of prior art discussed: N/A.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

The Representative authorized Examiner's Amendment to correct a typo-error "predication" to "prediction" in claim 1 and other independent claims.

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/PETER D LE/
Examiner, Art Unit 2488

Search Notes	**Application/Control No.** 13344893	**Applicant(s)/Patent Under Reexamination** UGUR ET AL.
	Examiner PETER D. LE	**Art Unit** 2488

CPC- SEARCHED		
Symbol	**Date**	**Examiner**
H04N19/42 OR H04N19/523 OR H04N19/577	7/21/2015	PL
Update Search	4/20/2016	PL

CPC COMBINATION SETS - SEARCHED		
Symbol	**Date**	**Examiner**

US CLASSIFICATION SEARCHED			
Class	**Subclass**	**Date**	**Examiner**

SEARCH NOTES		
Search Notes	**Date**	**Examiner**
See EAST Search History	7/21/2015	PL
See EAST Search History	4/20/2016	PL

INTERFERENCE SEARCH			
US Class/ CPC Symbol	**US Subclass / CPC Group**	**Date**	**Examiner**
	Limit to Text Search	4/20/2016	PL

/ELLYAR Y BARAZESH/ Examiner.Art Unit 2483	

Substitute for form SB08 (Revised 07/09)				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Application Number	13/344,893
				Filing Date	01/06/2012
				First Named Inventor	Kemal Ugur
				Art Unit	2488
				Examiner Name	Peter D. Le
Sheet	*1*	of	1	Attorney Docket Number	042933/452410

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	1	Office Action from Korean Patent Application No. 2013-7020731, dated August 26, 2015	YES

Examiner Signature	/Peter Le/ (04/20/2016)	Date Considered	04/20/2016

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#35877281v1

Submitted September 21, 2015

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.L./

Index of Claims	Application/Control No. 13344893	Applicant(s)/Patent Under Reexamination UGUR ET AL.
	Examiner PETER D. LE	Art Unit 2488

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/10/2014	01/13/2015	07/21/2015	04/20/2016					
	1	✓	✓	✓	=					
	2	✓	✓	✓	=					
	3	✓	✓	✓	=					
	4	✓	✓	✓	=					
	5	✓	✓	✓	=					
	6	✓	✓	✓	=					
	7	✓	✓	✓	=					
	8	✓	✓	✓	=					
	9	✓	✓	✓	=					
	10	✓	✓	✓	=					
	11	✓	✓	✓	=					
	12	✓	✓	✓	=					
	13	✓	✓	✓	=					
	14	✓	✓	✓	=					
	15	✓	✓	✓	=					
	16	✓	✓	✓	=					
	17	✓	✓	✓	=					
	18	✓	✓	✓	=					
	19	✓	✓	✓	=					

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S2	1	13/344893.app.	US-PGPUB; USPAT	OR	ON	2015/07/15 21:24
S3	6190	(H04N19/42 OR H04N19/523 OR H04N19/577).CPC.	US-PGPUB; USPAT	OR	ON	2015/07/15 21:26
S4	38055	(bit NEAR2 pixel)	US-PGPUB; USPAT	OR	ON	2015/07/15 21:48
S5	4413	(bit NEAR2 pixel) WITH (resolution)	US-PGPUB; USPAT	OR	ON	2015/07/15 21:49
S6	4897	(bit NEAR2 pixel) WITH (resolution precision)	US-PGPUB; USPAT	OR	ON	2015/07/15 21:49
S7	7265	((bit NEAR2 pixel) (bit NEAR2 depth)) WITH (resolution precision)	US-PGPUB; USPAT	OR	ON	2015/07/15 22:35
S8	160	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits)) WITH (resolution precision) WITH (predict$3))	US-PGPUB; USPAT	OR	ON	2015/07/15 22:37
S9	8	("6512523" | "20100002770" | "20100086027" | "20090087111" | "6539058" | "20090257503" | "20080089417" | "20100086027" | "20130142262").PN.	US-PGPUB; USPAT	OR	ON	2015/07/15 22:48
S10	1	S9 and S7	US-PGPUB; USPAT	OR	ON	2015/07/15 22:59
S11	100132	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits) (bit NEAR2 length)) WITH (determin$3 conver$5 increas$3 increment$3 decreas$3 decrement$3))	US-PGPUB; USPAT	OR	ON	2015/07/15 23:31
S12	2914	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits) (bit NEAR2 length)) WITH (determin$3 conver$5 increas$3 increment$3 decreas$3 decrement$3) WITH (predict$3 precision))	US-PGPUB; USPAT	OR	ON	2015/07/15 23:32
S13	1	13/344893.app. AND (predict$3 WITH precision)	US-PGPUB; USPAT	OR	ON	2015/07/15 23:51
S14	90	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits) (bit NEAR2 length)) WITH (determin$3 conver$5 increas$3 increment$3 decreas$3 decrement$3) WITH (predict$3 precision)) SAME (inter$2predict$3 intra$2predict$3 inter$2frame intra$2frame)	US-PGPUB; USPAT	OR	ON	2015/07/15 23:56

S15	806	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits) (bit NEAR2 length)) WITH (predict$3 precision)) SAME (inter$2predict$3 intra$2predict$3 inter$2frame intra$2frame)	US-PGPUB; USPAT	OR	ON	2015/07/16 00:44
S16	716	S15 not S14	US-PGPUB; USPAT	OR	ON	2015/07/16 00:44
S17	546	(((bit NEAR2 pixel) (bit NEAR2 depth) (bit NEAR2 length)) WITH (predict$3 precision)) SAME (inter$2predict$3 intra$2predict$3 inter$2frame intra$2frame)	US-PGPUB; USPAT	OR	ON	2015/07/16 00:46
S18	509	(((bit NEAR2 pixel) (bit NEAR2 depth) (bit NEAR2 length)) WITH (determin$3 calculat$3 conver$5 precision)) SAME (inter$2predict$3 intra$2predict$3 inter$2frame intra$2frame) SAME (predict$3)	US-PGPUB; USPAT	OR	ON	2015/07/16 01:42
S19	14	(((bit NEAR2 pixel) (bit NEAR2 depth) (bit NEAR2 length)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME (inter$2predict$3 intra$2predict$3 inter$2frame intra$2frame) SAME (predict$3)	US-PGPUB; USPAT	OR	ON	2015/07/16 01:43
S20	5180	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision))	US-PGPUB; USPAT	OR	ON	2015/07/16 01:53
S21	219	(((bit NEAR2 pixel) (bit NEAR2 depth) (bit NEAR2 length)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME (predict$3)	US-PGPUB; USPAT	OR	ON	2015/07/16 01:54
S22	580	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME precision	US-PGPUB; USPAT	OR	ON	2015/07/16 01:54
S23	539	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) WITH precision	US-PGPUB; USPAT	OR	ON	2015/07/16 01:55
S24	2	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) WITH precision WITH offset WITH shift$5	US-PGPUB; USPAT	OR	ON	2015/07/16 02:02
S25	1	"20100086027".pn.	US-PGPUB; USPAT	OR	ON	2015/07/20 18:36
S26	1	13/344893.app. and (precision)	US-PGPUB; USPAT	OR	ON	2016/01/20 13:45
S27	1	13/344893.app. and (precision WITH (predict$3 bi$2predict$3))	US-PGPUB; USPAT	OR	ON	2016/01/20 13:55
S28	44	((((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits) (bit NEAR2 length)) NEAR2 (determin$3 conver$5 increas$3 increment$3 decreas$3 decrement$3 scal$5)) WITH (predict$3 precision)) SAME (inter$2predict$3 intra$2predict$3 inter$2frame intra$2frame)	US-PGPUB; USPAT	OR	ON	2016/01/20 15:39
S29	231	(round$3 WITH (bit$2depth precision) WITH bit WITH (add$5 combin$5))	US-PGPUB;	OR	ON	2016/04/14 11:43

			USPAT			

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S30	26	(round$3 WITH (bit$2depth precision) WITH bit WITH (add$5 combin$5)).clm.	US-PGPUB; USPAT	OR	ON	2016/04/14 12:01
S31	0	(round$3 SAME (bit$2depth precision) SAME bit SAME (add$5 combin$5) SAME (high$3 low$3 second) SAME (interpolat$5) SAME (shift$5 increas$5 increment$5 multipl$5)).clm.	US-PGPUB; USPAT	OR	ON	2016/04/14 12:04
S32	0	(round$3 SAME (bit$2depth precision) SAME bit SAME (add$5 combin$5) SAME (high$3 low$3 second) SAME (interpolat$5)).clm.	US-PGPUB; USPAT	OR	ON	2016/04/14 12:05
S33	0	(round$3 SAME (bit$2depth precision) SAME bit SAME (add$5 combin$5) SAME (interpolat$5)).clm.	US-PGPUB; USPAT	OR	ON	2016/04/14 12:05

4/20/2016 1:37:48 PM
C:\Users\ple1\Documents\EAST\Workspaces\13344893.wsp

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13344893	UGUR ET AL.
	Examiner	**Art Unit**
	PETER D LE	2488

CPC				
Symbol			**Type**	**Version**
H04N	19	/ 577	F	2014-11-01
H04N	19	/ 42	I	2014-11-01
H04N	19	/ 523	A	2014-11-01
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CPC Combination Sets						
Symbol			**Type**	**Set**	**Ranking**	**Version**
		/				
		/				

/PETER D LE/ Examiner.Art Unit 2488 (Assistant Examiner)	04/20/2016 (Date)	**Total Claims Allowed:** 19	
/SATH V PERUNGAVOOR/ Supervisory Patent Examiner.Art Unit 2488 (Primary Examiner)	04/20/2016 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 10

U.S. Patent and Trademark Office

Part of Paper No. 20160420

Issue Classification	**Application/Control No.** 13344893	**Applicant(s)/Patent Under Reexamination** UGUR ET AL.
	Examiner PETER D LE	**Art Unit** 2488

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCE(S)

CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**				

INTERNATIONAL CLASSIFICATION

CLAIMED					**NON-CLAIMED**				
H	0	4	N	19 / 577 (2014.01.01)					

/PETER D LE/ Examiner.Art Unit 2488 (Assistant Examiner)	04/20/2016 (Date)	**Total Claims Allowed:** 19
/SATH V PERUNGAVOOR/ Supervisory Patent Examiner.Art Unit 2488 (Primary Examiner)	04/20/2016 (Date)	O.G. Print Claim(s): 1 / O.G. Print Figure: 10

U.S. Patent and Trademark Office — Part of Paper No. 20160420

Issue Classification	**Application/Control No.** 13344893	**Applicant(s)/Patent Under Reexamination** UGUR ET AL.
	Examiner PETER D LE	**Art Unit** 2488

☒ **Claims renumbered in the same order as presented by applicant** ☐ **CPA** ☐ **T.D.** ☐ **R.1.47**

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		17												
	2		18												
	3		19												
	4														
	5														
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	10														
	11														
	12														
	13														
	14														
	15														
	16														

/PETER D LE/ Examiner.Art Unit 2488 (Assistant Examiner)	04/20/2016 (Date)	**Total Claims Allowed:** 19	
/SATH V PERUNGAVOOR/ Supervisory Patent Examiner.Art Unit 2488 (Primary Examiner)	04/20/2016 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 10

U.S. Patent and Trademark Office

Part of Paper No. 20160420

PTO/AIA/80 (07-12)
Approved for use through 11/30/2014. OMB 0651-0035
U.S. Patent and Trademark Office; U.S DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

☒ Practitioners associated with Customer Number: 10949

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignments documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

☒ The address associated with Customer Number: 10949

OR

☐

Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address: NOKIA TECHNOLOGIES OY
Karaportti 3
02610 Espoo, Finland

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be Filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of The practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record
The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	[signature]	Date	23 January 2015
Name	Harri H[illegible]lo Director, P[illegible]	Telephone	
Title	Legal and In[illegible] Property		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Jukka Nihtilä
Head, Business Development
Legal & IP

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Ugur et al.

Application No./Patent No.: 13/344,893 Filed/Issue Date: January 6, 2012

Titled: MOTION PREDICTION IN VIDEO CODING

Nokia Technologies Oy, a corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [x] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is ________ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

A. [ ] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel ________, Frame ________, or for which a copy therefore is attached.

OR

B. [x] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Inventors To: Nokia Corporation
The document was recorded in the United States Patent and Trademark Office at
Reel 028009, Frame 0259, or for which a copy thereof is attached.

2. From: Nokia Corporation To: Nokia Technologies Oy
The document was recorded in the United States Patent and Trademark Office at
Reel 035424, Frame 0779, or for which a copy thereof is attached.

3. From: ________ To: ________
The document was recorded in the United States Patent and Trademark Office at
Reel ________, Frame ________, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet(s).

[x] As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (*i.e.*, a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Guy R. Gosnell/ May 3, 2016
Signature Date

Guy R. Gosnell, Reg. No. 34,610 Patent Practitioner
Printed or Typed Name Title

Electronic Acknowledgement Receipt

EFS ID:	25666486
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	10949
Filer:	Christopher Jason Gegg/Joyce Smith
Filer Authorized By:	Christopher Jason Gegg
Attorney Docket Number:	042933/452410
Receipt Date:	03-MAY-2016
Filing Date:	06-JAN-2012
Time Stamp:	11:31:50
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		373POA452410.PDF	152641 eb4d093928c339ac7dd289898a7b448a8c2012b5	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Power of Attorney	1	1
	Assignee showing of ownership per 37 CFR 3.73	2	2

Warnings:

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NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 05/03/2016.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/tcouch/

Substitute for form SB08 (Revised 07/09) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				**Complete if Known**	
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U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.	Document Number Number - Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages of Relevant Figures Appear
	1	US-2010/0111182 A1	05-06-2010	Karczewicz et al.	

FOREIGN PATENT DOCUMENTS

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	2	WO 2008/048864 A2	04-24-2008	Qualcomm Inc.		

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	3	Extended European Search Report from corresponding European Patent Application No. 12731927.5 dated May 6, 2016	
	4	YE et al., "High Precision Interpolation and Prediction"; 35 VCEG Meeting; 85. MPEG Meeting; July 16, 2008 - July 18, 2008; Berlin; Video Coding Experts Group of ITU-T SG.16; No. VCEG-AI33; July 12, 2008; XP030003598	
	5	YI-JEN CHIU et al.: "TE1: Fast Techniques to Improve Self Derivation of Motion Estimation"; JCT-VC Meeting; July 21, 2010 - July 28, 2010; Geneva; Joint Collaborative Team on Video Coding of ISO/IEC JTC1/SC29/WG11 and ITU-T SG.16; July 28, 2010; XP030007627	

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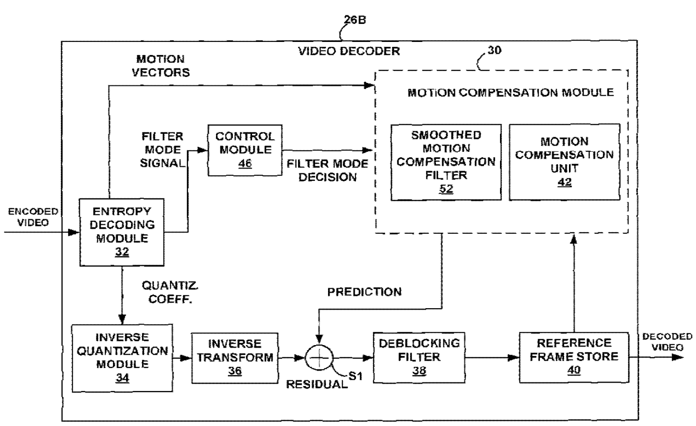
(54) **Title:** VIDEO CODING WITH ADAPTIVE FILTERING FOR MOTION COMPENSATED PREDICTION



(57) **Abstract:** This disclosure is directed to video coding techniques that support normal single layer video coding, or scalable video coding with features such as signal-to-noise ratio (SNR) scalability and spatial scalability. A video coding device may implement these techniques in a video decoder that includes a motion compensation module and a filter. The motion compensation module decodes a prediction frame from a digital video signal, wherein the motion compensation module determines each block of the inter-coded frame from motion vectors encoded in the digital video signal. The filter adaptively filters one or more of the inter-coded blocks based on a signal either encoded or inferred from the digital video signal. In some instances, the video decoder may adaptively apply different filter functions, one in the horizontal and another in the vertical direction, based on the signal. By implementing these techniques, the video decoder may increase the visual quality of the resulting decoded digital video signal while reducing complexity.

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VIDEO CODING WITH ADAPTIVE FILTERING FOR MOTION COMPENSATED PREDICTION

[0001] This application claims the benefit of U.S. Provisional Application No. 60/829,494, filed October 13, 2006, and U.S. Provisional Application No. 60/938,151, filed May 15, 2007, the entire content of each of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] This disclosure relates to digital video and, more particularly, coding of digital video.

BACKGROUND

[0003] Digital video capabilities can be incorporated into a wide range of devices, including digital televisions, digital direct broadcast systems, wireless communication devices, personal digital assistants (PDAs), laptop computers, desktop computers, digital cameras, digital recording devices, video gaming devices, cellular or satellite radio telephones, and the like. Digital video devices typically implement a video compression technique, such as MPEG-2, MPEG-4, or H.264/MPEG-4, Part 10 (Advanced Video Coding (AVC)), in order to transmit and receive digital video signals more efficiently. Video compression techniques perform spatial and temporal prediction to reduce or remove redundancy inherent in video signals. Scalable video coding techniques enable additional features such as spatial, temporal and/or signal-to-noise ratio (SNR) scalability, via a base layer and one or more enhancement layers.

[0004] In video coding, video compression generally includes motion estimation and motion compensation. Motion estimation tracks the movement of video objects between successive video frames. Motion estimation generates motion vectors, which indicate the displacement of video blocks relative to corresponding video blocks in one or more reference frames. Motion compensation uses the motion vector to generate a prediction video block from one or more reference frames. In addition, motion compensation forms a residual video block by subtracting the prediction video block from the original video block. The video encoder applies transform, quantization and entropy coding processes to further reduce the bit rate of the residual block. A video decoder performs inverse operations to reconstruct the encoded video, using the motion vectors and residual information for each of the blocks.

SUMMARY

[0005] In general, the disclosure is directed to video coding techniques that support adaptive filtering of motion compensated prediction blocks in a video decoder. Adaptive filtering of motion compensated prediction blocks may be applied to promote prediction accuracy. Additionally, or alternatively, adaptive filtering may be applied to reduce complexity.

