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Application Number	Filed Herewith
Filing Date	May 24, 2021
First Named Inventor	Kemal UGUR
Title	MOTION PREDICTION IN VIDEO CODING
Art Unit	N/A
Examiner Name	N/A
Attorney Docket Number	042933/74925-US-CNT5

SIGNATURE of Applicant or Patent Practitioner

Signature	/Guy R. Gosnell/	Date (Optional)	May 24, 2021
Name	Guy R. Gosnell	Registration Number	34,610
Title (if Applicant is a juristic entity)	Patent Practitioner		
Applicant Name (if Applicant is a juristic entity)	Nokia Technologies Oy		

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I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Nokia Technologies Oy, Karakaari 7, 02610 Espoo, Finland

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

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The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	[signatures]	Date (Optional)	18.02.2019
Name	Emmanuelle Wetzel Domenico Menzietti		
Title	Director, Patents Senior Patent Counsel		

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

Title of Invention	MOTION PREDICTION IN VIDEO CODING

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 15/250124

filed on August 29, 2016.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Kemal Ugur Date (Optional) : ____________

Signature: ____________

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/AIA/01 form for each additional inventor.

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LEGAL NAME OF INVENTOR

Inventor: Jani Lainema Date (Optional) : ____________

Signature: ____________

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- [x] United States application or PCT international application number 15/250124 filed on August 29, 2016.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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LEGAL NAME OF INVENTOR

Inventor: Antti Hallapuro Date (Optional) : ____________

Signature: AH · Ha

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NC74925-US-CNT

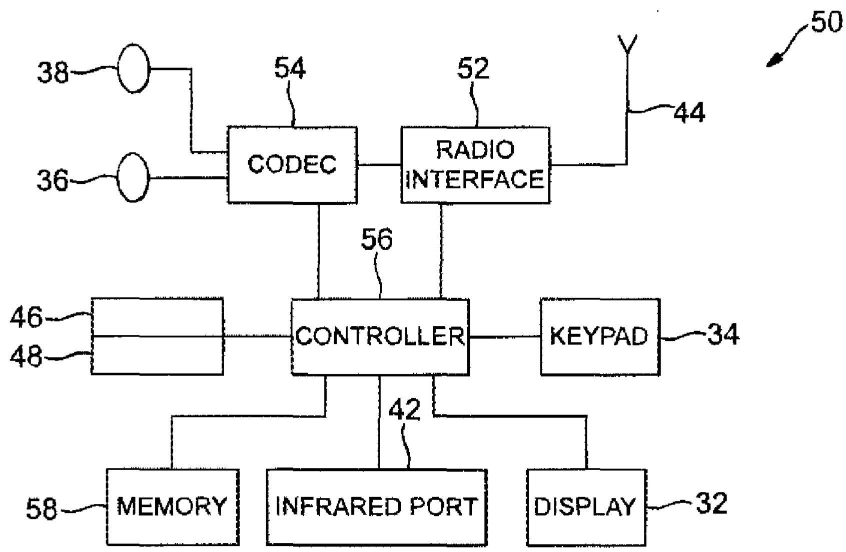

50
38
54
52
44
CODEC
RADIO INTERFACE
36
56
46
48
CONTROLLER
KEYPAD
34
42
58
MEMORY
INFRARED PORT
DISPLAY
32

FIG.1

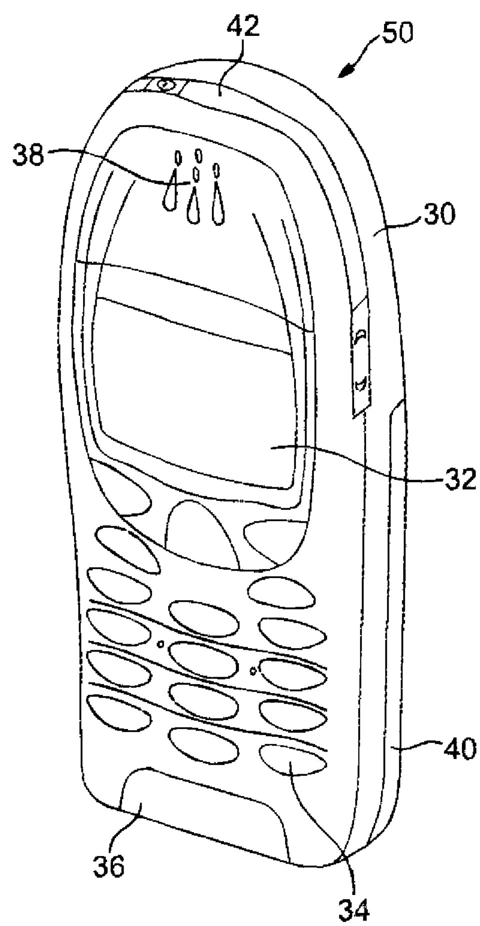

42
50
38
30
32
40
36
34

FIG. 2

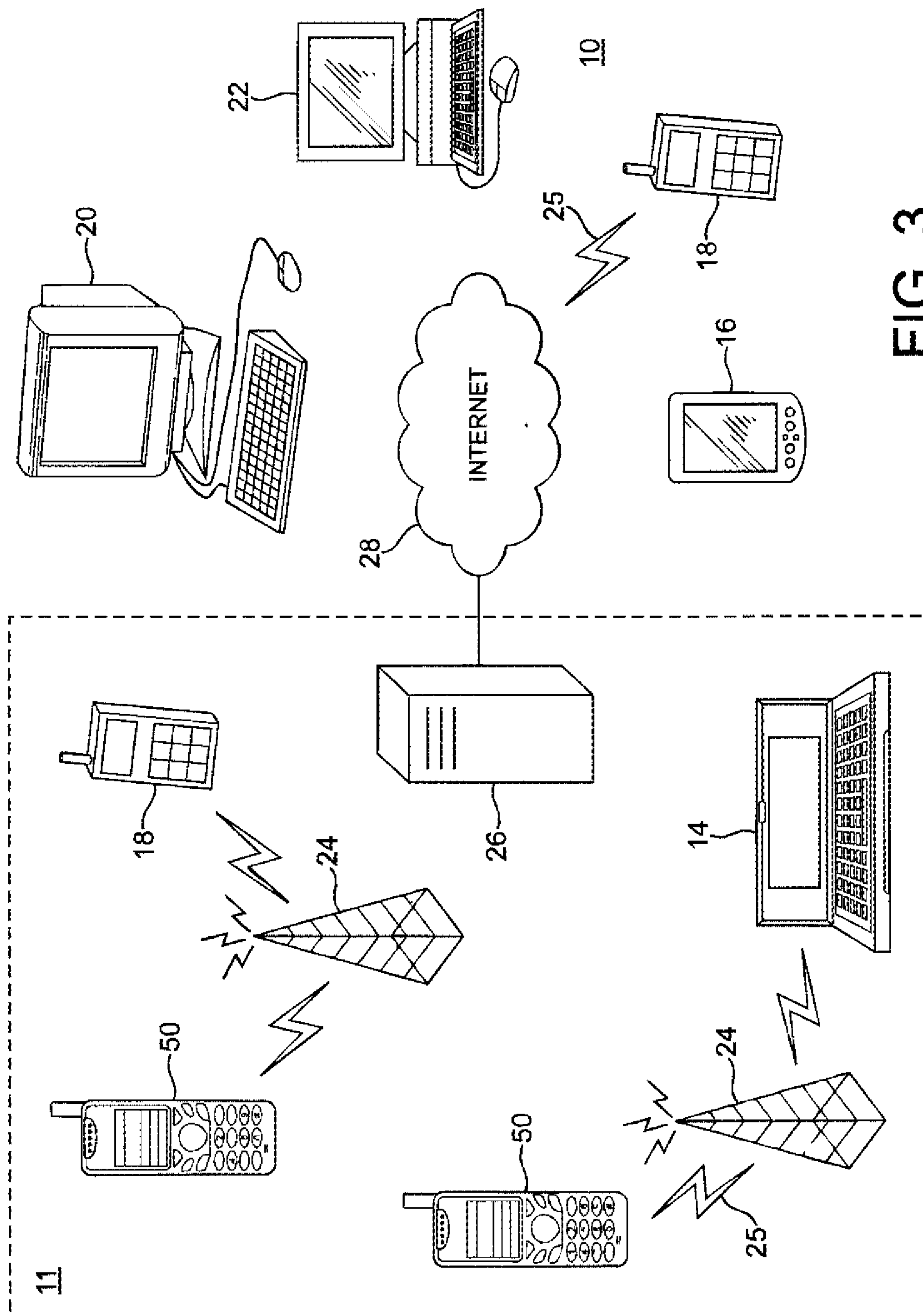


FIG. 3

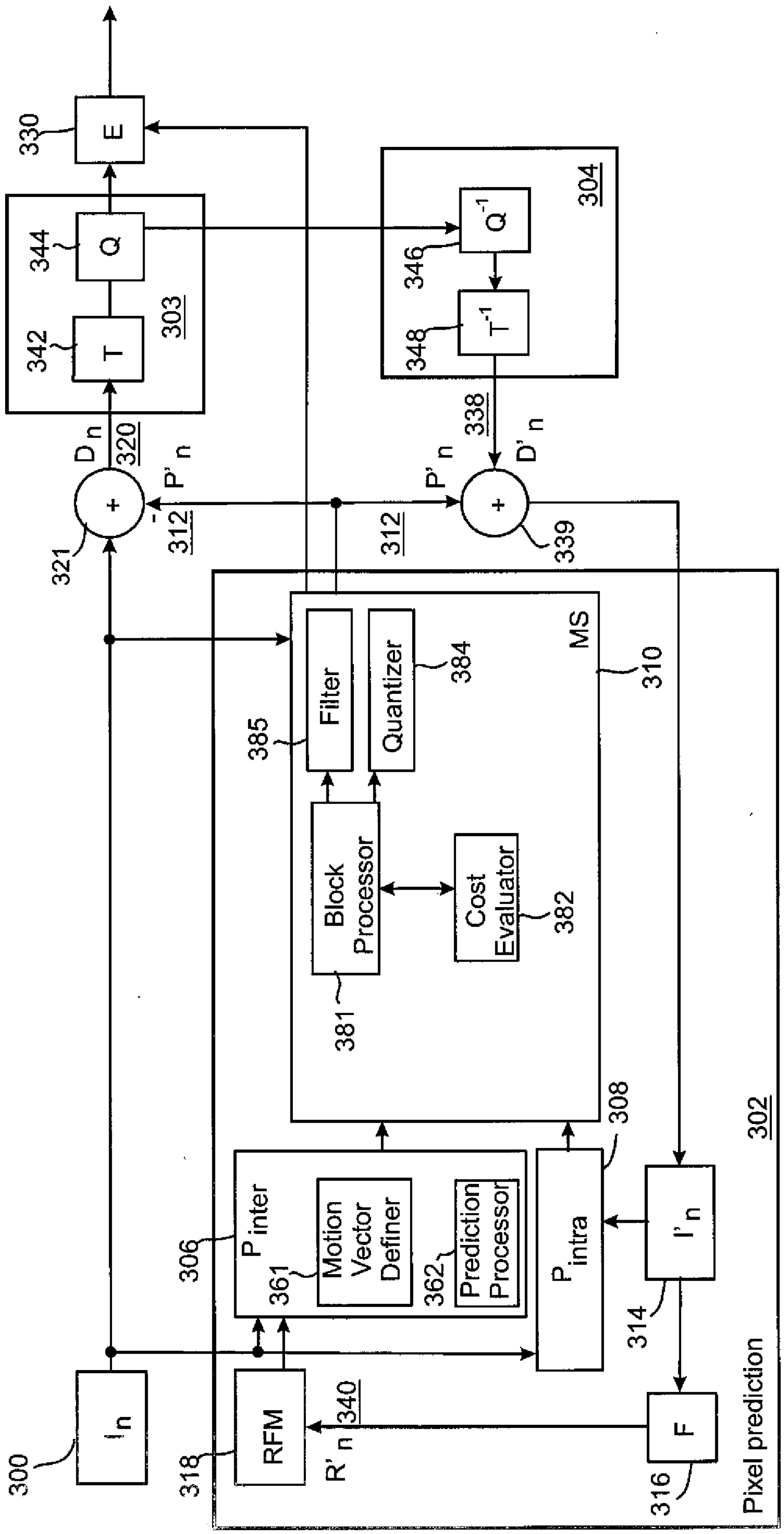
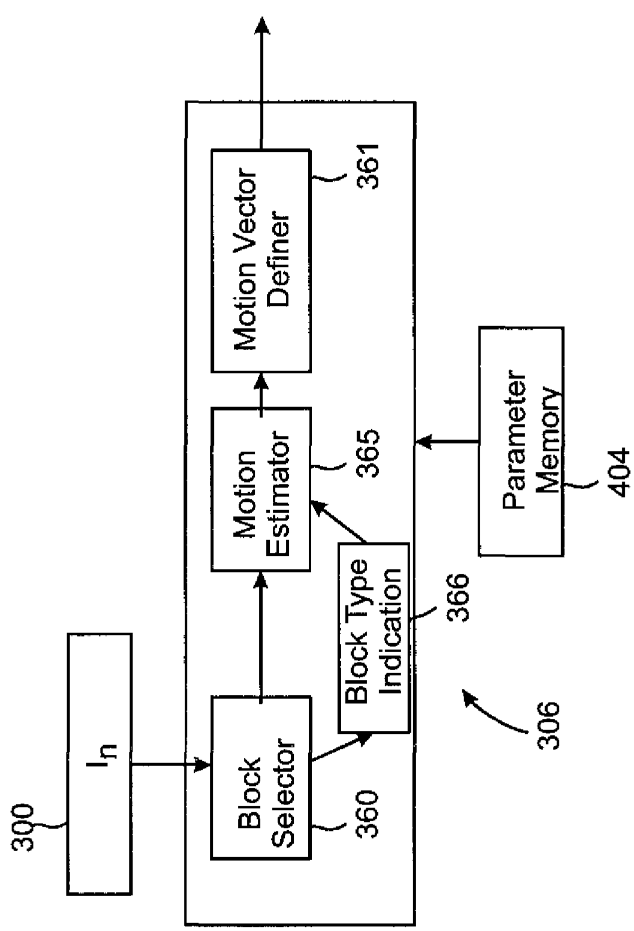