[0006] In one aspect, the disclosure provides a video coding device comprising a motion compensation module that applies motion compensation to blocks within a video frame to generate prediction video blocks, and a control module that adaptively adjusts the motion compensation to apply either a first filter mode or a second filter mode to each of the blocks based on a filter mode decision.

[0007] In another aspect, the disclosure provides a method comprising applying motion compensation to blocks within a video frame to generate prediction video blocks, and adaptively adjusting the motion compensation to apply either a first filter mode or a second filter mode to each of the blocks based on a filter mode decision.

[0008] In a further aspect, the disclosure provides a video coding device comprising a motion compensation module that performs motion compensation on blocks within a video frame to generate video blocks, wherein the motion compensation module includes a filter, and the motion compensation module applies the filter to the blocks for motion vectors that point to integer pixel locations.

[0009] In an additional aspect, the disclosure provides an integrated circuit device comprising a motion compensation module that applies motion compensation to blocks within a video frame to generate prediction video blocks, and a control module that adaptively adjusts the motion compensation to apply either a first filter mode or a second filter mode to each of the blocks based on a filter mode decision.

[0010] In another aspect, the disclosure provides a wireless communication device handset comprising a motion compensation module that applies motion compensation to blocks within a video frame to generate prediction video blocks, and a control module that adaptively adjusts the motion compensation to apply either a first filter mode or a second filter mode to each of the blocks based on a filter mode decision.

[0011] In another aspect, the disclosure provides a method comprising performing motion compensation on blocks within a video frame to generate prediction video blocks, and applying a filter to the blocks for motion vectors that point to integer pixel locations.

[0012] In a further aspect, the disclosure provides an integrated circuit device comprising a motion compensation module that performs motion compensation on blocks within a video frame to generate prediction video blocks, wherein the motion compensation module includes a filter, and the motion compensation module applies the filter to the blocks for motion vectors that point to integer pixel locations.

[0013] In another aspect, the disclosure provides a wireless communication device handset comprising a motion compensation module that performs motion compensation on blocks within a video frame to generate prediction video blocks, wherein the motion compensation module includes a filter, and the motion compensation module applies the filter to the blocks for motion vectors that point to integer pixel locations.

[0014] The techniques described in this disclosure may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the software may be executed in one or more processors, such as a microprocessor, application specific integrated circuit (ASIC), field programmable gate array (FPGA), or digital signal processor (DSP). The software that executes the techniques may be initially stored in a computer-readable medium and loaded and executed in the processor. Accordingly, this disclosure also contemplates a computer program product comprising a computer-readable medium comprising instructions to perform techniques as described in this disclosure.

[0015] The details of one or more aspects of the disclosure are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF DRAWINGS

[0016] FIG. 1 is a block diagram illustrating a video encoding and decoding system.

[0017] FIG. 2 is a block diagram illustrating an example of a video encoder.

[0018] FIG. 3 is a diagram illustrating formation of a prediction block by smaller subblocks with different motion vectors.

[0019] FIG. 4 is a block diagram illustrating an example of a video decoder configured to support adaptive filtering to generate prediction blocks.

[0020] FIG. 5 is a block diagram illustrating another example of a video decoder configured to support adaptive filtering to generate prediction blocks.

[0021] FIG. 6 is a block diagram illustrating an example of a video decoder configured to support scalable video coding (SVC) using adaptive filtering to generate prediction blocks.

[0022] FIG. 7 is a diagram illustrating application of a smoothed reference process in SVC enhancement layer coding.

[0023] FIG. 8 is a diagram illustrating application of a smoothed reference process using adaptive motion compensation in SVC enhancement layer coding.

[0024] FIG. 9 is a diagram illustrating example characteristics of a one-dimensional, six-tap filter for luma ½-pixel interpolation.

[0025] FIG. 10 is a block diagram illustrating an example of a video decoder configured to support application of different adaptive filters in the vertical and horizontal dimensions of a prediction block to accommodate motion vector components with integer or fractional pixel precision.

[0026] FIG. 11 is a flow diagram illustrating exemplary operation of a video decoder in performing adaptive motion compensation at the block level of inter coded frames.

[0027] FIG. 12 is a flow diagram illustrating exemplary operation of the video decoder in performing smoothing and motion compensation using a combined smoothed motion compensation unit at the block level of inter-coded frames.

[0028] FIG. 13 is a flow diagram illustrating exemplary operation of a video decoder in performing adaptive motion compensation with different filters in the vertical and horizontal dimensions.

DETAILED DESCRIPTION

[0029] In general, the disclosure is directed to video coding techniques that support adaptive filtering of motion compensated prediction blocks in a video decoder. Adaptive filtering of motion compensated prediction blocks may be applied to promote prediction accuracy and/or reduce complexity. The filtering mode may be dynamically adjusted, e.g., at a frame level, slice level, macroblock (MB) level, or block level. A filtering mode decision may be explicitly signaled by an encoder in the encoded bitstream. Alternatively, the mode decision may be determined at the decoder side based on statistics and/or characteristics of the video sequence.

[0030] In a first filtering mode, a video decoder may apply regular motion compensation to form a motion compensated prediction block. In a second filtering mode, the video decoder may apply regular motion compensation plus an additional filter to the motion compensated prediction block. The additional filter may have different characteristics. As an example, the additional filter may be a low pass filter, which also may be referred to as a smoothing filter in the following discussion. In some cases, the smoothing filter may be a 3-tap filter. In the second filtering mode, the video decoder may apply the additional filter in cascade with a regular motion compensation filter or by using a different filter that combines the regular motion compensation filter and the additional filter.

[0031] In some cases, different filters may be applied in the horizontal and vertical directions of the motion compensated prediction block. For example, a smoothing filter such as a 3-tap filter may be applied for motion vector components with integer pixel precision, while an interpolation filter such as a 2-tap filter, e.g., a bilinear filter, may be applied for motion vector components with fractional pixel precision. The different filters may be separate or form part of a combined filter.

[0032] Adaptive filtering may promote visual quality and coding efficiency. For example, adaptive filtering may be applied at the MB or block level, providing finely tuned filtering of individual blocks. A macroblock (MB) may refer to a 16-by-16 pixel area of a video frame, whereas a block or subblock may be used to refer to a smaller area. Also, additional or different filtering may be applied when needed, rather than full-time, reducing complexity.

[0033] In addition, the video coding techniques may be applied to single-layer video or multi-layer, scalable video. As mentioned above, the motion compensation filter and the additional filter may be combined, rather than applied in cascade, further reducing complexity. For scalable video coding, for example, a combined motion compensation filter module may replace a cascaded motion compensation filter and additional filter, such as a smoothing filter.

[0034] FIG. 1 is a block diagram illustrating a video encoding and decoding system 10. As shown in FIG. 1, system 10 includes a source device 12 that transmits encoded video to a receive device 14 via a communication channel 16. Source device 12 may include a video source 18, video encoder 20 and a transmitter 22. In some aspects, transmitter 22 may be a wireless transmitter. Receive device 14 may include a receiver 24, video decoder 26 and video display device 28. In some aspects, receiver 24 may be a wireless receiver, such as a wireless receiver in a wireless communication device handset. System 10 may be configured to support adaptive filtering of motion compensated prediction blocks to improve both visual quality and processing efficiency.

[0035] Video decoder 26 may apply motion compensation to blocks within a video frame to generate prediction video blocks, and adaptively adjust the motion compensation to apply either a first filter mode or a second filter mode to each of the blocks based on a filter mode decision. Video decoder 26 may adaptively apply additional filtering to some video blocks in the second filter mode. In the first filter mode, video decoder 26 may apply regular motion compensation, which may include interpolation filtering if motion vectors reference fractional pixel locations in either the vertical dimension, horizontal dimension or both. In the second filter mode, video decoder 26 may apply motion compensation plus an additional filter to the motion compensated prediction block. As an example, the additional filter may be a smoothing filter. Alternatively, in the second filter mode, video decoder 26 may apply a different filter that combines regular motion compensation and additional filtering such as smoothing.

[0036] Video decoder 26 may adaptively adjust the motion compensation on a block-by-block, macroblock-by-macroblock, slice-by-slice, or frame-by-frame basis. The filter mode decision may be based on a signal encoded in the video frame, e.g., by video encoder 20. For example, video encoder 20 may include a flag, command or other instruction in the encoded video to indicate whether video decoder 26 should adjust motion compensation to apply the first or second filter mode. Alternatively, video decoder 26 may make the filter mode decision based on analysis of one or more characteristics of the video frame. For example, video decoder 26 may analyze the reconstructed video blocks obtained after decoding, to determine whether the second filtering mode should be applied.

[0037] In the first filter mode, video decoder 26 may apply regular motion compensation, e.g., with interpolation filtering for motion vectors with fractional pixel values. In the H.264/MPEG-4, Part 10 (Advanced Video Coding (AVC)) scheme, for example, the motion compensation filter for interpolating a pixel at a ½ pixel location may comprise a 6-tap filter. The number of taps generally indicates the number of coefficients required to represent the filter mathematically. A filter with a higher tap number generally comprises a more complex filter than those having a lower tap number. Thus, a 6-tap filter comprises a more complex filter than either a 2-tap or 3-tap filter.

[0038] In the second filter mode, video decoder 26 may apply an additional filter, such as a smoothing filter. The smoothing filter may comprise, for example, a 3-tap filter. The smoothing filter may be provided in the second filter mode as an additional filter, e.g., in addition to the motion compensation filter. Alternatively, the smoothing filter may be combined with an interpolation filter used for regular motion compensation. The combined filter used in motion compensation therefore represents a different filter, such as a 2-tap filter, for interpolating a pixel at a partial pixel location. An exemplary 2-tap filter is a bilinear filter. Hence, the second filter mode applied by video decoder 26 may include application of both the motion compensation and smoothing filters, either by the use of a motion compensation filter and an additional smoothing filter, or by the use of the different filter that combines motion compensation and smoothing. In each case, additional filtering, such as smoothing, is provided in the second filter mode.

[0039] In the second filter mode, video decoder 26 may apply the smoothing filter to both dimensions for motion vectors with both components having integer pixel precision. Alternatively, the smoothing filter, such as a 3-tap filter, may be applied in either the horizontal dimension or vertical dimension, or both, for motion vectors having integer pixel precision in those dimensions. A 2-tap motion compensation filter, such as a bilinear filter, may be applied for interpolation in at least one of the dimensions in the event motion vectors have fractional precision in such dimensions. For motion vectors having fractional pixel precision in both dimensions, a 2-tap interpolation filter may be applied for both vertical and horizontal dimensions. Similarly, for motion vectors having integer pixel precision in both dimensions, a smoothing filter may be applied in both vertical and horizontal dimensions.

[0040] For example, video decoder 26 may apply the smoothing filter in the horizontal dimension and apply a 2-tap filter, such as a bilinear filter, in the vertical dimension when a motion vector points to an integer pixel location in the horizontal dimension and to a fractional pixel location in the vertical dimension. Alternatively, video decoder 26 may apply the smoothing filter in the vertical dimension and apply a 2-tap filter such as a bilinear filter, in the horizontal dimension when a motion vector points to an integer pixel location in the vertical dimension and to a fractional pixel location in the horizontal dimension. Alternatively, video decoder 26 may apply either the smoothing filter or the interpolation filter in both dimensions, depending on integer or fractional precision of the motion vectors.

[0041] Adaptive filter adjustment, e.g., at the frame level, slice level, macroblock (MB) level, or block level, can promote both coding efficiency and processing efficiency. With adaptive filtering, additional or different filtering may be applied to frames, slices, MBs, or blocks when needed, rather than on a full-time basis, thereby reducing processing overhead. In particular, the first filtering mode may omit the additional filter, while the second filtering mode may require the additional filter to promote coding efficiency. As mentioned above, in some aspects, the additional filter may be a smoothing filter. A smoothing filter may be useful in reducing or eliminating quantization noise or other artifacts from a motion compensated prediction block.

[0042] Video decoder 26 may apply the adaptive filtering technique to single-layer video or multi-layer, scalable video. In some cases, video decoder 26 may combine a motion compensation filter and a smoothing filter, rather than applying the filters in cascade, further reducing complexity. For scalable video coding (SVC), for example, video decoder 26 may be configured to apply a combined smoothed motion compensation filter module that supports simplified processing.

[0043] In the example of FIG. 1, communication channel 16 may comprise any wireless or wired communication medium, such as a radio frequency (RF) spectrum or one or more physical transmission lines, or any combination of wireless and wired media. Channel 16 may form part of a packet-based network, such as a local area network, wide-area network, or a global network such as the Internet. Communication channel 16 generally represents any suitable communication medium, or collection of different communication media, for transmitting video data from source device 12 to receive device 14.

[0044] Source device 12 generates video for transmission to destination device 14. In some cases, however, devices 12, 14 may operate in a substantially symmetrical manner. For example, each of devices 12, 14 may include video encoding and decoding components. Hence, system 10 may support one-way or two-way video transmission between video devices 12, 14, e.g., for video streaming, video broadcasting, or video telephony.

[0045] Video source 18 may include a video capture device, such as one or more video cameras, a video archive containing previously captured video, or a live video feed from a video content provider. As a further alternative, video source 18 may generate computer graphics-based data as the source video, or a combination of live video and computer-generated video. In some cases, if video source 18 is a camera, source device 12 and receive device 14 may form so-called camera phones or video phones, including satellite or mobile wireless telephones, or other wireless communication devices. Hence, in some aspects, the techniques described in this disclosure may be implemented within a mobile wireless communication device handset, such as a mobile telephone handset. In each case, the captured, pre-captured or computer-generated video may be encoded by video encoder 20 for transmission from video source device 12 to video decoder 26 of video receive device 14 via transmitter 22, channel 16 and receiver 24. Display device 28 may include any of a variety of display devices such as a liquid crystal display (LCD), plasma display or organic light emitting (OLED) diode display.

[0046] Video encoder 20 and video decoder 26 may be configured, in some aspects of this disclosure, to support scalable video coding for spatial, temporal and/or signal-to-noise ratio (SNR) scalability. Encoder 20 and decoder 26 may support various degrees of scalability by supporting encoding, transmission and decoding of a base layer and one or more scalable enhancement layers. For scalable coding, a base layer carries video data with a minimum level of quality. One or more enhancement layers carry additional bitstream to support higher spatial, temporal or SNR levels.

[0047] Video encoder 20 and video decoder 26 may operate according to a video compression standard, such as MPEG-2, MPEG-4, ITU-T H.263, or ITU-T H.264/ MPEG-4, Part 10 (AVC). Although not shown in FIG. 1, in some aspects, video encoder 20 and video decoder 22 may be integrated with an audio encoder and decoder, respectively, and include appropriate MUX-DEMUX units, or other hardware and software, to handle encoding of both audio and video in a common data stream or separate data streams. If applicable, MUX-DEMUX units may conform to the ITU H.223 multiplexer protocol, or other protocols such as the user datagram protocol (UDP).

[0048] The H.264 standard was developed by the ITU-T Video Coding Experts Group and the ISO/IEC Moving Picture Experts Group (MPEG), as the product of a partnership known as the Joint Video Team (JVT). The H.264 standard is described in ITU-T Recommendation H.264, Advanced video coding for generic audiovisual services, dated 03/2005, which may be referred to herein as the H.264 standard or H.264 specification, or the H.264/AVC standard or specification. In some aspects, techniques described in this disclosure may be applied to devices that generally conform to the H.264 standard, or other devices that do not generally conform to the H.264 standard.

[0049] The Joint Video Team (JVT) continues to work on a scalable video coding (SVC) extension to H.264/MPEG-4 AVC. The specification of both H.264/MPEG-4AVC and the evolving SVC extension are in the form of a Joint Draft (JD). The Joint Scalable Video Model (JSVM) created by the JVT implements tools for use in scalable video, which may be used within system 10 for various coding tasks described in this disclosure. Detailed information concerning SVC can be found in the Joint Draft documents, and particularly in Joint Draft 7 (JD7), by Thomas Wiegand, Gary Sullivan, Julien Reichel, Heiko Schwarz, and Mathias Wien, "Joint Draft 7 of SVC Amendment (revision 2)," JVT-T201r2, July 2006, Klagenfurt, Austria.

[0050] In some aspects, for video broadcasting, this disclosure contemplates application to Enhanced H.264 video coding for delivering real-time video services in terrestrial mobile multimedia multicast (TM3) systems using the Forward Link Only (FLO) Air Interface Specification, "Forward Link Only Air Interface Specification for Terrestrial Mobile Multimedia Multicast," to be published as Technical Standard TIA-1099 (the "FLO Specification"). The FLO Specification includes examples defining bitstream syntax and semantics and decoding processes suitable for the FLO Air Interface. Alternatively, video may be broadcasted according to other standards such as DVB-H (digital video broadcast-handheld), ISDB-T (integrated services digital broadcast - terrestrial), or DMB (digital media broadcast). Hence, in some cases, source device 12 may be a mobile wireless terminal, such as a wireless communication device handset, a video streaming server, or a video broadcast server. However, the techniques described in this disclosure are not limited to any particular type of broadcast, multicast, or point-to-point system.

[0051] Video encoder 20 and video decoder 26 each may be implemented as one or more microprocessors, digital signal processors (DSPs), application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), discrete logic, software, hardware, firmware or any combinations thereof. Hence, the techniques described herein may be implemented within one or more integrated circuit devices, which may be referred to collectively as an integrated circuit device. Such an integrated circuit device may be provided within a communication device, such as a wireless communication device handset. Each of video encoder 20 and video decoder 26 may be included in one or more encoders or decoders, either of which may be integrated as part of a combined encoder/decoder (CODEC) in a respective mobile device, subscriber device, broadcast device, server, or the like. In addition, video source device 12 and video receive device 14 each may include appropriate modulation, demodulation, frequency conversion, filtering, and amplifier components for transmission and reception of encoded video, as applicable, including radio frequency (RF) wireless components and antennas sufficient to support wireless communication. For ease of illustration, however, such components are not shown in FIG. 1.

[0052] A video sequence includes a series of video frames. Video encoder 20 operates on blocks of pixels within individual video frames in order to encode the video data. The video blocks may have fixed or varying sizes, and may differ in size according to a specified coding standard. As an example, the ITU-T H.264 standard supports intra prediction in various block sizes, such as 16 by 16, 8 by 8, 4 by 4 for luma components, and 8x8 for chroma component, as well as inter prediction in various block sizes, such as 16 by 16, 16 by 8, 8 by 16, 8 by 8, 8 by 4, 4 by 8 and 4 by 4 for luma components and corresponding scaled sizes for chroma components. Smaller video blocks can provide better resolution, and may be used for locations of a video frame that include higher levels of detail. In general, macroblocks and the various smaller blocks may be considered to be video blocks. In some cases, the smaller blocks may be referred to as subblocks. After prediction, a transform may be performed on the 8x8 residual block or 4x4 residual block, and an additional transform may be applied to the DC coefficients of the 4x4 blocks for chroma components or luma component if the intra_16x16 prediction mode is used.