300
I_n
318
RFM
R' n
340
306
P_{inter}
361
Motion Vector Definer
362
Prediction Processor
P_{intra}
308
314
I' n
316
F
Pixel prediction
302
310
MS
381
Block Processor
Cost Evaluator
382
Filter
385
Quantizer
384
321
+
-
312
P' n
D n
320
303
T
342
Q
344
E
330
304
Q^{-1}
346
T^{-1}
348
338
D' n
P' n
312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

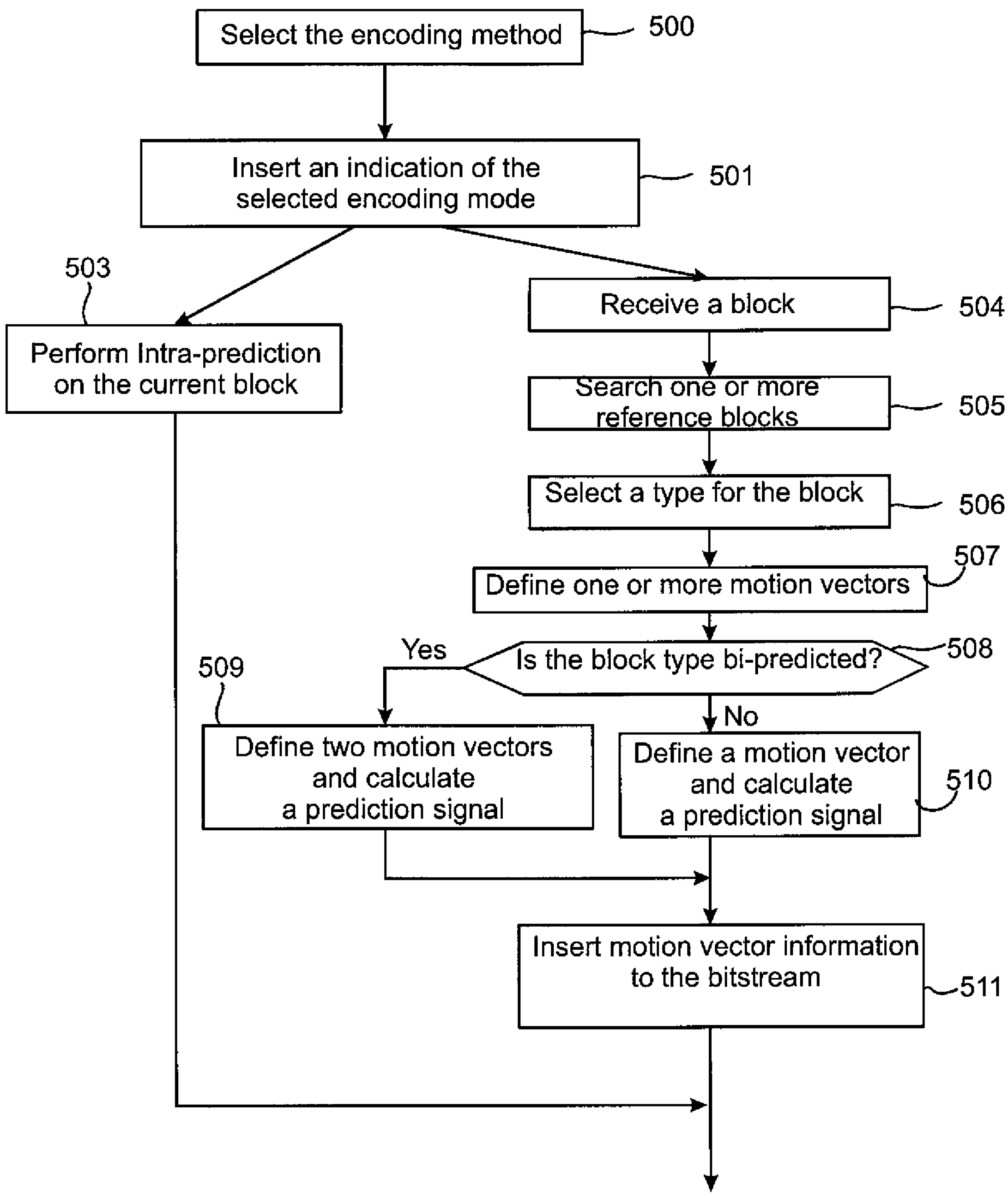

Select the encoding method
500
Insert an indication of the selected encoding mode
501
503
Perform Intra-prediction on the current block
Receive a block
504
Search one or more reference blocks
505
Select a type for the block
506
507
Define one or more motion vectors
Is the block type bi-predicted?
508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

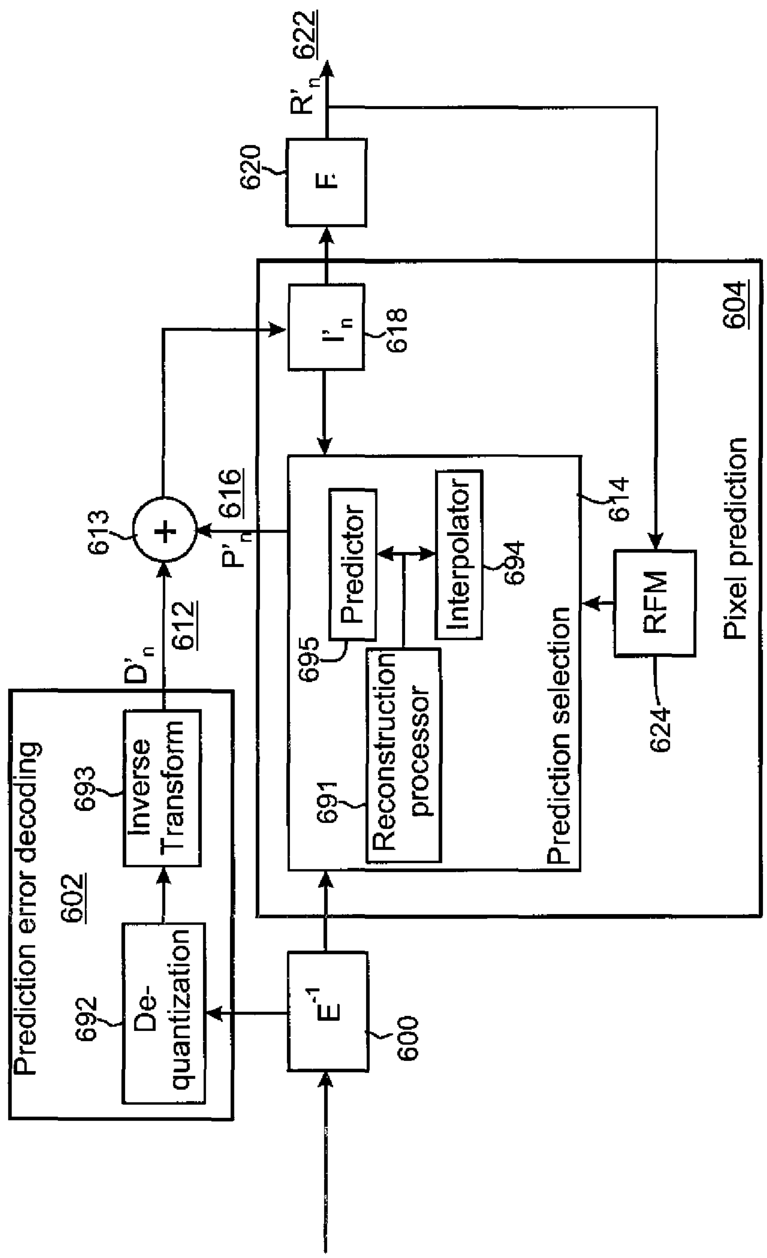

Prediction error decoding
602
692
De-quantization
693
Inverse Transform
600
E-1
D'n
612
613
+
P'n
616
618
I'n
620
F
R'n
622
604
Pixel prediction
614
Prediction selection
691
Reconstruction processor
695
Predictor
694
Interpolator
RFM
624