[0053] FIG. 2 is a block diagram illustrating an example of a video encoder 20. Video encoder 20 may perform intra- and inter-coding of blocks within video frames. Intra-coding relies on spatial prediction to reduce or remove spatial redundancy in video within a given video frame. Inter-coding relies on temporal prediction to reduce or remove temporal redundancy in video within adjacent frames. For inter-coding, video encoder 20 performs motion estimation to track the movement of matching video blocks between two or more adjacent frames.

[0054] As shown in FIG. 2, video encoder 20 receives a current video block 21 within a video frame to be encoded. In the example of FIG. 2, video encoder 20 includes motion estimation unit 23, reference frame store 25, motion compensation unit 27, block transform unit 29, quantization unit 31, inverse quantization unit 33, inverse transform unit 35 and entropy coding unit 37. Video encoder 20 also includes summer 39 and summer 41. FIG. 2 illustrates the temporal prediction components of video encoder 20 for inter-coding of video blocks. Although not shown in FIG. 2 for ease of illustration, video encoder 20 also may include spatial prediction components for intra-coding of some video blocks.

[0055] Motion estimation unit 23 compares video block 21 to blocks in one or more adjacent video frames to generate one or more motion vectors. The adjacent frame or frames may be retrieved from reference frame store 25. Motion estimation may be performed for blocks of variable sizes, e.g., 16x16, 16x8, 8x16, 8x8 or smaller block sizes. Motion estimation unit 23 identifies a block in an adjacent frame that most closely matches the current video block 21, e.g., based on a rate distortion model, and determines a displacement between the blocks. On this basis, motion estimation unit 23 produces a motion vector that indicates the magnitude and trajectory of the displacement.

[0056] Motion vectors may have half- or quarter-pixel precision, or even finer precision, allowing video encoder 20 to track motion with higher precision than integer pixel locations and obtain a better prediction block. When motion vectors with fractional pixel values are used, interpolation operations may be carried out in motion compensation unit 27. For example, in the AVC/H.264 standard, to obtain a luma signal at half-pixel positions, the 6-tap Wiener filter with coefficients (1, -5, 20, 20, -5, 1)/32 may be used. To obtain luma signals at quarter-pixel locations, bilinear filtering on the values at integer pixel locations and the interpolated values at half pixel locations may be used. The bilinear filter also may be used in fractional pixel interpolation for the chroma components, which may have up to 1/8-pixel precision.

[0057] Motion estimation unit 23 identifies the best motion vector for a video block using a rate-distortion model. Using the resulting motion vector, motion compensation unit 27 forms a prediction video block by motion compensation. Video encoder 20 forms a residual video block by subtracting the prediction video block produced by motion compensation unit 27 from the original, current video block 21 at summer 39. Block transform unit 29 applies a transform to the residual block. Quantization unit 31 quantizes the transform coefficients to further reduce bit rate. Entropy coding unit 37 entropy codes the quantized coefficients to even further reduce bit rate. Video decoder 26 performs inverse operations to reconstruct the encoded video.

[0058] Inverse quantization unit 33 and inverse transform unit 35 apply inverse quantization and inverse transformation, respectively, to reconstruct the residual block. Summer 41 adds the reconstructed residual block to the motion compensated prediction block produced by motion compensation unit 27 to produce a reconstructed video block for storage in reference frame store 25. The reconstructed video block is used by motion estimation unit 23 and motion compensation unit 27 to encode a block in a subsequent video frame.

[0059] When performing motion compensation for a given block in the current video frame 21, motion compensation unit 27 may use a fixed set of filters to interpolate a reference block from a reference frame. One reference block is needed if the current block is uni-directionally predicted or two reference blocks are needed if the current block is bi-directionally predicted. In H.264, multiple reference frames in forward and backward directions may be used in some cases. The actual filters used in motion compensation unit 27 depend on the fractional part of the motion vector. For example, if the motion vector points to a half-pixel location in the reference frame in a given dimension, to obtain the value of the half-pixel location, a 6-tap filter such as (1, -5, 20, 20, -5, 1)/32 is used in that dimension with a half-pixel motion vector. If both motion vector components point to integer locations, the pixel values from the reference frame in reference frame store 25 may be used directly without performing any interpolation filtering operation.

[0060] FIG. 3 is a diagram illustrating formation of a prediction block by blocks with different motion vectors. In the example of FIG. 3, an 8x16 prediction block 43 is formed by a combination of two 8x8 subblocks 45, 47 from a reference frame 49, each with a different motion vector (MV). For example, 8x8 block 45 has a subblock motion vector of (0, -6) and 8x8 subblock 47 has a block motion vector of (-2, -6).

[0061] As discussed above, the reconstructed video block is formed by taking the sum of the motion compensated prediction video block produced by motion compensation unit 27 and the reconstructed residual block produced by inverse quantization unit 33 and inverse transform unit 35, with additional clipping operations performed if necessary. The reconstructed blocks are then stored in the reference frame store 25 for future prediction use. The reconstructed blocks may contain quantization noise and undesired artifacts when directly used to generate the prediction video block.

[0062] Applying smoothing operations on the prediction video block may alleviate such artifacts. Also, the prediction video block may be formed by subblocks that are motion compensated with different motion vectors, e.g., as shown in FIG. 3. Thus, discontinuity may exist along the borders of these subblocks. Applying an in-loop deblocking filter, e.g., as in AVC/H.264, where the deblocking filter parameters depend on the motion information, may alleviate the discontinuity problem within the reconstructed block. However, the deblocking filter may have high computational complexity. In addition, a deblocking filter such as in H.264 is designed for improving the visual quality of the current frame instead of altering the frame such that future frames may be better predicted. Therefore, applying a smoothing operation to the prediction block obtained from motion compensation, e.g., via a low-pass filter, may provide better prediction for the current block.

[0063] Depending on the nature and magnitude of noise that may exist in individual prediction blocks, it may or may not be beneficial to apply additional smoothing filtering. This is also true if the smoothing filter is applied for the purpose of altering the reference block to make it more closely match the current block, because the objects in the reference frame and in the current frame may go through different spatial transforms. Hence, smoothing may have different impacts on the coding process as a function of the actual content of the blocks.

[0064] In accordance with various aspects of this disclosure, it is possible to adaptively decide whether a regular or filtered (smoothed) prediction block should be used. Use of a regular prediction block may involve application of motion compensation according to a first filter mode. The first filter mode may involve application of an interpolation filter if a pertinent motion vector specifies fractional pixel values. Smoothing of the prediction block may involve application of an additional filter according to a second filter mode. The filter mode decision may be encoded and sent in the encoded video bitstream. Alternatively, the filter mode decision may be inferred at the video decoder using statistics and/or characteristics of the received video.

[0065] In some instances, additional filtering, such as low pass filtering for smoothing of predictive blocks, may improve the resulting visual quality of digital video when displayed on display device 28. For example, application of a smoothing filter, such as a 3-tap [1,2,1] filter, may reduce quantization noise and the number of artifacts that occur in the predictive frame. Also, application of this smoothing filter may generate the effects of motion blur, such that the reference frame and current frame better match one another.

[0066] System 10 may be configured to support adaptive filtering of motion compensated to generate prediction blocks, which improves both visual quality and processing efficiency. For example, video decoder 26 may adaptively adjust motion compensation to apply either a first filter mode without additional filtering or a second filter mode with additional filtering. The filter mode may be adapted on a block-by-block, macroblock-by-macroblock, slice-by-slice, or frame-by-frame basis, and may be based on a signal encoded in the video frame, or analysis of one or more characteristics of the video frame. In some cases, video decoder 26 may combine a motion compensation filter and a smoothing filter, rather than applying the filters in cascade, further reducing complexity.

[0067] FIG. 4 is a block diagram illustrating an example of a video decoder 26a configured to support adaptive filtering to generate prediction blocks. In the example of FIG. 4, video decoder 26a implements adaptive filtering based on a filter mode decision indicated by a filter mode signal encoded in the video bitstream. As shown in FIG. 4, video decoder 26A includes a motion compensation module 30, an entropy decoding module 32, an inverse quantization module 34, an inverse transform module 36, a summer S1, a deblocking filter 38, a reference frame store 40, a motion compensation unit 42, a smoothing filter 44, and a control module 46.

[0068] In a first filter mode, video decoder 26A performs regular motion compensation, which may include interpolation filtering for fractional pixel values. In a second filter mode, video decoder 26A performs motion compensation with additional filtering.

Smoothing filter 44 represents an exemplary additional filter to be applied in the second filter mode. However, the disclosure should not be limited to smoothing filter 44, but may include other additional filters comprising different filtering characteristics. Although not shown in FIG. 4, video decoder 26A also supports decoding of intra-coded (I) blocks. For ease of illustration, however, FIG. 4 focuses on decoding of inter-coded (P or B) blocks.

[0069] In the example of FIG. 4, entropy decoding module 32 applies entropy decoding to encoded video to produce quantized transform coefficients, motion vectors, and a filter mode signal. Inverse quantization module 34 and inverse transform module 36 convert the transform coefficients to residual block information. Motion compensation module 30 forms a predictive block that is summed, as represented by summer S1, with the residual block information. Deblocking filter 38 filters the resulting summed block to remove "blocky" artifacts. "Blocky" artifacts often occur at lower bitrates. Exemplary inverse quantization, inverse transform and deblocking filter techniques are described in the H.264 / MPEG-4 Part 10 AVC standard, although the techniques described in this disclosure may be used with other video compression standards or techniques. Video frames filtered by deblocking filter 38 are stored in reference frame store 40. Reference frame store 40 may comprise a memory capable of storing reference frames used for further predictions.

[0070] Motion compensation module 30 comprises motion compensation unit 42, which receives motion vectors from entropy decoding module 32 and reference frames from reference frame store 40 to produce predictive blocks. For example, motion compensation unit 42 applies the motion vectors to a reference frame to select matching blocks, and provides the selected blocks as predictive blocks for summing with the residual information produced by inverse transform module 36, as represented by summer S1. In some cases, motion compensation unit 42 may apply an interpolation filter to generate the predictive block from a block in the reference frame. To obtain video data at fractional pixel locations, for example, motion compensation unit 42 may include an interpolation filter. Accordingly, the first filter mode may be a mode in which regular motion compensation is performed with or without interpolation filtering, depending on whether the applicable motion vector points to integer or fractional pixel values. Motion compensation module 30 may provide the predictive block directly in a first filter mode, or apply smoothing filter 44 to the predictive block in a second filter mode 44. Hence, the second filter mode may be a mode substantially identical to the first filter mode, but with the addition of a smoothing filter 44 or other filter.

[0071] A control module 46 receives the filter mode signal from entropy decoding module 32 and controls switch 50 within motion compensation module 30 to select either a first filter mode in which the additional smoothing filter 44 is not applied, or a second filtering mode in which the additional smoothing filter 44 is applied to the predictive block produced by motion compensation unit 42. Control module 46 retrieves the filter mode signal from the decoded bitstream to determine whether the encoder has indicated the first or second filter mode, and makes an appropriate filter mode decision.

[0072] Although the selection of the first filter mode or the second filter mode is represented by a switch 50 for purposes of illustration, the selection may be a software function and need not be realized by an actual switch. In addition, although control module 46 retrieves the filter mode signal form the entropy decoded bitstream in the example of FIG. 4, the filter mode signal may be determined from the statistics and/or characteristics of the decoded video signal before or after inverse quantization or inverse transformation.

[0073] Entropy decoding module 32 transmits motion vectors to motion compensation unit 42, which performs motion compensation techniques to generate predictive blocks from reference frames stored in reference frame store 40. Smoothing filter 44, as described above, is an example of an additional filter that may be adaptively applied in accordance with the principles of this disclosure. Video decoder 26A may, in some aspects, adaptively apply smoothing filter 44 at the block level of the predicted frames based on the filter mode decision. In other words, encoder 20 may adjust the filter mode signal on a block-by-block basis. Alternatively, the filter mode signal may be adjusted on a frame-by-frame, slice-by-slice, or macroblock-by-macroblock basis. Consequently, motion compensation module 30 may adaptively apply smoothing filter 44 at the frame-, slice-, macroblock- or block-level.

[0074] Video encoder 20 may generate the filter mode decision based on analysis of one or more characteristics of the digital video being encoded. Particular statistics of the predictive block may be used to determine the filter mode to be used. For example, the amount of low- and high-pass frequency components in the predictive block may be used to derive the filter mode. If a large amount of high-pass frequency components are present in the predictive block, then the second filter mode may be applied, e.g., to provide smoothing. Alternatively, if the amount of high frequency components in the predictive block is not large, the first filter mode may be applied. Other statistics or characteristics of the predictive block and/or neighboring video blocks may be used. For example, if the predictive block is formed by small (e.g., 4x4) block partitions during motion compensation, then the second filter mode may be applied. Alternatively, if the predictive block is not formed by small block partitions, the first filter mode may be applied.

[0075] When the filter mode signal is not transmitted in the encoded bitstream, control module 46 at the decoder side may infer the filter mode signal based on analysis of the encoded video received via channel 16, using substantially the same statistics and/or characteristics of the video signal that the encoder in source device 12 might use to decide the filter mode during encoding of the video, as described above. Accordingly, like the encoder, the decoder 26A may analyze the predictive block to determine the presence of high frequency and low frequency components, and/or to determine whether the block is made up of small block partitions. On this basis, the decoder 26 selects the appropriate filter mode in substantially the same way as the encoder. In general, the encoder 20 and decoder 26 should use the same information and follow the same logic to derive the filter mode in order to prevent drifting in the decoder.

[0076] FIG. 5 is a block diagram illustrating another exemplary aspect of a video decoder 26B. Video decoder 26B may be substantially similar to the video decoder 26A of FIG. 4. However, video decoder 26B further includes a smoothed motion compensation module 52 that combines interpolation filtering associated with regular motion compensation and additional smoothing. When control module 46 generates a filter mode decision indicating the first filter mode, motion compensation module 30 selects motion compensation unit 42 to generate the predictive block without additional filtering. In this case, motion compensation unit 42 performs regular motion compensation, which may include interpolation filtering for motion vectors with fractional pixel precision. When control module 46 generates a filter mode decision indicating the second filter mode, however, motion compensation module 30 selects smoothed motion compensation filter 52. Hence, control module 46 selects whether a regular or smoothed prediction block should be used.

[0077] In effect, smoothed motion compensation filter 52 may combine the features of motion compensation unit 42 and a smoothing filter. In this manner, in the second filter mode, smoothing may be applied in combination with interpolation filtering, rather than in a cascade. With a single filter module, instead of two or more filter modules, processing complexity may be reduced. To obtain video at fractional pixel locations, motion compensation unit 42 may include the functionality of an interpolation filter. When an additional filter, such as a smoothing filter, is applied, it may be combined with the interpolation filter in motion compensation unit 42 to form smoothed motion compensation filter 48, and thereby reduce system complexity. Smoothed motion compensation module 52 combines the functionality of motion compensation unit 42 and a smoothing filter based on multiple assumptions and approximations, which will be described below.

[0078] An alternative way to view this combination of interpolation filter and smoothing filter is that motion compensation module 30 invokes a different, modified filter, i.e., smoothed motion compensation filter 52, in the second filter mode when a smoothed prediction block is to be produced. In other words, the cascade of a smoothing filter S with motion compensation MC to produce S(MC(reference block(s), motion vector(s)) is replaced with a combined filter MC'(reference block(s), motion vector(s)) that is the mathematical approximation of S(MC()).

[0079] This mathematical approximation may be embodied in smoothed motion compensation filter 52 for application in the second filter mode when smoothing is desired. An example of how to form the filters used in MC' of smoothed motion compensation filter 52 may be derived from the framework of the scalable video coding (SVC) extension to H.264/AVC. The approach of performing additional filtering on the motion compensated prediction may be referred to as adaptive motion compensation in this disclosure. In some cases, the filter mode signal may be the smoothedPred flag specified in the H.264 / AVC standard. In particular, control module 46 may interpret the status of the smoothedPred flag as an indication of the filter mode decision.

[0080] FIGS. 6-8 illustrate a context for derivation of an example smoothed motion compensation filter 52. However, the techniques should not be limited to this exemplary derivation and may be applied to the general framework discussed above. Smoothed motion filter 52 may be substantially similar to smoothed motion filter 52 discussed below in reference to FIG. 6.

[0081] FIG. 6 is a block diagram illustrating another exemplary video decoder 26C. In FIG. 6, video decoder 26C may be configured to support scalable video coding (SVC). As an example, video decoder 26C may be compliant with the SVC extension of the H.264/ MPEG-4 Part 10 AVC standard. Video decoder 26C may be substantially similar to the video decoder 26B of FIG. 5, but be further configured to support SVC. As in the example of FIG. 5, the filter mode signal in the example of FIG. 6 may be the smoothedPred flag specified in the H.264 / MPEG-4 Part 10 AVC standard. In this example, control module 46 may interpret the status of the smoothedPred flag as an indication of the filter mode decision. In the example of FIG. 6, video decoder 26C further includes the functionality of a switch 54 that may receive as an input a ResPred flag according to the SVC extension to AVC/H.264, as described in more detail below.

[0082] The Joint Video Team (JVT), which consists of video coding experts from ISO/IEC MPEG and ITU-T VCEG, is currently working on the SVC extension to H.264/AVC. The common software, called JSVM (Joint Scalable Video Model), is being used by the participants. JSVM supports combined scalability. A bitstream may have SNR scalability, Fine Granularity Scalability (FGS), spatial scalability, and temporal scalability. Spatial scalability allows video decoder 26C to reconstruct and display a video signal of higher spatial resolution, e.g., common intermediate format (CIF) instead of quarter common intermediate format (QCIF), by decoding enhancement layer bitstreams from an SVC bitstream.

[0083] SVC supports a number of inter-layer prediction techniques to improve coding performance. For example, when coding an enhancement layer macroblock, the corresponding macroblock mode, motion information, and residual signals from the base or previous layer may be used. In particular, a BLskip flag may be added as the macroblock (MB) level syntax element. If the current MB is an inter MB and the BLskip flag is set to 1, then the enhancement layer MB will inherit MB mode, motion vectors, and reference picture indices from the corresponding base or previous layer MB.