Fig. 6

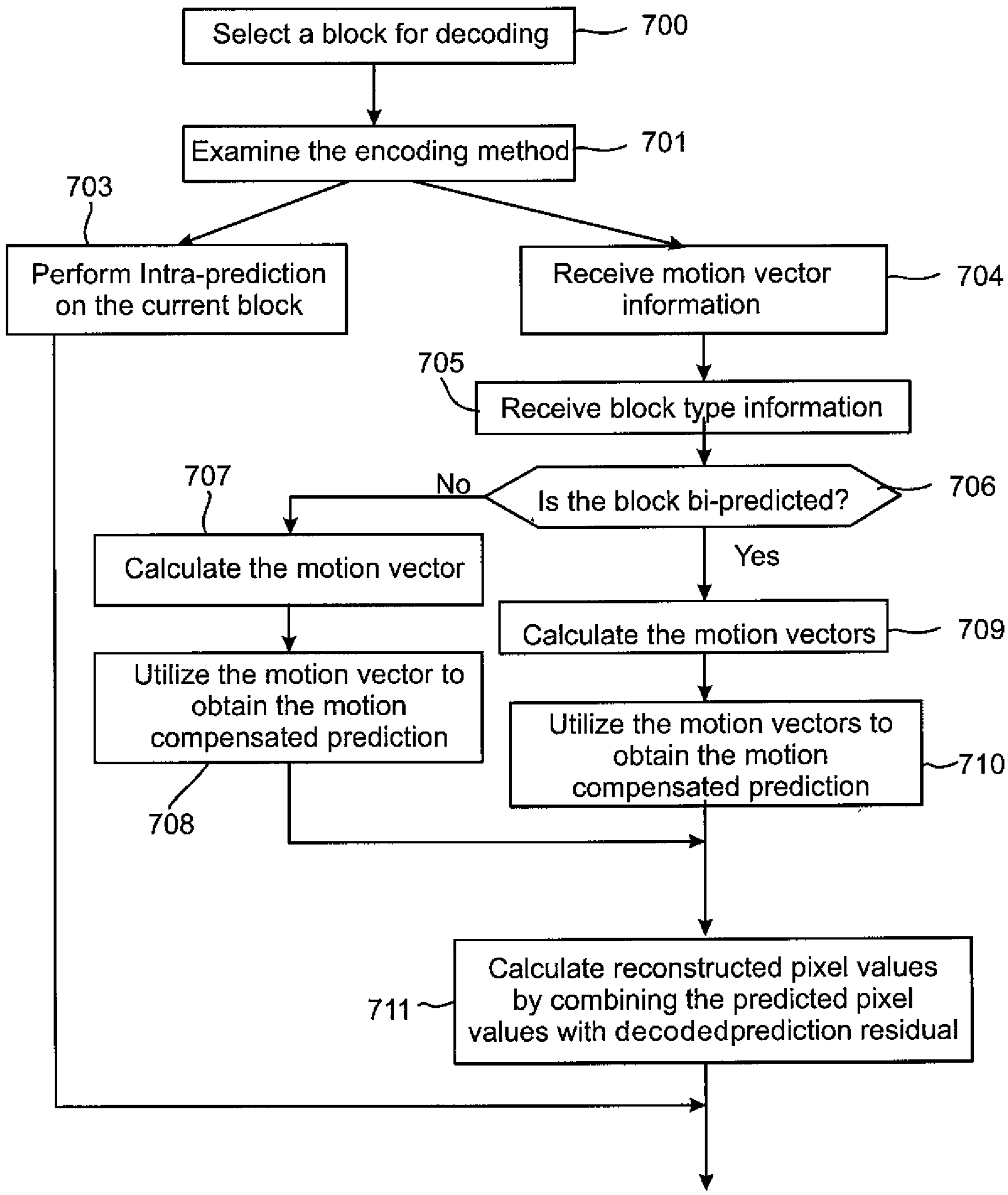

Select a block for decoding
700
Examine the encoding method
701
703
Perform Intra-prediction on the current block
Receive motion vector information
704
705
Receive block type information
707
No
Is the block bi-predicted?
706
Yes
Calculate the motion vector
Calculate the motion vectors
709
Utilize the 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

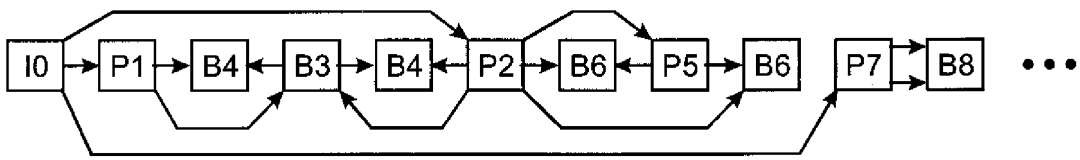
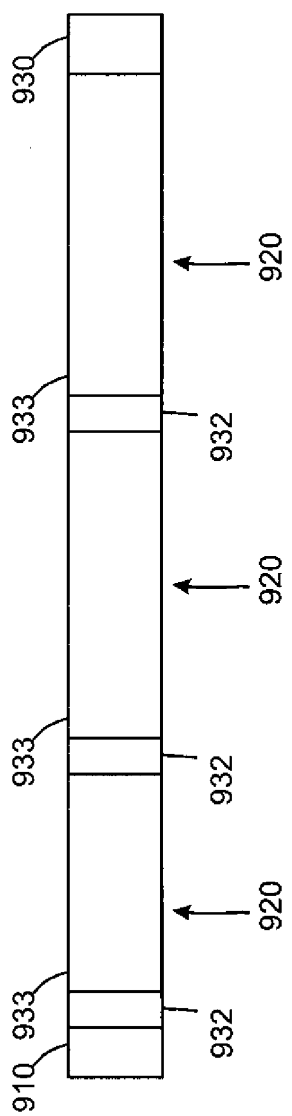
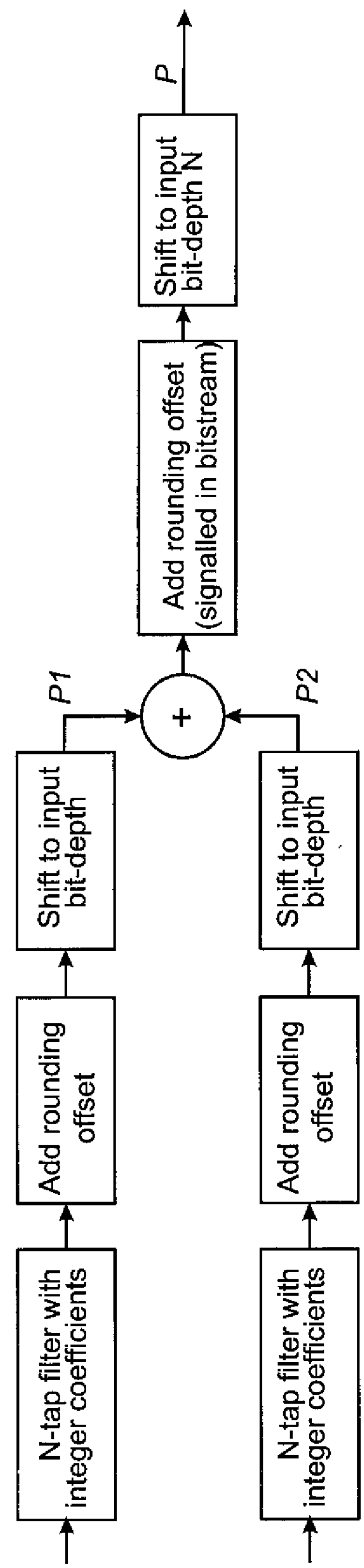


Fig. 8



910
933
932
920
933
932
920
933
932
920
930

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

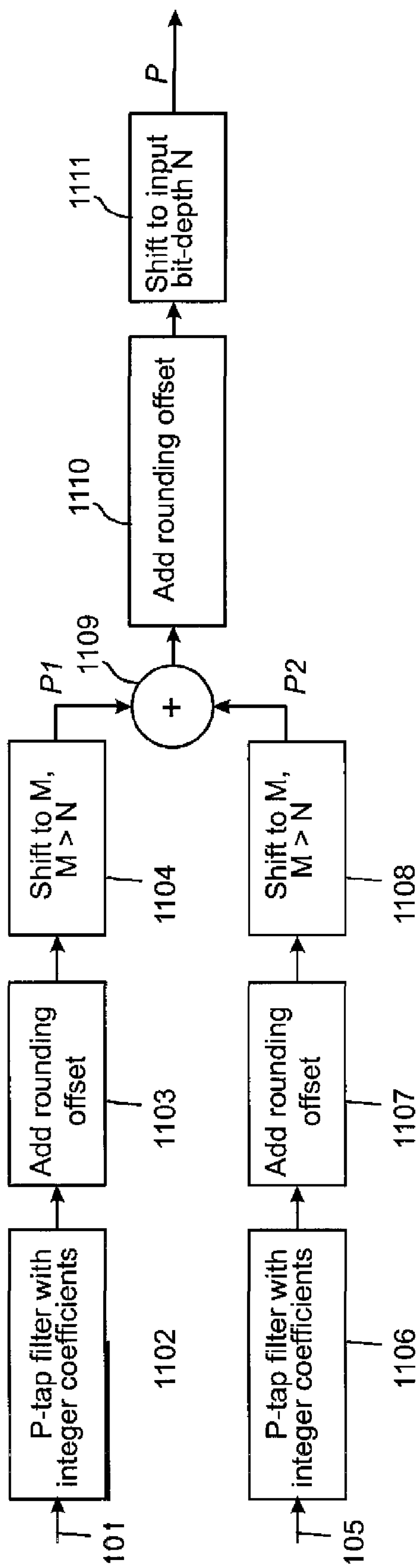

P-tap filter with integer coefficients
Add rounding offset
Shift to M, M > N
P1
1109
+
P2
Add rounding offset
Shift to input bit-depth N
P
1101
1102
1103
1104
1105
1106
1107
1108
1110
1111

Fig. 11

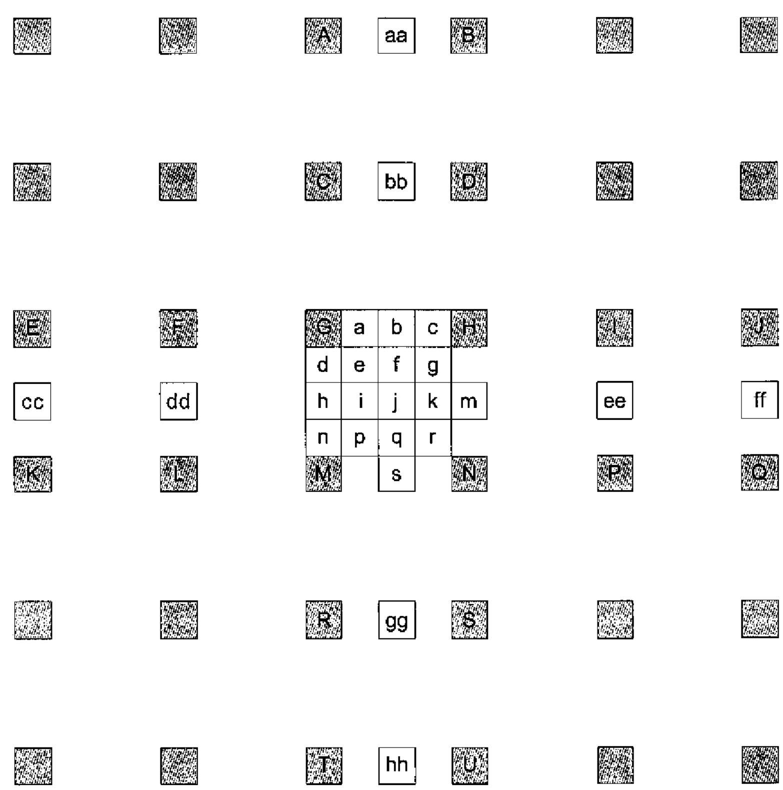

A
aa
B
C
bb
D
E
F
G
a
b
c
H
I
J
d
e
f
g
cc
dd
h
i
j
k
m
ee
ff
n
p
q
r
K
L
M
s
N
P
Q
R
gg
S
T
hh
U

Fig. 12

MOTION PREDICTION IN VIDEO CODING

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Application No. 16/729,974, filed December 30, 2019, which is a continuation of U.S. Application No. 15/876,495, filed January 22, 2018, which is a continuation of U.S. Application No. 15/490,469, filed April 18, 2017, which is a continuation of U.S. Application No. 15/250,124, filed August 29, 2016, which is a continuation of U.S. Application No. 13/344,893, filed on January 6, 2012, which claims priority to U.S. Provisional Application No. 61/430,694, filed January 7, 2011, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] 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

[0003] 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.

[0004] 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.

[0005] 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.

[0006] 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.

[0007] 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).

[0008] An example of the encoding process is illustrated in Figure 1.

[0009] 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).

[0010] 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.

[0011] 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.

[0012] An example of the decoding process is illustrated in Figure 2.

[0013] 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.

[0014] 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).

[0015] 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.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] 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.

[0020] 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.

[0021] This may be represented by the equation:

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

[0022] 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).

[0023] 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.

[0024] 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.

[0025] 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.

[0026] 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

[0027] 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.

[0028] 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

[0029] 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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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

[0036] For better understanding of the present invention, reference will now be made by way of example to the accompanying drawings in which:

[0037] Figure 1 shows schematically an electronic device employing some embodiments of the invention;

[0038] Figure 2 shows schematically a user equipment suitable for employing some embodiments of the invention;

[0039] Figure 3 further shows schematically electronic devices employing embodiments of the invention connected using wireless and wired network connections;

[0040] Figure 4a shows schematically an embodiment of the invention as incorporated within an encoder;

[0041] Figure 4b shows schematically an embodiment of an inter predictor according to some embodiments of the invention;

[0042] 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;

[0043] Figure 6 shows a schematic diagram of a decoder according to some embodiments of the invention;

[0044] 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;

[0045] Figure 8 illustrates an example of a prediction structure in a video sequence;

[0046] Figure 9 depicts an example of a bit stream of an image;

[0047] Figure 10 depicts an example of bi-directional prediction using rounding;

[0048] Figure 11 depicts an example of bi-directional prediction according to an example embodiment of the present invention; and

[0049] Figure 12 illustrates an example of some possible prediction directions for a motion vector.