[0084] When spatial scalability is used, the enhancement layer represents a video signal of higher spatial resolution than that of the base or previous layer bitstream. In this case, the base or previous layer MB information is upsampled before it is used in inter-layer prediction. As an example, when the spatial scalability factor is 2:1 (dyadic spatial scalability), the base or previous layer MB information is upsampled by a factor of 2 in each dimension. If the base or previous layer MB has MODE_8x8 (inter predicted macroblock with four 8x8 blocks), then the upsampled video signal will have four macroblocks with MODE_16x16 at corresponding locations.

[0085] Another inter-layer prediction method, residual prediction, is also supported in SVC. Some residual blocks in the base or previous layer may be correlated to the corresponding enhancement layer residual blocks. For these blocks, applying residual prediction may reduce the enhancement layer residual energy and improve coding performance. In SVC, whether residual prediction is used or not is indicated using a one-bit flag ResPred. Like BLskip, ResPred is also coded as a macroblock level syntax element. If ResPred=1, then the enhancement layer residual is coded after subtracting from it the base or previous layer residual block.

[0086] Therefore, to properly decode the enhancement layers, video decoder 26C may add the base or previous layer residual blocks to the enhancement layer. With reference to FIG. 6, for example, if ResPred=1, switch 54 provides the base or previous layer residual ("base layer residual" in FIG. 6) to the summer S1 that sums the enhancement layer residual ("residual" in FIG. 6) and prediction block ("prediction" in FIG. 6). In contrast to the SVC context, FIG. 5 shows similar techniques but does not include the representation of switch 58 to provide the base layer residual to this summer. Similar to switch 50 of FIG. 4, however, switch 54 is for purposes of illustration only and the selection of whether to provide the base layer residual may be a software function and need not be realized by an actual switch.

[0087] If spatial scalability is used, then the base or previous layer residual signal is upsampled before being used in inter-layer prediction. In the case of dyadic spatial scalability, SVC uses the bilinear filter to upsample the residual signal. More details on inter layer prediction used in SVC may be found, e.g., in Thomas Wiegand, Gary Sullivan, Julien Reichel, Heiko Schwarz, and Mathias Wien, "Joint Draft 7 of SVC Amendment (revision 2)," JVT-T201r2, July 2006, Klagenfurt, Austria (JD7).

[0088] Based on residual prediction, a technique called Smoothed Reference (SR) may be applied in a video decoder to further improve coding performance for spatial scalability. An example of the SR technique is described in Woo-Jin Han "Modified IntraBL design using smoothed reference," JVT-R091r1, January 2006, Bangkok, Thailand. Video coding techniques that support adaptive filtering of motion compensated prediction blocks, as described in this disclosure, may achieve coding gain similar to the SR technique but with significantly lower complexity. For context, an example SR technique is described below in conjunction with FIG. 7, which is a diagram illustrating application of a smoothed reference (SR) process in SVC enhancement layer coding.

[0089] Derivation of an example implementation of smoothed motion compensation filter 52, in accordance with certain aspects of this disclosure, will now be described with reference to the H.264/MPEG-4 Part 10 AVC standard. First, the following equation (1) describes, in part, the Smoothed Reference operation of the SVC extension to the H.264 / MPEG-4 Part 10 AVC standard as:

$$O - S(P+U_R(R_b)) \quad (1)$$

where O represents the original block in the current coding layer, S represents the application of the smoothing filter, P represents the predictive block, U_R represents the upsampling operation between the current layer and the base or previous layer, and R_b represents the reconstructed residual block. In accordance with this disclosure, equation (1) may be simplified as follows by typical mathematical operations, yielding the following equation (2):

$$O - S(P) - S(U_R(R_b)) \quad (2)$$

Equation (2) may be further simplified to equation (3) below by noting that the effects of smoothing the upsampled reconstructed residual block, or the $S(U_R(R_b))$ part of equation (2), often yields minor if any improvements in visual quality. It has been observed experimentally that the performance gain from the SR process may be retained by smoothing only the prediction signal P. Thus, based on the assumption that $S(U_R(R_b))$ can be adequately represented as $U_R(R_b)$, the following equation (3) results:

$$O - S(P) - U_R(R_b). \quad (3)$$

According to equation (3) above, smoothed reference in SVC may be considered a special case of the more general framework shown in the exemplary aspect of video decoder 26A of FIG. 4. Contrary to the SR technique of applying cascaded motion compensation MC() and smoothing S(), smooth motion compensation filter 52 may be configured to support a modified motion compensation MC'(), herein referred to as smoothed motion compensation.

[0090] FIG. 7 is a diagram illustrating exemplary application of a smoothed reference (SR) process in SVC enhancement layer coding. More particularly, FIG. 7 shows a motion compensation process in a video decoder involving a forward reference frame 51A, current frame 51B and backward reference frame 51C in an enhancement layer (Layer N) and a forward reference frame 53A, current frame 53B and backward reference frame 53C in a base or previous layer (Layer N-1). FIG. 7 illustrates bi-directional prediction. However, prediction in one direction may be used.

[0091] First, when both the ResPred and BLskip flags are set for a given MB 55B in the enhancement layer, an additional flag SmoothedRef is sent by encoder 20. When SmoothedRef = 1, the possibly upsampled motion vectors $U_{mv}(MVb)$ from the corresponding macroblock 57B in the base or previous layer (Layer N-1) are used to code the current video block 55B in the enhancement layer (Layer N), where $U_{mv}()$ is the upsampling operation on motion vectors. This step is indicated as "motion reuse" 59A, 59B in the diagram of FIG. 7. If the resolution of the enhancement layer is the same as that of the base layer, then $U_{mv}(MVb) = MVb$. Alternatively, the upsampling operation $U_{mv}()$ is needed to upsample from the spatial resolution of the base layer (or previous layer) to the resolution of the applicable enhancement layer.

[0092] Second, a prediction block (P) 61 is generated through motion compensation with regular motion compensation filtering 68 using the motion vectors derived in the motion reuse operation 59A, 59B. Third, the corresponding reconstructed residual block 57B (Rb) from the base or previous layer (Layer N-1) is upsampled to obtain $U_R(Rb)$, where $U_R()$ is the upsampling operation on the residual. Reconstructed residual block 57B is obtained from motion vectors pointing to corresponding blocks 57A, 57C in the reference frames 53A, 53C in the base or previous layer N-1. If spatial scalability is not used, then the $U_R(r) = r$. Upsampled block $U_R(Rb)$ is added to the prediction block 61 (P). This addition occurs because the ResPred flag is set, thereby causing a switch, such as switch 54 of FIG. 6, to provide the base layer residual, which in this instance is upsampled block $U_R(Rb)$, to a summer S1.

[0093] Fourth, a smoothing filter 63 (S) is applied to the block P+ $U_R(Rb)$ to obtain a smoothed block 65 (S(P+ $U_R(Rb)$)). As an example, a 3-tap low-pass filter with coefficients [1,2,1] may be used as the smoothing filter 63. A macroblock (MB) is filtered in the horizontal direction first and then in the vertical direction. Fifth, the prediction residual difference $O\text{-}S(P+U_R(Rb))$, where O is the original block in the current layer (Layer N), is the prediction residual and is coded in typical steps such as transform, quantization and entropy coding 67. An SR process, as in SVC, may entail high complexity. SR adds one additional filtering operation, e.g., smoothing filter 63, on top of any fractional pixel interpolation filters used in motion compensation, presenting very high computational complexity.

[0094] For different prediction blocks, given different amounts and types of noise, application of additional smoothing filtering is not always necessary. In accordance with various aspects of this disclosure, it is possible to adaptively decide whether a regular or filtered (smoothed) prediction block should be used. Use of a regular prediction block may involve application of motion compensation according to a first filter mode. The first filter mode may involve application of an interpolation filter if a pertinent motion vector specifies fractional pixel values. Smoothing of the prediction block may involve application of an additional filter according to a second filter mode. As described in this disclosure, selection of the first or second filter mode may be based on a filter mode decision. By selectively applying either the first or second filter mode, computational complexity may be reduced for some blocks.

[0095] FIG. 8 is a diagram illustrating exemplary application of a smoothed reference (SR) process using adaptive motion compensation in SVC enhancement layer coding. More particularly, FIG. 8 shows another motion compensation process in a video decoder involving a forward reference frame 51A, current frame 51B and backward reference frame 51C in an enhancement layer (Layer N) and a forward reference frame 53A, current frame 53B and backward reference frame 53C in a base or previous layer (Layer N-1). FIG. 8 illustrates bi-directional prediction. However, prediction in one direction may be used. The motion compensation process shown in FIG. 8 may be substantially similar to the motion compensation process shown in FIG. 7. In FIG. 8, however, the motion compensation process comprises adaptive motion compensation (MC) filtering 69, which replaces regular motion compensation filtering 68 and smoothing filter 63 of FIG. 7.

[0096] As described above, adaptive motion compensation filtering 69 may apply a different filter that represents a combination of two filters, e.g., an interpolation filter and a smoothing filter. The different filter provided by adaptive motion compensation filtering 69 may be used, for example, as smoothed motion compensation filter 52 in the example of FIG. 5 or FIG. 6. Mathematically, in the example of FIG. 8, the cascade of a smoothing filter 63 with regular motion compensation filtering 68 to produce S(MC(reference block(s), motion vector(s)) is replaced with a combined filter MC'(reference block(s), motion vector(s)) or advanced motion compensation filtering 69 that is the mathematical approximation of S(MC()), or cascaded regular motion compensation filtering 68 and smoothing filter 63. By combining application of these two filters, the complexity of a video decoder may be reduced, while still possibly generating a prediction video block 61 of equal or higher visual quality than the same prediction visual block 61 generated above in reference to FIG. 7.

[0097] Adaptive motion compensation filtering 69, which applies smoothed motion compensation filter 52, may further be described through consideration of an example case, dyadic spatial scalability. In dyadic spatial scalability, ¼-pixel motion vectors in the base or any previous layers are upsampled to become ½-pixel motion vectors in the enhancement layer. For ½-pixel precision motion vectors, a 6-tap filter is used in H.264 / MPEG-4 Part 10 AVC and SVC motion compensation process MC().

[0098] FIG. 9 is a diagram of an example of a one-dimensional, six-tap filter for luma ½-pixel interpolation. In FIG. 9, the gray boxes represent integer pixel locations, the black boxes represent ½ pixel locations, and the white boxes represent ¼ pixel locations. To interpolate the ½-pixel locations denoted by *a*, *b*, and *c*, the following equations (4) may be used:

$$\begin{aligned} a &= (A - 5*B + 20*C + 20*D - 5*E + F + 16) >> 5 \\ b &= (B - 5*C + 20*D + 20*E - 5*F + G + 16) >> 5 \\ c &= (C - 5*D + 20*E + 20*F - 5*G + H + 16) >> 5 \end{aligned} \quad (4)$$

where A, B, C, D, E, F, G, and H represent integer pixel locations.

[0099] By assuming that a slightly different smoothing filter with coefficients [1, 4, 1] is used in place of the conventional [1, 2, 1] filter defined in the SVC extension, the equation for center ½-pixel location, or b, reduces to the following equation (5):

$$\begin{aligned} b' &= (a + 4 * b + c + 3) / 6 \\ &= (A - B + C + 95 * D + 95 * E + F - G + H + 16 + 96) / 192 \\ &\cong (D + E + 1) >> 1 \end{aligned} \tag{5}$$

In the above equation (5) and below equations (6) and (7), rounding offsets are omitted to simplify the discussion without loss of generality. In actual implementation, a rounding offset can be used before the division is performed in each of equations (5)-(7). Equation (5) results in a low-complexity 2-tap filter: $(D + E)/2$. This 2-tap filter may be used in the combined smoothed motion compensation filter MC'() for ½-pixel interpolation. For integer pixel motion vectors, smoothed motion compensation filter MC'() may apply a 3-tap [1, 2, 1] smoothing filter to obtain the smoothing effect. In this way, the complexity of the filters used in MC'(), i.e., smoothed motion compensation filter 52, may be significantly less than the combined complexity of the normal motion compensation filter MC(), i.e., in motion compensation unit 42, cascaded with the additional smoothing operation, i.e., smoothing filter 44. In summary, smoothed motion compensation filter MC'() in smoothed motion compensation module 52 may be configured to provide the following filter functions:

(1) if both components (vertical and horizontal) of the base motion vector (after upsampling) have integer precision, then a smoothing filter is applied in vertical and horizontal directions;

(2) if one component of the base motion vector has integer precision and the other has fractional (e.g., ½) pixel precision, then the interpolation with a 2-tap filter, such as a bilinear filter, is carried out on the ½ pixel component first, in conjunction with the application of the smoothing filter to the other component in the other dimension; and

(3) if both components of the base motion vector have fractional pixel precision, then the interpolation with the 2-tap filter is performed in both dimensions, i.e., vertical and horizontal.

[00100] SVC may also support extended spatial scalability (ESS), where the scaling factor between base and enhancement layer video dimensions may be arbitrary. For ESS, the base or previous layer motion vectors are upsampled by the scaling factor and rounded to the nearest ¼-pixel locations. For motion vectors with ¼-pixel precisions, the bilinear filter may be used in interpolation. Similar to equation (5) above, the combination of the bilinear filter in MC() and the smoothing filter in S() may be roughly approximated by a weighted average filter in MC'(), according to equation (6) below. As the smoothing filter may be combined with the bilinear filter in ½-pixel interpolation, so can the smoothing filter be combined with the bilinear filter in ¼-pixel interpolation, yielding a weighted average filter in MC'() defined in the following equation (6):

$$\begin{aligned} e' &= (d + 4 * e + f + 3)/6 \\ &= (223 * D + 127 * E + 33 * C + F - B - G + A + H + 192)/384 \\ &\cong (7 * D + 4 * E + C + 6)/12 \\ &\cong (2 * D + E + 3)/6 \end{aligned} \tag{6}$$

where e' represents the ¼-pixel location to be approximated and d, e, and f represent ¼-pixel locations. Again, the cascaded filtering operations can be approximated by interpolation with a 2-tap filter. Although this weighted average filter may improve visual quality, this improvement may not warrant the added complexity introduced by a weighted average filter. Accordingly, in some cases, smoothed motion compensation module 52 may not implement this weighted average filter. Instead, smoothed motion compensation module 52 may implement a 2-tap filter with lower implementation complexity, such as a bilinear filter defined by the following equation (7):

$$e' \cong (3 * D + E)/4 \tag{7}$$

In this case, the 2-tap filter used for interpolating at a partial pixel location becomes a bilinear filter for both ½-pixel locations and ¼-pixel locations in the case of ESS. Note that the above example of spatial scalability in SVC serves only as an example to illustrate the filters that may be used in the combined MC'() of smoothed compensation module 52, as shown in FIGS. 5 and 6, and is not intended to limit the scope of this disclosure. The concept of a locally adaptive motion compensation filter and the filter with the special characteristics discussed above may be applied to general single-layer or multiple-layer video coding systems.

[00101] FIG. 10 is a block diagram illustrating another exemplary aspect of video decoder 26D configured to support application of different filters in the vertical and horizontal dimensions of a prediction block to accommodate motion vectors components with integer or fractional pixel precision. In FIG. 10, video decoder 26D substantially conforms to video decoder 26C in the example of FIG. 6, but further illustrates the application of different filter functions for integer and fractional pixel precision motion vectors, e.g., in the vertical and horizontal dimensions. In the example of FIG. 10, video decoder 26D implements adaptive motion compensation by adaptively applying different filter functions in the horizontal and vertical dimension of the predictive blocks when motion vectors in one dimension point to integer pixel positions and motion vectors in the other dimension point to fractional pixel positions. For example, the combined filter implemented by smoothed motion compensation filter 52 may, in effect, apply a smoothing filter for motion vector components having integer pixel precision, and an interpolation filter, such as a 2-tap filter, which may be a bilinear filter, for motion vector components having fractional pixel precision. Hence, FIG. 10 further illustrates the operation of smoothed motion compensation filter 52, e.g., as described with respect to smoothed motion compensation filter MC'() above.

[00102] Similar to video decoder 26C shown in FIG. 6, video decoder 26D of FIG. 10 comprises motion compensation module 30, entropy decoding module 32, an inverse quantization module 34, an inverse transform module 36, a deblocking filter 38, a reference frame store 40, motion compensation unit 42, and switch 54. As described above, if decoder 26D is used in decoding an SVC video stream and both the residual prediction mode is used and the additional filtering is indicated, the base layer (or previous layer) residual, with proper upsampling if the base layer has a different resolution from that of the enhancement layer, may be added to the reconstructed residual at the current layer and the prediction to obtain the reconstructed video. In these embodiments, video decoder 26D may include the functionality of a switch 54 to provide the base layer residual for summation with the enhancement layer residual and prediction blocks in accordance with the SVC extension of H.264/MPEG 4 Part 10.

[00103] In addition, in the example of FIG. 10, motion compensation module 30 includes a smoothed motion compensation filter 52. In the example of FIG. 10, smoothed motion compensation filter 52 further includes a smoothing filter 56 and a 2-tap filter 58, where 2-tap filter 58 may comprise a bilinear filter. Smoothing filter 56 may be formed by a 3-tap filter.

[00104] Control unit 46 generates a filter mode decision based on the filter mode signal obtained from the encoded video bitstream. The filter mode decision may change on a block-by-block basis to apply regular motion compensation via motion compensation unit 42 or motion compensation plus additional filtering represented by smoothing filter 56 or 2-tap filter 58 via smoothed motion compensation filter 52. In particular, for the second filtering mode, control module 46 adaptively applies one or both of additional filters 56, 58 via smoothed motion compensation filter 52 when the filter mode signal in the encoded video bitstream indicates that additional filtering should be applied or, in some alternative implementations, when control module 46 infers from analysis of the received video that additional filtering should be applied. Smoothed motion compensation filter 52 applies smoothing filter 56 and 2-tap filter 58, such as a bilinear filter, in appropriate dimensions of predicted blocks when the second filter mode is selected.

[00105] Application of smoothing filter 56 and 2-tap filter 58 in the second filtering mode depends on the motion vector associated with a predicted block. For example, if a motion vector points to fractional pixel locations in the horizontal dimension of a reference frame stored in reference frame store 40, and the second filter mode is selected, smoothed motion compensation filter 52 applies a 2-tap filter 58, e.g., a bilinear filter, as a horizontal filter in the horizontal dimension of the predictive block. If the motion vector points to integer pixel locations in the horizontal dimension of the reference frame, however, and the second filter mode is selected, smoothed motion compensation filter 52 applies a smoothing filter 56, e.g., a 3-tap filter, as a horizontal filter in the horizontal dimension of the predictive block.