DETAILED DESCRIPTION OF SOME EXAMPLE EMBODIMENTS

[0050] 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.

[0051] 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.

[0052] 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.

[0053] 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.

[0054] 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.

[0055] 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).

[0056] 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.

[0057] 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.

[0058] The system 10 may include both wired and wireless communication devices or apparatus 50 suitable for implementing embodiments of the invention.

[0059] 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.

[0060] 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.

[0061] 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.

[0062] 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.

[0063] 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.

[0064] 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.

[0065] 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.

[0066] 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.

[0067] 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.

[0068] 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.

[0069] 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.

[0070] 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.

[0071] 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).

[0072] 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.

[0073] 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).

[0074] It is also possible that the type of the block is determined before the motion vector is calculated.

[0075] The motion vector definer 361 provides motion vector information to the block processor 381 which uses this information to obtain the prediction signal.

[0076] 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.

[0077] 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.

[0078] 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.

[0079] 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.

[0080] The operation of the pixel predictor 302 may be configured to carry out any known pixel prediction algorithm known in the art.

[0081] The pixel predictor 302 may also comprise a filter 385 to filter the predicted values before outputting them from the pixel predictor 302.

[0082] 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.

[0083] 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.

[0084] 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.

[0085] 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.

[0086] 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.

[0087] 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.

[0088] 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).

[0089] 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.

[0090] 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.

[0091] 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.

[0092] 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.

[0093] 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.

[0094] 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.

[0095] 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:

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

[0096] 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.

[0097] 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.

[0098] 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.

[0099] 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.

[00100] The bit stream may further be encoded by the entropy encoder 330.

[00101] 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.

[00102] In the following the operation of an example embodiment of the decoder 600 is depicted in more detail with reference to figure 6.

[00103] 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.

[00104] 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.

[00105] 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.

[00106] 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.

[00107] 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.

[00108] 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).

[00109] 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).

[00110] 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.

[00111] The above described procedures may be repeated to each pixel of the current block to obtain all reconstructed pixel values for the current block.

[00112] In some embodiments the reconstruction processor 691 use the interpolator 694 to perform the calculation of the fractional pixel values.

[00113] 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.

[00114] 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.

[00115] 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.

[00116] 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.

[00117] 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.

[00118] Thus, user equipment may comprise a video codec such as those described in embodiments of the invention above.

[00119] 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.

[00120] Furthermore elements of a public land mobile network (PLMN) may also comprise video codecs as described above.

[00121] 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.

[00122] 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.

[00123] 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.

[00124] 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.

[00125] 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.

[00126] 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.

[00127] 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.

[00128] In some methods according to the first embodiment a first rounding offset is inserted to said first prediction and said second prediction.

[00129] 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.

[00130] In some methods according to the first embodiment a second rounding offset is inserted to the combined prediction before said decreasing.

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

[00132] In some methods according to the first embodiment said type of the block is a multidirectional block.

[00133] 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.

[00134] In some methods according to the first embodiment the first precision is 8 bits.

[00135] In some methods according to the first embodiment the value of y is 5.

[00136] 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.

[00137] In some methods according to the first embodiment the filtering is performed by a P-tap filter.

[00138] 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.

[00139] 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.

[00140] 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.

[00141] 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.

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

[00143] In some apparatuses according to the second embodiment said type of the block is a multidirectional block.

[00144] 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.

[00145] In some apparatuses according to the second embodiment the first precision is 8 bits.

[00146] In some apparatuses according to the second embodiment the value of y is 5.

[00147] 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.

[00148] In some apparatuses according to the second embodiment said filtering comprises a P-tap filter.

[00149] 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.

[00150] 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.

[00151] According to some example embodiments the apparatus is an encoder.

[00152] According to some example embodiments the apparatus is a decoder.

[00153] 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.

[00154] 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 for encoding a block of pixels, the method comprising:

determining, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

using said second reference block to obtain a second prediction, said second prediction having the second precision;

obtaining a combined prediction based at least partly upon said first prediction and said second prediction;

decreasing a precision of said combined prediction by shifting bits of the combined prediction to the right; and

encoding residual data in a bitstream, wherein the residual data is determined based upon a difference between the combined prediction and the block of pixels.

2. The method according to claim 1, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

3. The method according to claim 2, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

4. The method according to claim 2, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

5. The method according to claim 1, wherein said decreasing said precision of said combined prediction by shifting bits of the combined prediction to the right, further comprises:

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

6. The method according to claim 1, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

7. An apparatus for encoding a block of pixels, the 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, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

use said second reference block to obtain a second prediction, said second prediction having the second precision;

obtain a combined prediction based at least partly upon said first prediction and said second prediction;

decrease a precision of said combined prediction by shifting bits of the combined prediction to the right; and

encode residual data in a bitstream, wherein the residual data is determined based upon a difference between the combined prediction and the block of pixels.

8. The apparatus according to claim 7, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

9. The apparatus according to claim 8, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

10. The apparatus according to claim 8, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

11. The apparatus according to claim 7, wherein the at least one memory and computer code are configured to cause the apparatus to decrease said precision of said combined prediction by shifting bits of the combined prediction to the right, by:

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

12. The apparatus according to claim 7, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

13. A computer program product for encoding a block of pixels, the 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, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

use said second reference block to obtain a second prediction, said second prediction having the second precision;

obtain a combined prediction based at least partly upon said first prediction and said second prediction;

decrease a precision of said combined prediction by shifting bits of the combined prediction to the right; and

encode residual data in a bitstream, wherein the residual data is determined based upon a difference between the combined prediction and the block of pixels.

14. The computer program product according to claim 13, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

15. The computer program product according to claim 14, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

16. The computer program product according to claim 14, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

17. The computer program product according to claim 13, wherein the program code instructions configured to decrease said precision of said combined prediction by shifting bits of the combined prediction to the right, further comprise program code instructions configured to:

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

18. The computer program product according to claim 13, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

19. A method for decoding a block of pixels, the method comprising:

determining, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

using said second reference block to obtain a second prediction, said second prediction having the second precision;

obtaining a combined prediction based at least partly upon said first prediction and said second prediction;

decreasing a precision of said combined prediction by shifting bits of the combined prediction to the right; and

reconstructing the block of pixels based on the combined prediction.