[00106] If the motion vector also points to fractional pixel locations in the vertical dimension of the reference frame, and the second filter mode is selected, smoothed motion compensation filter 52 applies a 2-tap filter 58, e.g., the bilinear filter, as a vertical filter in the vertical dimension of the predictive block. Further, if the motion vector points to integer pixel locations in the vertical dimension of the reference frame, and the second filter mode is selected, smoothed motion compensation filter 52 applies smoothing filter 56 as a vertical filter in the vertical dimension to the predictive block. Hence, smoothed motion compensation filter 52 may apply a 2-tap filter 58, such as a bilinear filter, in the horizontal dimension and a smoothing filter, such as a low pass filter, in the vertical dimension, a smoothing filter 56, such as a low pass filter,

in the horizontal dimension and a 2-tap filter, such as a bilinear filter, in the vertical dimension, 2-tap filters such as bilinear filters in both the horizontal and vertical dimensions, or smoothing filters, such as 3-tap low pass filters, in both the horizontal and vertical dimensions.

[00107] In this way, in the second filter mode, video decoder 26D may adaptively apply different filters in the horizontal and vertical dimensions of a predictive block based on whether the motion vectors point to fractional or integer pixel locations. In the first filter mode, motion compensation unit 42 applies regular motion compensation without additional filtering. Regular motion compensation in the first filter mode may include interpolation filtering in some cases, e.g., for fractional precision motion vector components. In the second filtering mode, because additional filtering may be achieved by adaptively using smoothed motion compensation filter 52 in different dimensions at the block-level and tailored to specific instances, video decoder 26D of FIG. 10 may provide improved coding efficiency and processing efficiency over conventional video decoders.

[00108] In summary, for the second filtering mode, if both components (vertical and horizontal) of the motion vector have integer precision, then smoothed motion compensation filter 52 applies smoothing filter 56 in both the vertical and horizontal dimensions. If one component of a base motion vector has integer precision and the other has fractional pixel precision, then smoothed motion compensation filter 52 applies 2-tap filter 58 for the fractional pixel component in one dimension, and smoothing filter 56 is applied for the other integer pixel component in the other dimension. If both components of the motion vector have fractional pixel precision, then smoothed motion compensation filter 52 applies 2-tap filter 58 in both dimensions, i.e., vertical and horizontal. Hence, horizontal filtering may comprise one of a 2-tap filter 58 or a smoothing filter 56, and vertical filtering may comprise one of a 2-tap filter or a smoothing filter, according to whether a pertinent motion vector component in the horizontal or vertical dimension has fractional or integer pixel precision. Horizontal filtering may be applied before application of vertical filtering, or vice versa.

[00109] FIG. 11 is a flow diagram illustrating exemplary operation of the video decoder 26A of FIG. 4 in performing adaptive motion compensation at the block level of inter-coded frames. As shown in FIG. 11, video decoder 26A receives encoded digital video (70), e.g., via channel 16, and performs motion compensation to form predicted blocks (72). Motion compensation in a first filter mode may involve selection of corresponding blocks in one or more reference frames using motion vectors received with the digital video, and interpolation filtering if the motion vectors point to fractional pixel locations. Additional filtering, such as smoothing via smoothing filter 44 to remove quantization noise or other artifacts, may be applied to a predicted block on an adaptive basis in a second filter mode, along with regular motion compensation. The additional filtering may be achieved by applying an additional filter after a regular motion compensation filter, or by applying a different filter that combines both regular motion compensation and additional filtering, such as smoothing. In the example of FIG. 4, however, the additional filtering is achieved by applying smoothing filter 44 in conjunction with motion compensation unit 42, e.g., on a cascaded basis.

[00110] As described above, motion compensation module 30 may adaptively apply either a first filter mode or a second filter mode based on a filter mode signal provided with the encoded digital video. In some cases, the filter mode signal may be an encoded signal such as, for example, a smoothed_reference flag as specified in Joint Draft 7 (JD7). In this manner, video decoder 26A may make a filter mode decision as directed by video encoder 20. Alternatively, video decoder 26 may analyze characteristics of the encoded digital video to determine whether the additional filtering mode should be applied.

[00111] The first filter mode may involve regular motion compensation, e.g., with any necessary interpolation filters, while the second filter mode involves regular motion compensation plus additional filtering, such as smoothing. As examples, interpolation may be applied using a 2-tap filter, and smoothing may be applied by using a 3-tap filter. If the second filter mode is indicated (74), motion compensation module 30 applies the additional filter to the predicted block (76). Notably, the filter mode decision may be made on a block-by-block basis, where the term "block" may refer to a macroblock or smaller block, such as a subblock. Alternatively, the filter mode decision may be made at the frame- or slice-level, and applied to all blocks within a given frame or slice, as applicable. If the second filter mode is not indicated (74), the additional filtering is not applied, thereby saving processing complexity for some blocks in the case of block-by-block adaptive motion compensation.

[00112] After either regular motion compensation (72) or motion compensation plus additional filtering (76), video decoder 26A sums the predicted block with residual data provided in the encoded digital video (78) and forms a decoded block based on the sum (80). In instances where the video decoder conforms to the SVC extension of H.264/AVC, e.g., such as a video decoder similar to video decoder 26C of FIG. 6 or video decoder 26D of FIG. 10, the video decoder may further include the functionality of a switch 54 that provides the base layer residual for summation (e.g., as indicated by S1). In this case, motion compensation is applied to blocks in an enhancement layer of an SVC frame. Video decoder 26C, in these instances, may sum the base layer residual with the predicted block and the residual data provided in the encoded digital video (78) to form a decoded block based on the sum (80). In either instance, the sum may be processed by a deblocking filter 38 to remove blocking artifacts. The decoded blocks may be used to form a video frame to drive display device 28, and may be added to a reference frame store to form reference frames for decoding of subsequent frames. By applying additional filtering at the block-level, the decoded digital video may exhibit enhanced coding efficiency. By applying the additional filtering on an adaptive basis rather than full-time, however, video decoder 26C may achieve significant performance gains without excessive processing complexity.

[00113] FIG. 12 is a flow diagram illustrating exemplary operation of the video decoder 26B of FIG. 5 in performing smoothing and motion compensation using a combined smoothed motion compensation unit. The process shown in FIG. 12 may be adapted for application to SVC coding. As shown in FIG. 12, upon receiving digital video (82) via channel 16, a video encoder 26B (FIG. 5) or video decoder 26C (FIG. 6) determines whether a second filter mode is indicated (84). Again, the second filter mode may be indicated by a filter mode signal included in the encoded video bitstream. The second filter mode may be indicated on a frame-, slice-, macroblock- or subblock-basis. Alternatively, video decoder 26B may be configured to determine whether the second filter mode should be applied based on analysis of one or more characteristics of the digital video.

[00114] If the second filter mode is indicated (84), motion compensation module 30 performs a combined smoothing and regular motion compensation, i.e., smoothed motion compensation, to form a predicted block (86). Smoothed motion compensation may be performed via smoothed motion compensation filter 52 (FIG. 5 or 6) of motion compensation module 30 in FIG. 5. If the second filter mode is not indicated (84), motion compensation module 30 performs regular motion compensation to form the predicted block (88), e.g., via motion compensation unit 42 of motion compensation module 30, without additional filtering. Video decoder 26B of 26C then sums the predicted block with residual data (90) and forms a decoded block based on the sum (92).

[00115] Again, in instances where the video decoder conforms to the SVC extension of H.264/AVC, e.g., similar to video decoder 26C of FIG. 6 or video decoder 26D of FIG. 10, the video decoder may further include the functionality of a switch 54 that provides the base layer residual for summation. In this case, motion compensation is applied to blocks in an enhancement layer of an SVC frame. The video decoder, in these instances, may sum the base layer residual with the predicted block and the residual data provided in the encoded digital video (90) to form a decoded block based on the sum (92). In either instance, the sum may be processed by a deblocking filter 38 to remove blocking artifacts. The decoded blocks may be used to form a video frame to drive display device 28, and may be added to a reference frame store to form reference frames for decoding of subsequent frames.

[00116] FIG. 12 illustrates the use of a combined smoothed motion compensation unit 52 that combines smoothing with regular motion compensation in a single filter module, instead of applying regular motion compensation and smoothing as separate filtering operations in a cascaded manner. In this way, in the example of FIG. 12, by combining regular motion compensation and smoothing, processing complexity can be reduced. This process may continue over the blocks in each frame, and over the multiple frames and slices associated with a video sequence. Again, the filter mode decision of whether to apply smoothed motion compensation unit 52 or regular motion compensation unit 42 may be determined on a frame-by-frame, slice-by-slice, macroblock-by-macroblock, or block-by-block basis.

[00117] FIG. 13 is a flow diagram illustrating exemplary operation of the video decoder 26D of FIG. 10 in performing adaptive motion compensation with different filters in the vertical and horizontal dimensions. In the example of FIG. 13, video decoder 26D applies an adaptive filter mode, similar to FIG. 12. In particular, motion compensation module 30 may apply regular motion compensation unit 42 in a first filter mode. In a second filter mode, motion compensation module 30 may apply a smoothed motion compensation filter 52, which combines regular motion compensation and additional filtering, such as smoothing. As shown in FIG. 10, however, application of smoothed motion compensation filter 52 may further involve application of different filters 56, 58 in the horizontal and vertical dimensions. Upon receiving digital video (94), video decoder 26 determines whether a second filter mode is indicated (96). If the second filter mode is not indicated, motion compensation module 30 applies regular motion compensation (98), e.g., via motion compensation unit 42 (FIG. 10). If the second filter mode is indicated (96), motion compensation module 30 may apply smoothed motion compensation filter 52, in effect providing both regular motion compensation and additional filtering.

[00118] The additional filtering may be provided by a smoothing filter such as a 3-tap filter applied by smoothed motion compensation unit 52 in a dimension in which the pertinent motion vector points to an integer pixel location (100), i.e., in the integer dimension. In addition, smoothed motion compensation unit 52 may apply an interpolation filter, e.g., a 2-tap filter such as a bilinear filter, in a dimension of the prediction block in which the pertinent motion vector points to a fractional pixel location (102), i.e., a fractional dimension. Hence, smoothed motion compensation unit 52 may apply different filters in different dimensions when the second filter mode is indicated. If the second filter mode is not indicated (96), the regular motion compensation is applied instead (98).

[00119] In either case, the video decoder sums the predicted block with applicable residual data (104) and forms a decoded block based on the sum (106). As discussed previously, in instances where the video decoder conforms to the SVC extension of H.264/AVC, e.g., similar to video decoder 26D of FIG. 10, video decoder 26D further may include the functionality of a switch 54 that provides the base layer residual for summation. In this case, motion compensation is applied to blocks in an enhancement layer of an SVC frame. Video decoder 26D, in these instances, may sum the base layer residual with the predicted block and the residual data provided in the encoded digital video (104) to form a decoded block based on the sum (106). In either instance, the sum may be processed by a deblocking filter 38 to remove blocking artifacts. The decoded blocks may be used to form a video frame to drive display device 28, and may be added to a reference frame store to form reference frames for decoding of subsequent frames. As described above, smoothed motion compensation filter 52 effectively applies both motion compensation and smoothing operations, thus reducing the complexity relative to independent application of each operation in a cascaded manner. In addition, smooth motion compensation filter 52 is configured to adaptively apply different filters in the horizontal and vertical dimensions depending on the applicable motion vector.

[00120] Any device described in this disclosure may represent various types of devices, such as a wireless phone, a cellular phone, a laptop computer, a wireless multimedia device, a wireless communication personal computer (PC) card, a personal digital assistant (PDA), an external or internal modem, a gaming device, or any device that communicates through a wireless or wired channel. Such a device may have various names, such as access terminal (AT), access unit, subscriber unit, mobile station, mobile device, mobile unit, mobile phone, mobile, remote station, remote terminal, remote unit, user device, user equipment, handheld device, or the like. In one aspect, a device as described in this disclosure may be or form part of a wireless communication device handset.

[00121] The techniques described herein may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the techniques may be realized at least in part by one or more stored or transmitted instructions or code on a computer-readable medium. Computer-readable media may include computer storage media, communication media, or both, and may include any medium that facilitates transfer of a computer program from one place to another. A storage media may be any available media that can be accessed by a computer.

[00122] By way of example, and not limitation, such computer-readable media can comprise a data storage medium such as RAM, such as synchronous dynamic random access memory (SDRAM), read-only memory (ROM), non-volatile random access memory (NVRAM), ROM, electrically erasable programmable read-only memory (EEPROM), EEPROM, FLASH memory, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other computer-readable data storage medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer.

[00123] Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk and blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically, e.g., with lasers. Combinations of the above should also be considered computer-readable media.

[00124] The code associated with a computer-readable medium of a computer program product may be executed by a computer, e.g., by one or more processors, such as one or more digital signal processors (DSPs), general purpose microprocessors, application specific integrated circuits (ASICs), field programmable logic arrays (FPGAs), or other equivalent integrated or discrete logic circuitry. In some aspects, the functionality described herein may be provided within dedicated software modules or hardware modules configured for encoding and decoding, or incorporated in a combined video encoder-decoder (CODEC). Hence, the disclosure contemplates an integrated circuit device configured to implement the techniques described in this disclosure. Such integrated circuit devices may have a variety of applications, including use within wireless communication device handsets.

[00125] Various aspects of the disclosure have been described. These and other aspects are within the scope of the following claims.

CLAIMS:

1. A method comprising:

applying motion compensation to blocks within a video frame to generate prediction video blocks; and

adaptively adjusting the motion compensation to apply either a first filter mode or a second filter mode to each of the blocks based on a filter mode decision.

2. The method of claim 1, further comprising applying a 3-tap filter to the blocks for motion vectors that point to integer pixel locations.

3. The method of claim 1, further comprising generating the filter mode decision based on one of a signal encoded in the video bitstream or one or more characteristics of the video frame.

4. The method of claim 1, wherein the blocks comprise blocks in an enhancement layer of a scalable video coding frame.

5. The method of claim 1, further comprising applying a motion compensation filter in the first filter mode, and applying a 3-tap filter in the second filter mode.

6. The method of claim 5, further comprising applying the 3-tap filter and the motion compensation filter in the second filter mode, wherein the motion compensation filter includes a 2-tap filter.

7. The method of claim 5, further comprising, in the second filter mode, applying a filter that combines the 3-tap filter with an interpolation filter.

8. The method of claim 7, wherein the interpolation filter includes a 2-tap filter, the method further comprising, in the second filter mode, applying the 3-tap filter in one of a horizontal dimension and a vertical dimension, and applying the 2-tap filter in another of the horizontal and vertical dimensions.

9. The method of claim 7, wherein the interpolation filter includes a 2-tap filter, the method further comprising, in the second filter mode:

applying the 3-tap filter in the horizontal dimension and applying the 2-tap filter in the vertical dimension when a motion vector points to an integer pixel location in the horizontal dimension and to a fractional pixel location in the vertical dimension; and

applying the 3-tap filter in the vertical dimension and applying the 2-tap filter in the horizontal dimension when a motion vector points to an integer pixel location in the vertical dimension and to a fractional pixel location in the horizontal dimension.

10. The method of claim 1, further comprising adaptively adjusting the motion compensation on one of a block-by-block, macroblock-by-macroblock, slice-by-slice, or frame-by-frame basis.

11. A video coding device comprising:

a motion compensation module that applies motion compensation to blocks within a video frame to generate prediction video blocks; and

a control module that adaptively adjusts the motion compensation to apply either a first filter mode or a second filter mode to each of the blocks based on a filter mode decision.

12. The device of claim 11, wherein the control module applies a 3-tap filter to the blocks for motion vectors that point to integer pixel locations.

13. The device of claim 11, wherein the control module generates the filter mode decision based on one of a signal encoded in the video bitstream or one or more characteristics of the video frame.

14. The device of claim 11, wherein the blocks comprise blocks in an enhancement layer of a scalable video coding frame.

15. The device of claim 11, wherein the motion compensation module applies a motion compensation filter in the first filter mode, and applying a 3-tap filter in the second filter mode.

16. The device of claim 15, wherein the motion compensation module applies the 3-tap filter and the motion compensation filter in the second filter mode, wherein the motion compensation filter includes a 2-tap filter.

17. The device of claim 15, wherein the motion compensation module, in the second filter mode, applies a filter that combines the 3-tap filter with an interpolation filter.

18. The device of claim 17, wherein the interpolation filter includes a 2-tap filter, and wherein the motion compensation module, in the second filter mode, applies the 3-tap filter in one of a horizontal dimension and a vertical dimension, and applies the 2-tap filter in another of the horizontal and vertical dimensions.

19. The device of claim 17, wherein the interpolation filter includes a 2-tap filter, and wherein the motion compensation module, in the second filter mode, applies the 3-tap filter in the horizontal dimension and the 2-tap filter in the vertical dimension when a motion vector points to an integer pixel location in the horizontal dimension and to a fractional pixel location in the vertical dimension, and applies the 3-tap filter in the vertical dimension and the 2-tap filter in the horizontal dimension when a motion vector points to an integer pixel location in the vertical dimension and to a fractional pixel location in the horizontal dimension.

20. The device of claim 11, wherein the control module adaptively adjusts the motion compensation on one of a block-by-block, macroblock-by-macroblock, slice-by-slice, or frame-by-frame basis.

21. The device of claim 11, wherein the device is one of a wireless communication device handset or an integrated circuit device.

22. A video coding device comprising:

means for applying motion compensation to blocks within a video frame to generate prediction video blocks; and means for adaptively adjusting the motion compensation to apply either a first filter mode or a second filter mode to each of the blocks based on a filter mode decision.

23. The device of claim 22, further comprising means for applying a 3-tap filter to the blocks for motion vectors that point to integer pixel locations.

24. A computer program product comprising a computer-readable medium comprising instructions to cause a processor to:

apply motion compensation to blocks within a video frame to generate prediction video blocks; and

adaptively adjust the motion compensation to apply either a first filter mode or a second filter mode to each of the blocks based on a filter mode decision.

25. The computer program product of claim 24, further comprising instructions to cause the processor to apply a 3-tap filter to the blocks for motion vectors that point to integer pixel locations.

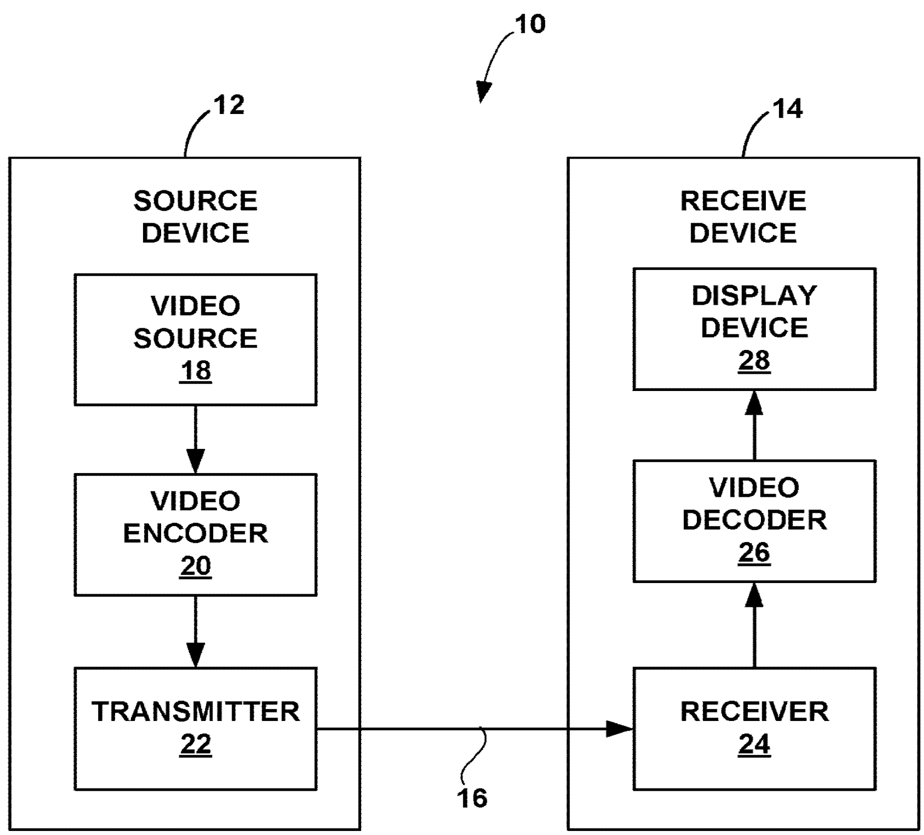

10
12
14
SOURCE DEVICE
VIDEO SOURCE 18
VIDEO ENCODER 20
TRANSMITTER 22
16
RECEIVE DEVICE
DISPLAY DEVICE 28
VIDEO DECODER 26
RECEIVER 24

FIG. 1

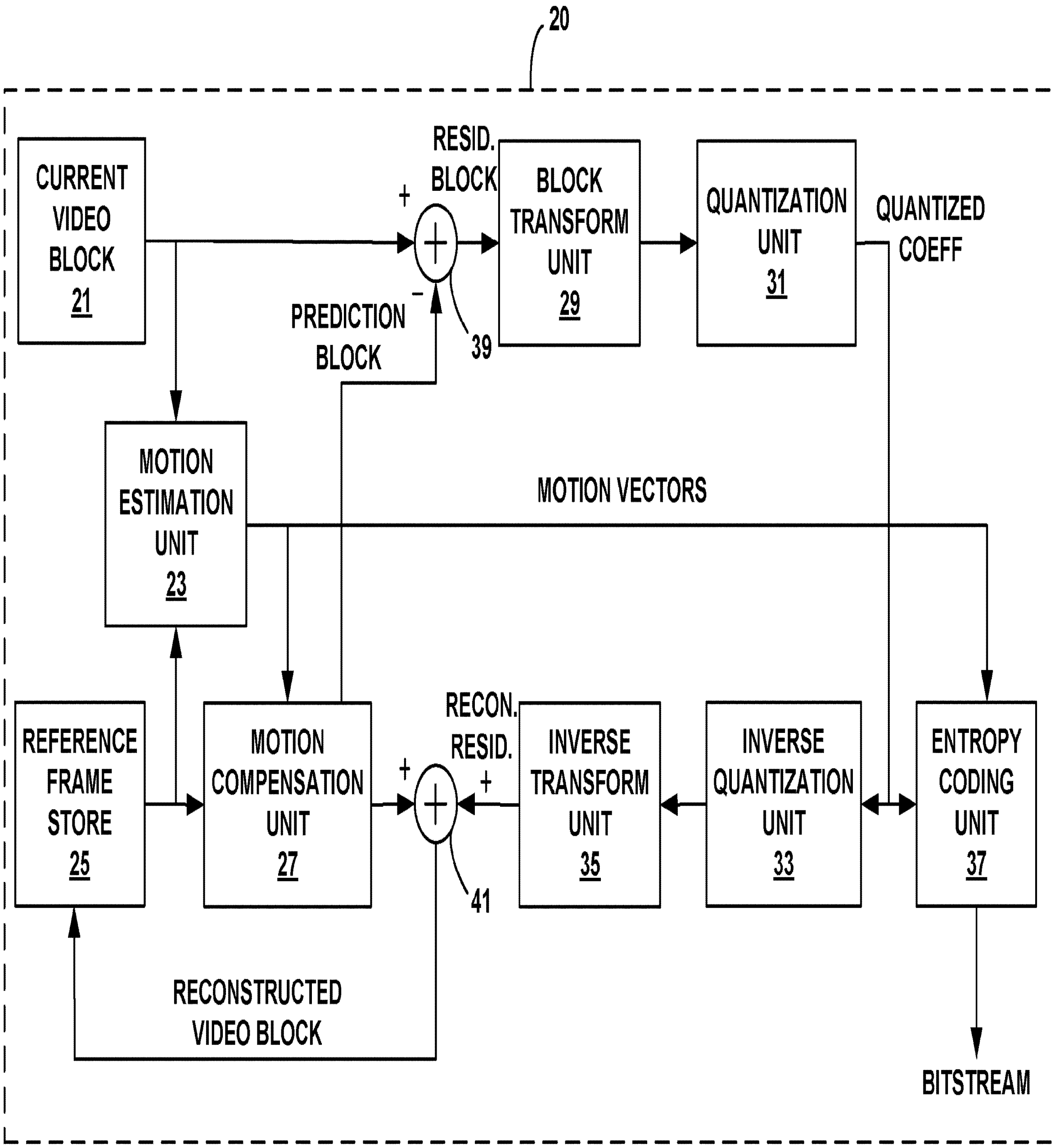
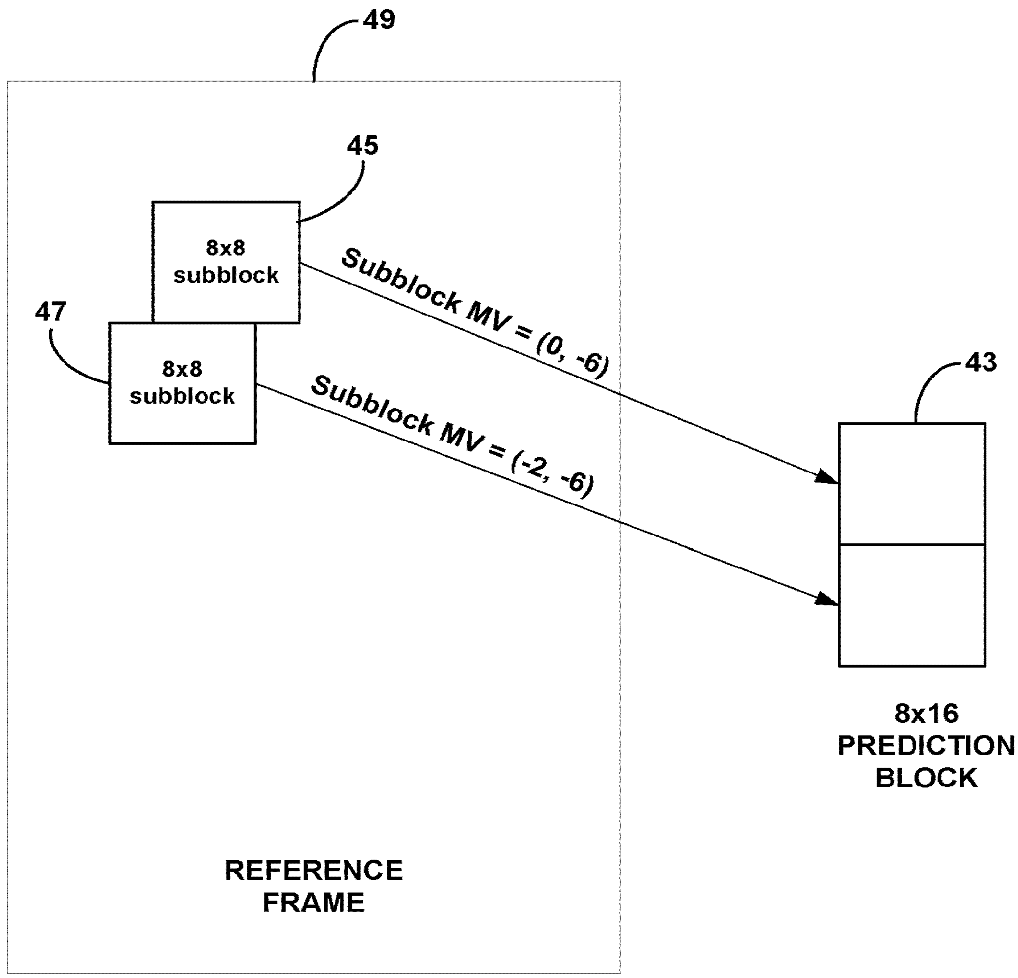

20
CURRENT VIDEO BLOCK 21
RESID. BLOCK
+
−
BLOCK TRANSFORM UNIT 29
QUANTIZATION UNIT 31
QUANTIZED COEFF
PREDICTION BLOCK
39
MOTION ESTIMATION UNIT 23
MOTION VECTORS
REFERENCE FRAME STORE 25
MOTION COMPENSATION UNIT 27
RECON. RESID.
+
+
INVERSE TRANSFORM UNIT 35
INVERSE QUANTIZATION UNIT 33
ENTROPY CODING UNIT 37
41
RECONSTRUCTED VIDEO BLOCK
BITSTREAM

FIG. 2



49
45
8x8
subblock
47
8x8
subblock
Subblock MV = (0, -6)
Subblock MV = (-2, -6)
43
8x16
PREDICTION
BLOCK
REFERENCE
FRAME

FIG. 3

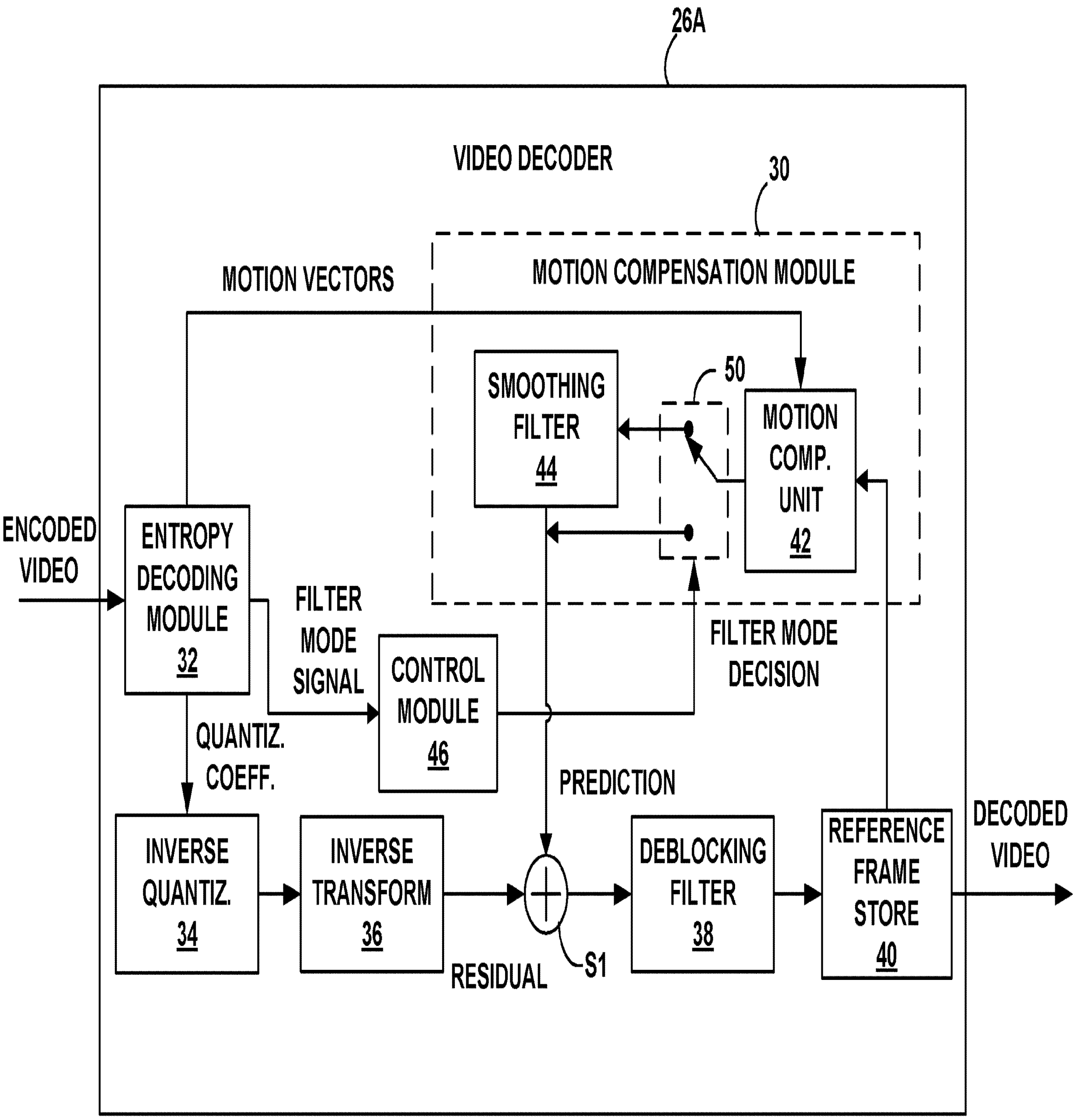

26A
VIDEO DECODER
30
MOTION COMPENSATION MODULE
MOTION VECTORS
SMOOTHING FILTER 44
50
MOTION COMP. UNIT 42
ENCODED VIDEO
ENTROPY DECODING MODULE 32
FILTER MODE SIGNAL
CONTROL MODULE 46
FILTER MODE DECISION
QUANTIZ. COEFF.
PREDICTION
INVERSE QUANTIZ. 34
INVERSE TRANSFORM 36
DEBLOCKING FILTER 38
REFERENCE FRAME STORE 40
DECODED VIDEO
RESIDUAL
S1

FIG. 4

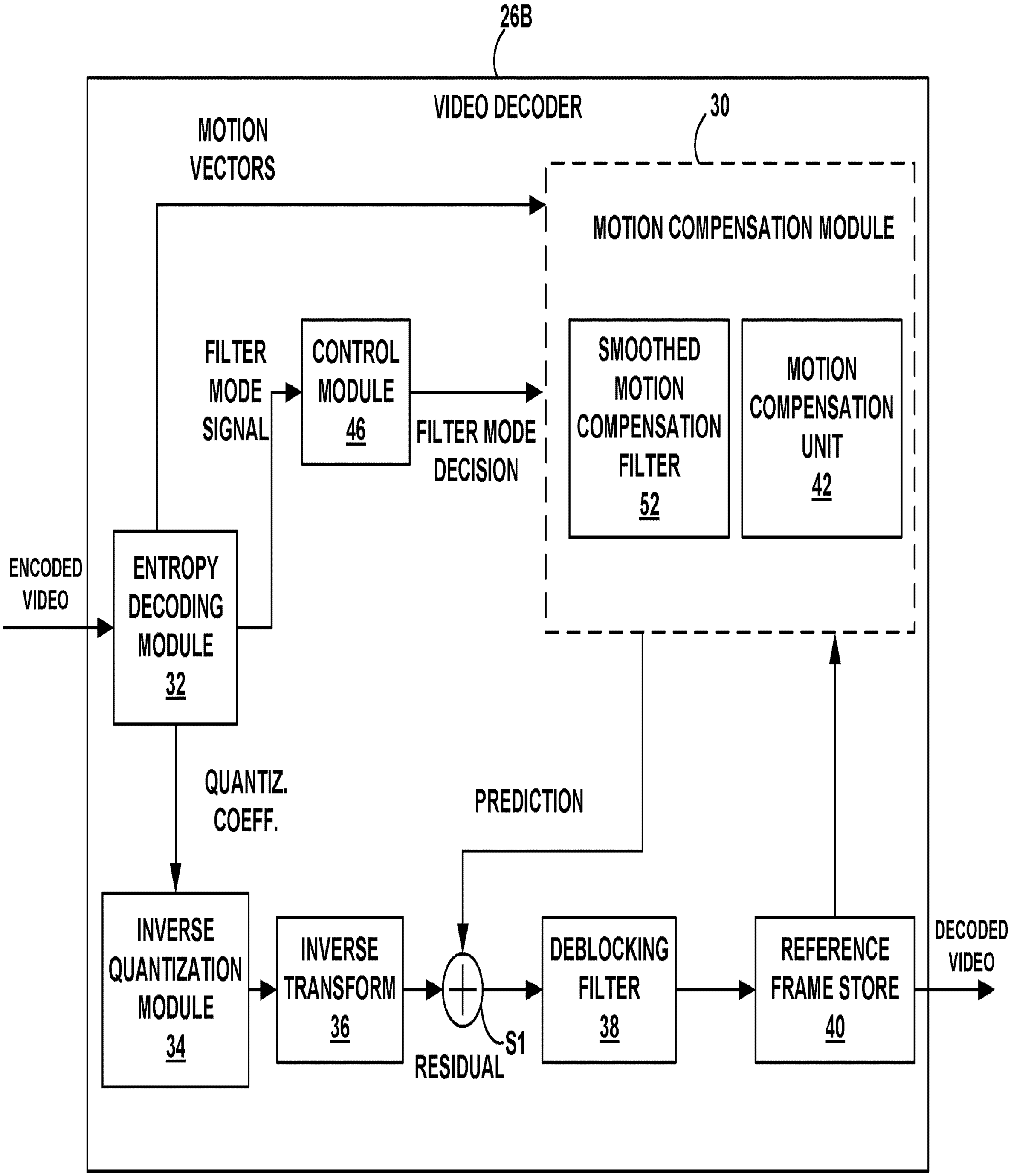

26B
VIDEO DECODER
30
MOTION VECTORS
MOTION COMPENSATION MODULE
FILTER MODE SIGNAL
CONTROL MODULE 46
FILTER MODE DECISION
SMOOTHED MOTION COMPENSATION FILTER 52
MOTION COMPENSATION UNIT 42
ENCODED VIDEO
ENTROPY DECODING MODULE 32
QUANTIZ. COEFF.
PREDICTION
INVERSE QUANTIZATION MODULE 34
INVERSE TRANSFORM 36
S1
RESIDUAL
DEBLOCKING FILTER 38
REFERENCE FRAME STORE 40
DECODED VIDEO

FIG. 5

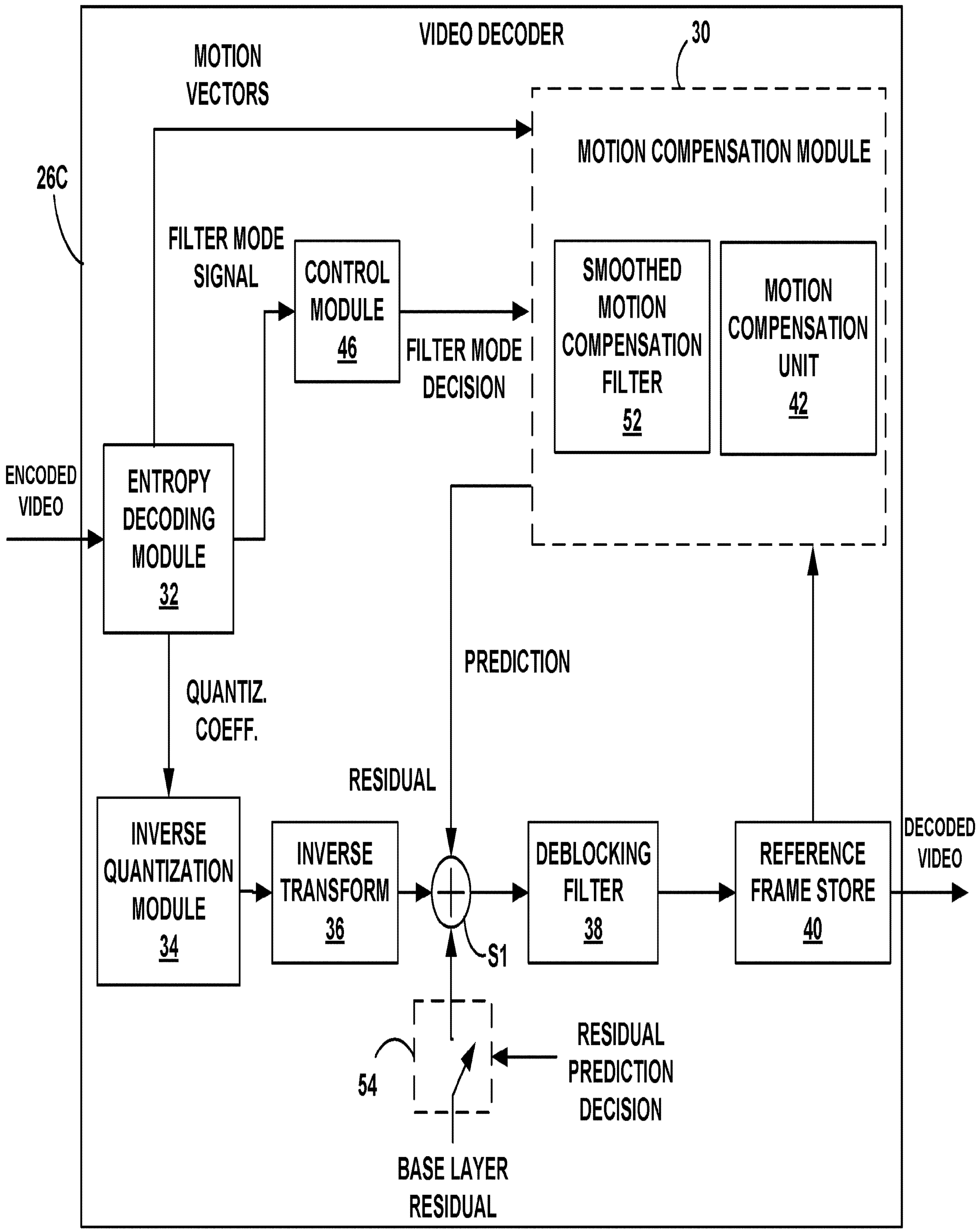


FIG. 6

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6/13

PCT/US2007/081145

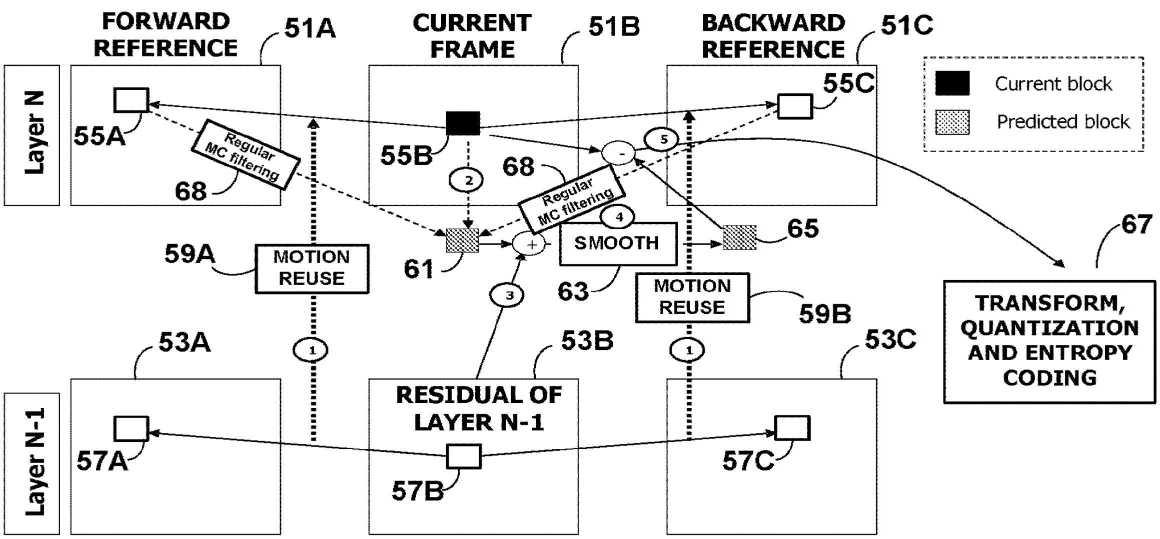
FORWARD REFERENCE
51A
CURRENT FRAME
51B
BACKWARD REFERENCE
51C
Current block
Predicted block
Layer N
55A
Regular MC filtering
68
55B
2
68
Regular MC filtering
55C
5
4
65
SMOOTH
59A
MOTION REUSE
61
63
MOTION REUSE
59B
67
TRANSFORM, QUANTIZATION AND ENTROPY CODING
3
53A
1
53B
1
53C
RESIDUAL OF LAYER N-1
Layer N-1
57A
57B
57C

FIG. 7

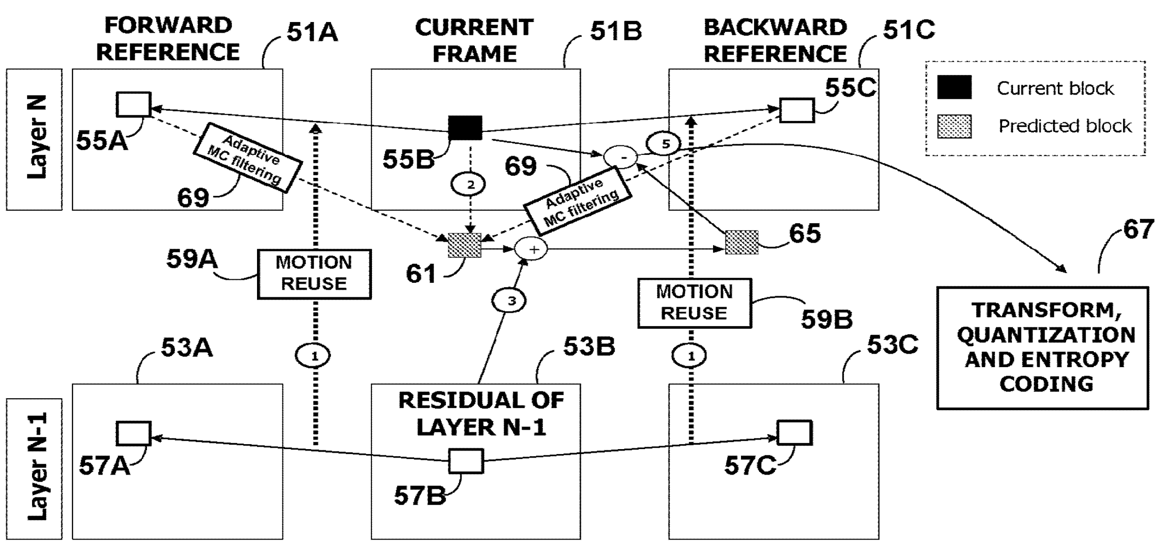
FORWARD REFERENCE
51A
CURRENT FRAME
51B
BACKWARD REFERENCE
51C
Current block
Predicted block
Layer N
55A
Adaptive MC filtering
69
55B
2
69
Adaptive MC filtering
5
55C
65
67
59A
MOTION REUSE
61
3
MOTION REUSE
59B
TRANSFORM, QUANTIZATION AND ENTROPY CODING
53A
1
53B
1
53C
Layer N-1
57A
RESIDUAL OF LAYER N-1
57B
57C

FIG. 8

FIG. 9

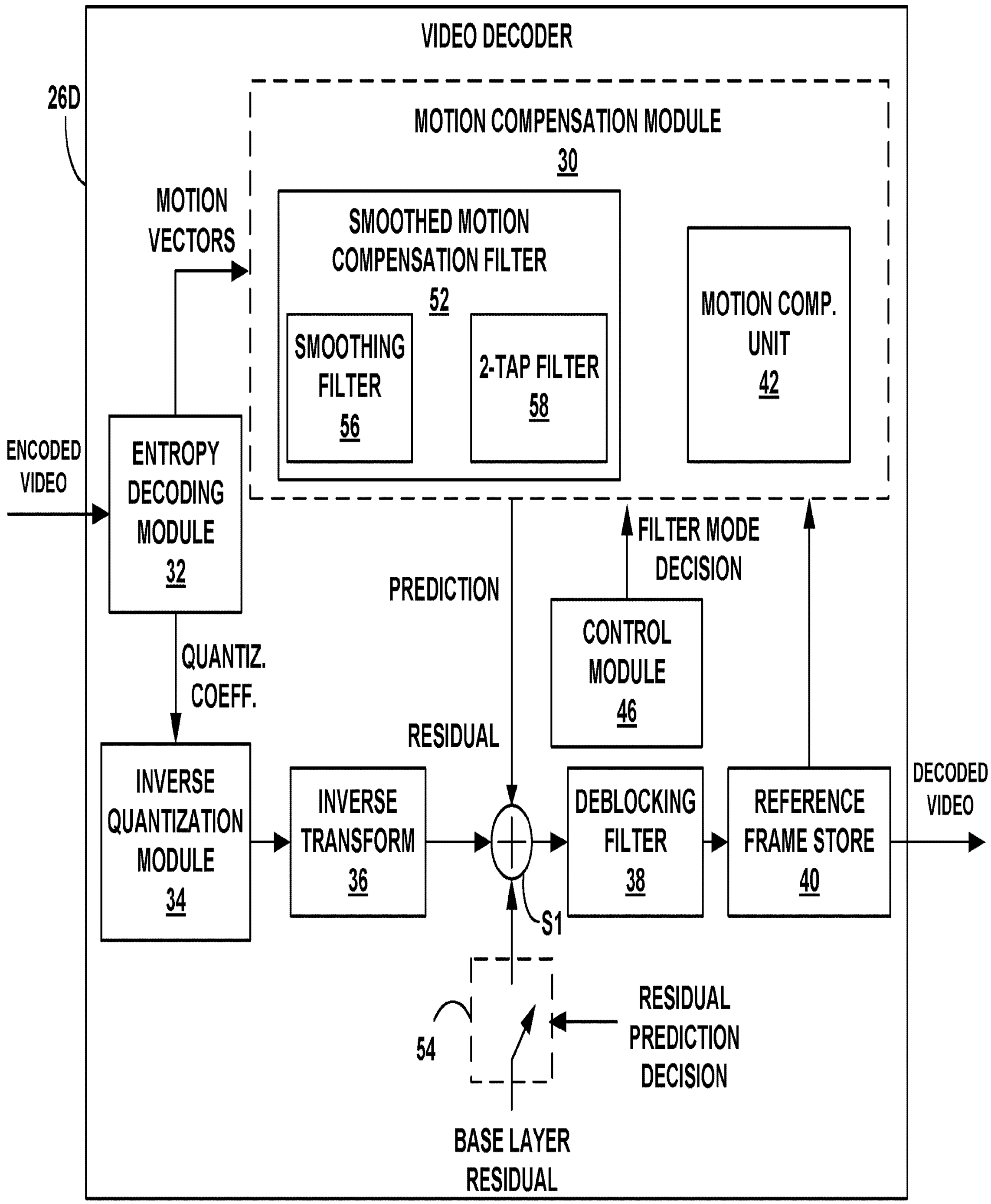
VIDEO DECODER
26D
MOTION COMPENSATION MODULE
30
MOTION
VECTORS
SMOOTHED MOTION
COMPENSATION FILTER
52
SMOOTHING
FILTER
56
2-TAP FILTER
58
MOTION COMP.
UNIT
42
ENCODED
VIDEO
ENTROPY
DECODING
MODULE
32
PREDICTION
FILTER MODE
DECISION
CONTROL
MODULE
46
QUANTIZ.
COEFF.
RESIDUAL
INVERSE
QUANTIZATION
MODULE
34
INVERSE
TRANSFORM
36
DEBLOCKING
FILTER
38
REFERENCE
FRAME STORE
40
DECODED
VIDEO
S1
54
RESIDUAL
PREDICTION
DECISION
BASE LAYER
RESIDUAL

FIG.10

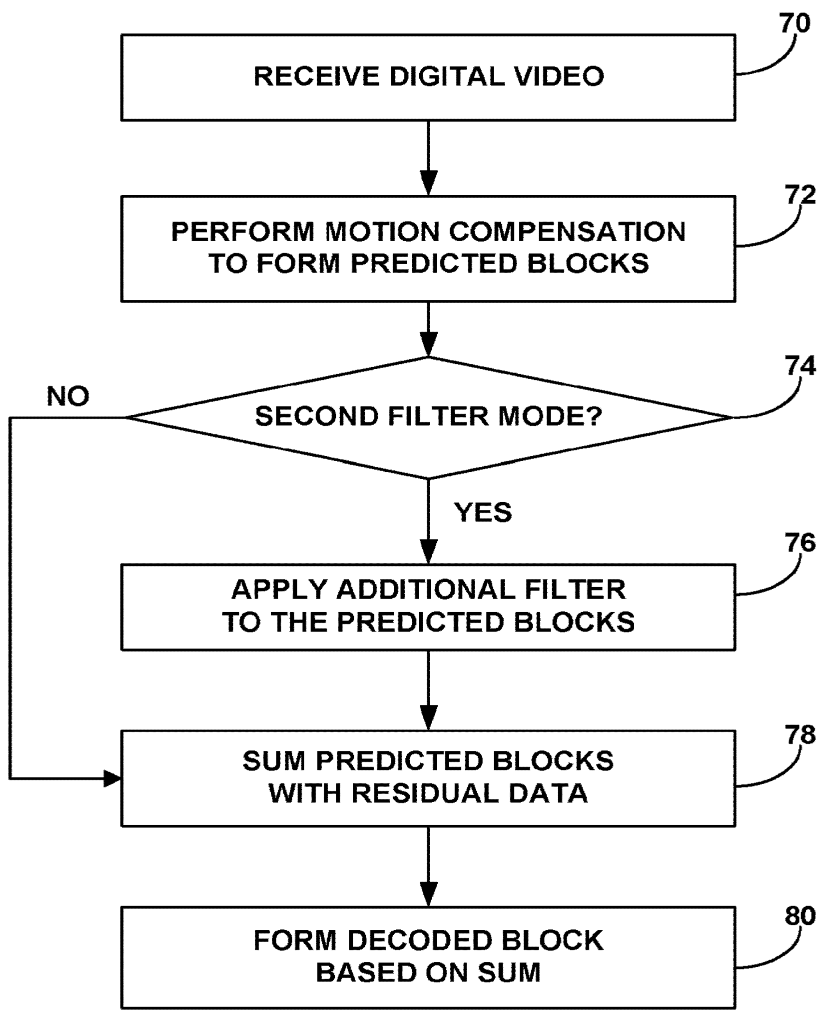
70
RECEIVE DIGITAL VIDEO
72
PERFORM MOTION COMPENSATION TO FORM PREDICTED BLOCKS
74
SECOND FILTER MODE?
NO
YES
76
APPLY ADDITIONAL FILTER TO THE PREDICTED BLOCKS
78
SUM PREDICTED BLOCKS WITH RESIDUAL DATA
80
FORM DECODED BLOCK BASED ON SUM

FIG. 11

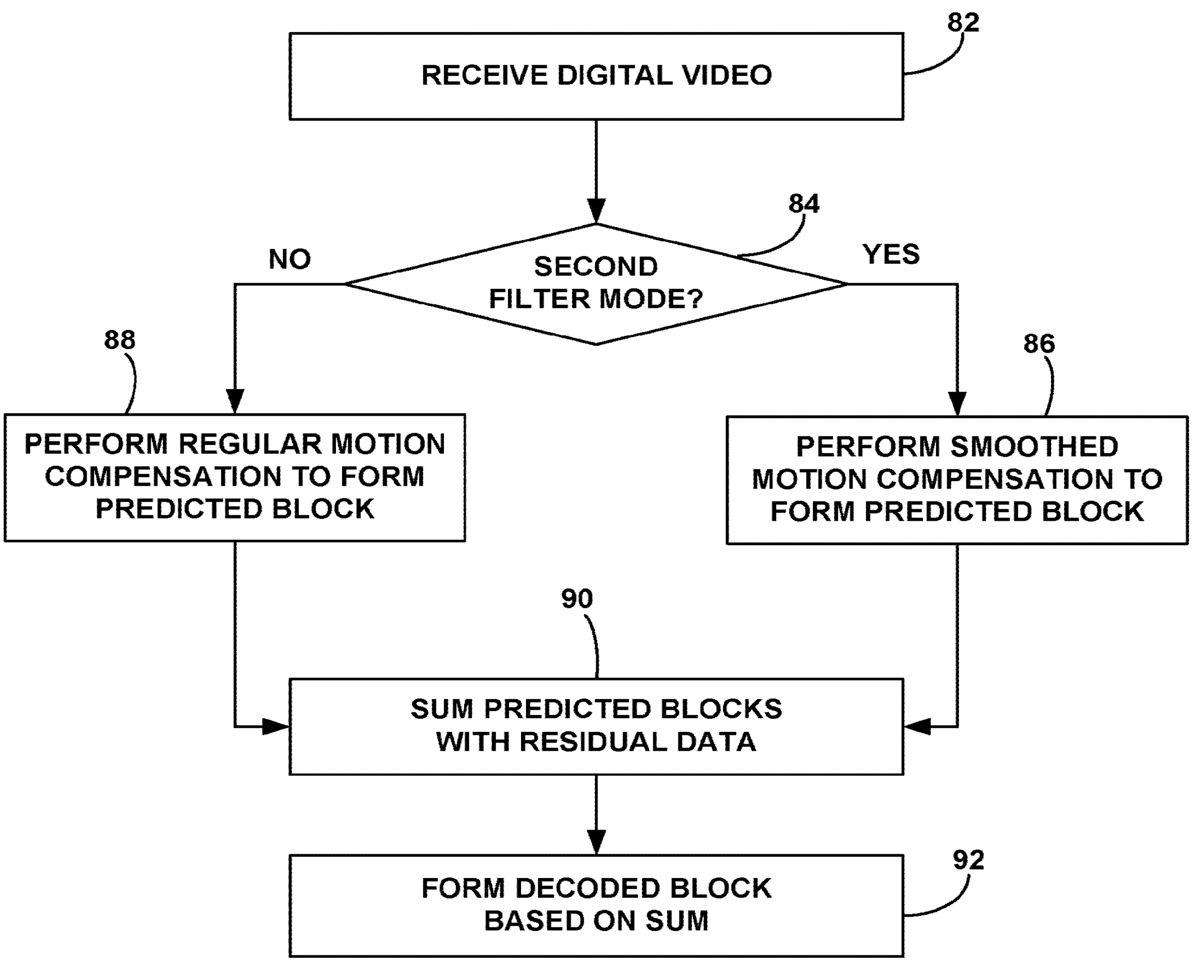
82
RECEIVE DIGITAL VIDEO
84
NO
SECOND FILTER MODE?
YES
88
PERFORM REGULAR MOTION COMPENSATION TO FORM PREDICTED BLOCK
86
PERFORM SMOOTHED MOTION COMPENSATION TO FORM PREDICTED BLOCK
90
SUM PREDICTED BLOCKS WITH RESIDUAL DATA
92
FORM DECODED BLOCK BASED ON SUM

FIG. 12

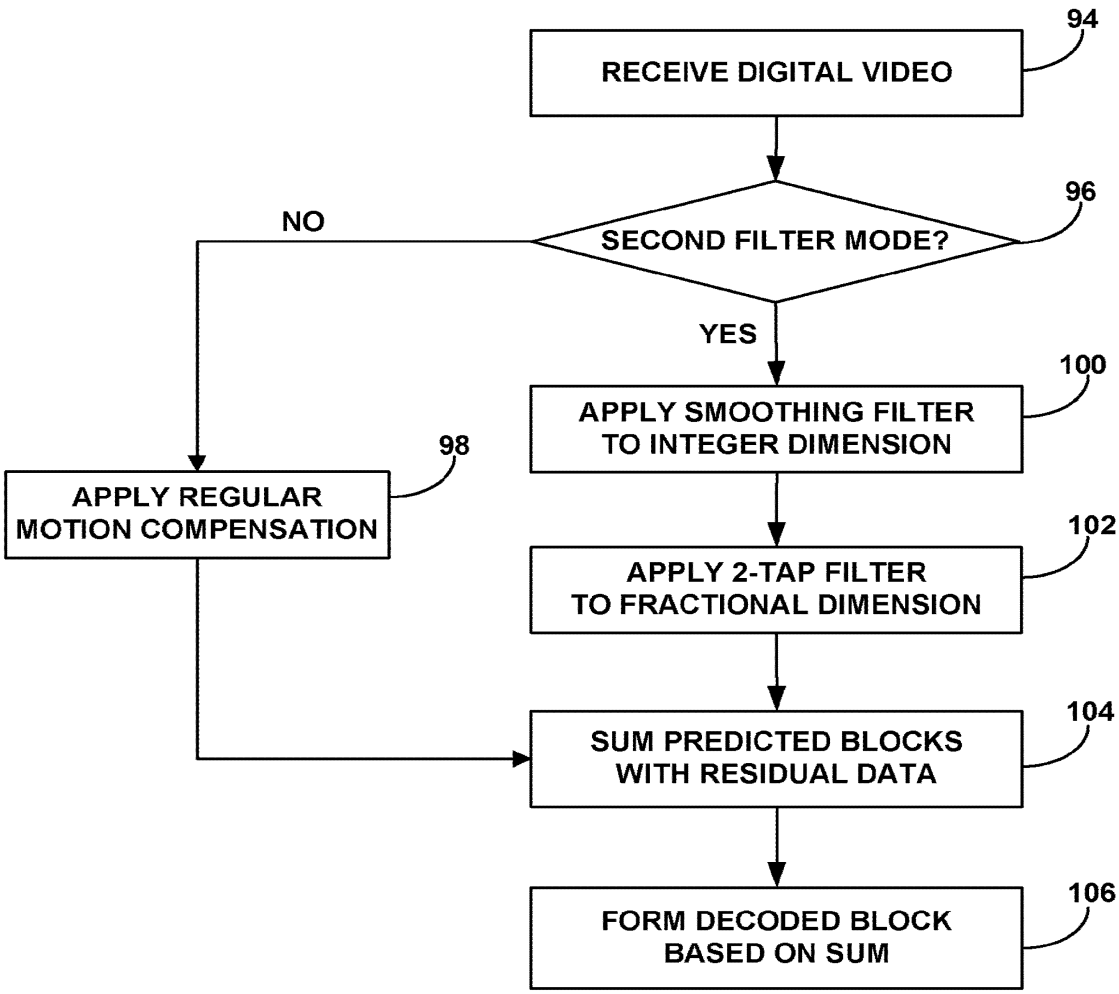
RECEIVE DIGITAL VIDEO
94
SECOND FILTER MODE?
96
NO
YES
APPLY SMOOTHING FILTER TO INTEGER DIMENSION
100
APPLY REGULAR MOTION COMPENSATION
98
APPLY 2-TAP FILTER TO FRACTIONAL DIMENSION
102
SUM PREDICTED BLOCKS WITH RESIDUAL DATA
104
FORM DECODED BLOCK BASED ON SUM
106

FIG. 13

Electronic Patent Application Fee Transmittal

Application Number:	13344893
Filing Date:	06-Jan-2012
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal UGUR
Filer:	Jonathan Abbott Thomas/Lisa Rone
Attorney Docket Number:	042933/452410

Filed as Large Entity

Filing Fees for **Utility under 35 USC 111(a)**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	25880133
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Lisa Rone
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/452410
Receipt Date:	25-MAY-2016
Filing Date:	06-JAN-2012
Time Stamp:	12:39:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$180
RAM confirmation Number	9201
Deposit Account	160605
Authorized User	Rone, Lisa
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		452410-IDS.pdf	254195 db288fb2e911c7520cf6f0a20ea678068015b669	yes	2

Multipart Description/PDF files in .zip description

Document Description	Start	End
Transmittal Letter	1	1
Information Disclosure Statement (IDS) Form (SB08)	2	2

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Foreign Reference	452410-WO2008048864A2.PDF	2464946 bb209b7c93f10e6595049e6e68eb41d231cc5c89	no	54

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
3	Non Patent Literature	452410-EP_Search_Report.PDF	672345 2ab7ba5b75a14227dc40df3a263dfcb02e7b2fc8	no	12

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
4	Non Patent Literature	452410-Ye-High_Precision_Interpolation-NPL.PDF	46587 412b1ef70e3b8db034cf08b5c84903b9312be226	no	4

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
5	Non Patent Literature	452410-YI-JEN-NPL.PDF	563501 3f08fd11cb7650b1fd5308fe487ac23cfd588da3	no	26

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
6	Fee Worksheet (SB06)	fee-info.pdf	30560 615c3808c5ac3af98cdca70e6e83a7c3c4fba72a	no	2

Warnings:

Information:

Total Files Size (in bytes):	4032134

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Attorney's Docket No. 042933/452410

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Kemal Ugur	Confirmation No.:	2120
Appl. No.:	13/344,893	Group Art Unit:	2488
Filed:	01/06/2012	Examiner:	Peter D. Le
For:	MOTION PREDICTION IN VIDEO CODING		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
UNDER 37 C.F.R. § 1.97(d)

This Information Disclosure Statement is being filed after a Final Office Action under 37 C.F.R. § 1.113 or a Notice of Allowance under 37 C.F.R. § 1.311, but before payment of the Issue Fee. The Final Office Action or Notice of Allowance was mailed on April 27, 2016.

Attached is a list of documents on form PTO-1449 along with any cited foreign patent documents and non-patent literature documents in accordance with 37 CFR 1.98(a)(2). Also enclosed is a translation or a concise explanation of each non-English language document.

By identifying the listed documents, Applicant in no way makes any admission as to the prior art status of the listed documents, but is instead identifying the listed documents for the sake of full disclosure.

In accordance with the requirements of 37 C.F.R. § 1.97(d)(2), the following statement as specified in 37 C.F.R. § 1.97(e) is made:

Each item of information contained in this statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three (3) months prior to the filing of this statement. In this regard, Applicant notes that the communication from the foreign patent office was not received by any individual designated by 37 CFR 1.56(c) more than thirty (30) days prior to the filing of this Information Disclosure Statement.

The $180.00 fee specified in 37 C.F.R. § 1.17(p) is being paid at the time of e-filing. The Commissioner is authorized to charge any additional fee, or credit any refund, to our Deposit Account No. 16-0605.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610

CUSTOMER NO. 10949
ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000
Fax Charlotte Office (704) 444-1111

Substitute for form SB08 (Revised 07/09)	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*	Application Number	13/344,893
	Filing Date	01/06/2012
	First Named Inventor	Kemal Ugur
	Art Unit	2488
	Examiner Name	Peter D. Le
Sheet *1* of 1	Attorney Docket Number	042933/452410

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.	Document Number Number - Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages of Relevant Figures Appear
	1	US-2010/0111182 A1	05-06-2010	Karczewicz et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials	Cite No.	Foreign Patent Document Country Code - Number Kind Code (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	English Language Translation Attached
	2	WO 2008/048864 A2	04-24-2008	Qualcomm Inc.		

OTHER DOCUMENTS

Examiner Initials*	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s) , volume-issue number(s), publisher, city and/or country where published.	English Language Translation Attached
	3	Extended European Search Report from corresponding European Patent Application No. 12731927.5 dated May 6, 2016	
	4	YE et al., "High Precision Interpolation and Prediction"; 35 VCEG Meeting; 85. MPEG Meeting; July 16, 2008 - July 18, 2008; Berlin; Video Coding Experts Group of ITU-T SG.16; No. VCEG-AI33; July 12, 2008; XP030003598	
	5	YI-JEN CHIU et al.: "TE1: Fast Techniques to Improve Self Derivation of Motion Estimation"; JCT-VC Meeting; July 21, 2010 - July 28, 2010; Geneva; Joint Collaborative Team on Video Coding of ISO/IEC JTC1/SC29/WG11 and ITU-T SG.16; July 28, 2010; XP030007627	

Examiner Signature	/PETER D LE/	Date Considered	05/27/2016

**Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

CLT#36434519v1

Submitted May 25, 2016

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.D.L/

Search Notes	Application/Control No. 13344893	Applicant(s)/Patent Under Reexamination UGUR ET AL.
	Examiner PETER D. LE	**Art Unit** 2488

CPC- SEARCHED

Symbol	Date	Examiner
H04N19/42 OR H04N19/523 OR H04N19/577	7/21/2015	PL
Update Search	4/20/2016	PL
Update Search to consider IDS filed on 5/25/2016	5/27/2016	PL

CPC COMBINATION SETS - SEARCHED

Symbol	Date	Examiner

US CLASSIFICATION SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES

Search Notes	Date	Examiner
See EAST Search History	7/21/2015	PL
See EAST Search History	4/20/2016	PL
See EAST Search History (IDS filed on 5/25/2016 is consdiered)	5/27/2016	PL

INTERFERENCE SEARCH

US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
	Limit to Text Search	4/20/2016	PL

/ELLYAR Y BARAZESH/ Examiner.Art Unit 2483	

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/344,893	01/06/2012	Kemal UGUR	042933/452410	2120

10949 7590 06/14/2016
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER	
LE, PETER D	

ART UNIT	PAPER NUMBER
2488	

NOTIFICATION DATE	DELIVERY MODE
06/14/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

usptomail@alston.com

PTOL-90A (Rev. 04/07)

Corrected Notice of Allowability	**Application No.** 13/344,893	**Applicant(s)** UGUR ET AL.	
	Examiner PETER D. LE	**Art Unit** 2488	**AIA (First Inventor to File) Status** No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *05/2/2016*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on______.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *1-19*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 05/25/2016
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/PETER D LE/ Examiner, Art Unit 2488	/SATH V PERUNGAVOOR/ Supervisory Patent Examiner, Art Unit 2488

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

10949 7590 04/27/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/344,893	01/06/2012	Kemal UGUR	042933/452410	2120

TITLE OF INVENTION: MOTION PREDICTION IN VIDEO CODING

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$960	$0	$0	$960	07/27/2016

EXAMINER	ART UNIT	CLASS-SUBCLASS
LE, PETER D	2488	375-240150

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
   - ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
   - ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
   (1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
   (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
   1 Alston & Bird LLP
   2 ____
   3 ____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Nokia Technologies Oy

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Espoo, Finland

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies ____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☒ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number 160605 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Guy R. Gosnell/ Date July 26, 2016

Typed or printed name Guy R. Gosnell Registration No. 34,610

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Electronic Patent Application Fee Transmittal

Application Number:	13344893
Filing Date:	06-Jan-2012
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal UGUR
Filer:	Jonathan Abbott Thomas/jennifer son
Attorney Docket Number:	042933/452410

Filed as Large Entity

Filing Fees for **Utility under 35 USC 111(a)**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**960**

Electronic Acknowledgement Receipt

EFS ID:	26457352
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/jennifer son
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/452410
Receipt Date:	26-JUL-2016
Filing Date:	06-JAN-2012
Time Stamp:	14:16:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$960
RAM confirmation Number	072716INTEFSW00000578160605
Deposit Account	160605
Authorized User	Jennifer Son

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	452410_Issuefee.pdf	213996 4a552d2d54cb8232062826ea0d889754d418f561	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30668 93b93a4187b804f34f4dd22c862e1b72f90c9830	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	244664	

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	13344893
	Filing Date	2012-01-06
	First Named Inventor	Kemal Ugur
	Art Unit	2482
	Examiner Name	TBD
	Attorney Docket Number	NC74925-US-NP

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6512523		2003-01-28	Gross	
	2	6539058		2003-03-25	Pearlstein et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20100086027	A1	2010-04-08	Panchal et al.	
	2	20090257503	A1	10/2009 ~~2010-10-15~~	Ye et al.	

Change(s) applied to document, /S.X.R./ 5/2/2016

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2729615	CA	A1	2010-01-07	Kabushiki kaisha toshiba		☐

 ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.B./

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/344,893	08/30/2016	9432693	042933/452410	2120

10949 7590 08/10/2016

Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
Bank of America Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 575 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Kemal UGUR, Tampere, FINLAND;
Jani LAINEMA, Tampere, FINLAND;
Antti HALLAPURO, Tampere, FINLAND;

IR103 (Rev. 10/09)

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April 28, 2017

Certificate of Correction Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Re: United States Patent for *Motion Prediction In Video Coding*
Application No. 13/344,893; Filed January 6, 2012
Patent No. 9,432,693; Issued August 30, 2016
Our File 042933/452410

It is respectfully requested that a Certificate of Correction be issued for the above-identified patent in order to correct an error appearing in the printed patent. This error is identified in the Certificate of Correction being filed simultaneously herewith. The reason for this correction is set forth below.

Claim 1 contains a printing error and did not print in accordance with the USPTO record. Specifically, in the Examiner's Amendment attached to the Notice of Allowance mailed April 27, 2016, part of Claim 1 was amended to read "...the **second** precision and a rounding valve". However, the same part of Claim 1 of the printed patent reads "...the precision and a rounding valve."

In view of the above, applicant respectfully requests the USPTO to issue a Certificate of Correction to align Claim 1 with the aforementioned Examiner's Amendment. A Certificate of Correction setting forth the requested correction is being filed simultaneously herewith. If the Certificate of Correction fee of $100 is required, the fee may be charged to Deposit Account No. 16-0605.

Respectfully submitted,

Guy R. Gosnell
Registration No. 34,610

GRG:mhf
Enclosure

LEGAL02/37169033v1

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 9,432,693 B2 Page 1 of 1

APPLICATION NO. : 13/344,893

ISSUE DATE : August 30, 2016

INVENTOR(S) : Ugur et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the claims:

Column 21,
Line 25, "the precision" should read --the second precision--.

MAILING ADDRESS OF SENDER

ALSTON & BIRD LLP
Bank of America Plaza
101 South Tryon Street, Suite 4000
Charlotte, NC 28280-4000
Tel Charlotte Office (704) 444-1000

Electronic Acknowledgement Receipt

EFS ID:	29130808
Application Number:	13344893
International Application Number:	
Confirmation Number:	2120
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	10949
Filer:	Jonathan Abbott Thomas/Marigrace Faulkner
Filer Authorized By:	Jonathan Abbott Thomas
Attorney Docket Number:	042933/452410
Receipt Date:	05-MAY-2017
Filing Date:	06-JAN-2012
Time Stamp:	15:55:29
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Certificate of Correction	coc452410.PDF	50493 e28ae85f3df8524c6047f5390a4a7cb02c0d1a2c	no	2

Warnings:

Information:	
Total Files Size (in bytes):	50493

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,432,693 B2
APPLICATION NO. : 13/344893
DATED : August 30, 2016
INVENTOR(S) : Ugur et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

<u>Column 21</u>,
Line 25, “the precision” should read --the second precision--.

Signed and Sealed this
Sixth Day of June, 2017

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office