20. The method according to claim 19, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

21. The method according to claim 20, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

22. The method according to claim 20, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

23. The method according to claim 19, wherein said decreasing said precision of said combined prediction by shifting bits of the combined prediction to the right, further comprises:

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

24. The method according to claim 19, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

25. An apparatus for decoding a block of pixels, the 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, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

use said second reference block to obtain a second prediction, said second prediction having the second precision;

obtain a combined prediction based at least partly upon said first prediction and said second prediction;

decrease a precision of said combined prediction by shifting bits of the combined prediction to the right; and

reconstruct the block of pixels based on the combined prediction.

26. The apparatus according to claim 25, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

27. The apparatus according to claim 26, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

28. The apparatus according to claim 26, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

29. The apparatus according to claim 25, wherein the at least one memory and computer code are configured to cause the apparatus to decrease said precision of said combined prediction by shifting bits of the combined prediction to the right, by:

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

30. The apparatus according to claim 25, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

31. A computer program product for decoding a block of pixels, the 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, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

use said second reference block to obtain a second prediction, said second prediction having the second precision;

obtain a combined prediction based at least partly upon said first prediction and said second prediction;

decrease a precision of said combined prediction by shifting bits of the combined prediction to the right; and

reconstruct the block of pixels based on the combined prediction.

32. The computer program product according to claim 31, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

33. The computer program product according to claim 32, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

34. The computer program product according to claim 32, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

35. The computer program product according to claim 31, wherein the program code instructions configured to decrease said precision of said combined prediction by shifting bits of the combined prediction to the right, further comprise program code instructions configured to:

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

36. The computer program product according to claim 31, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

ABSTRACT

Apparatuses, methods and computer programs are provided 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. The 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.

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:	Guy Randall Gosnell/Torrey Wyatt
Attorney Docket Number:	042933/74925-US-CNT5

Filed as Large Entity

Filing Fees for **Utility under 35 USC 111(a)**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	320	320
UTILITY SEARCH FEE	1111	1	700	700
UTILITY EXAMINATION FEE	1311	1	800	800
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1202	16	100	1600
INDEPENDENT CLAIMS IN EXCESS OF 3	1201	3	480	1440
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**4860**

Electronic Acknowledgement Receipt

EFS ID:	42805896
Application Number:	17328750
International Application Number:	
Confirmation Number:	8335
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal UGUR
Customer Number:	10949
Filer:	Guy Randall Gosnell/Torrey Wyatt
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/74925-US-CNT5
Receipt Date:	24-MAY-2021
Filing Date:	
Time Stamp:	17:50:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$4860
RAM confirmation Number	E20215NH50160859
Deposit Account	
Authorized User	

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1	Application Data Sheet	74925-US-CNT5_ADS_.pdf	139588 ec9882d96638821037f3f94350cba5b5bce56fe7	no	9

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2	Power of Attorney	74925-US-CNT5_POA.pdf	396054 85c001a6d5ead2909ecaa97eb72de3d742474856	no	2

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
3	Oath or Declaration filed	74925-US-CNT5_Declarations.pdf	218375 cec1f8b2839c67bcf585b42084e1bc7230cd9cc6	no	3

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
4	Drawings-only black and white line drawings	74925-US-CNT5_Drawings.pdf	237194 5c9558944f99b4d796eccdd6383a03a58c6abd86	no	11

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
5		74925-US-CNT5_CONT_Specification.pdf	263104 cd32bb04beb22685d40dd4814b1ee3057e661bbf	yes	39

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	30
Claims	31	38

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Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	38311 934c7c3c4ab9b329a7afb71629fd2b0d0696cbde	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1292626		

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.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	042933/74925-US-CNT5
	Application Number	

Title of Invention	MOTION PREDICTION IN VIDEO CODING

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove
Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Kemal		UGUR	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Tampere	Country of Residence i	FI

Mailing Address of Inventor:

Address 1	Kuninkaankatu 5 J 221		
Address 2			
City	Tampere	**State/Province**	
Postal Code	33210	**Country** i	FI

Inventor 2 Remove
Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jani		LAINEMA	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Tampere	Country of Residence i	FI

Mailing Address of Inventor:

Address 1	Kisakentankatu 12 B 6		
Address 2			
City	Tampere	**State/Province**	
Postal Code	33230	**Country** i	FI

Inventor 3 Remove
Legal Name

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	042933/74925-US-CNT5
	Application Number	
Title of Invention	MOTION PREDICTION IN VIDEO CODING	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Antti		HALLAPURO	

Residence Information (Select One) ◯ US Residency ◉ Non US Residency ◯ Active US Military Service

City	Tampere	Country of Residence	FI

Mailing Address of Inventor:

Address 1	Opiskelijankatu 11 A 12		
Address 2			
City	Tampere	**State/Province**	
Postal Code	33720	**Country**	FI

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	10949
Email Address	Add Email Remove Email

Application Information:

Title of the Invention	MOTION PREDICTION IN VIDEO CODING		
Attorney Docket Number	042933/74925-US-CNT5	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	11	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY MM DD)	Intellectual Property Authority or Country

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	042933/74925-US-CNT5
	Application Number	
Title of Invention	MOTION PREDICTION IN VIDEO CODING	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	10949		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the “Application Number” field blank.

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
	Continuation of	16/729974	2019-12-30	11019354	2021-05-25
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16/729974	Continuation of	15/876495	2018-01-22	10523960	2019-12-31
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/876495	Continuation of	15/490469	2017-04-18	9877037	2018-01-23
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/490469	Continuation of	15/250124	2016-08-29	9628816	2017-04-18

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	042933/74925-US-CNT5
	Application Number	

Title of Invention	MOTION PREDICTION IN VIDEO CODING

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15/250124	Continuation of	13/344893	2012-01-06	9432693	2016-08-30

Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
13/344893	Claims benefit of provisional	61/430694	2011-01-07

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	042933/74925-US-CNT5
	Application Number	
Title of Invention	MOTION PREDICTION IN VIDEO CODING	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	042933/74925-US-CNT5
	Application Number	
Title of Invention	MOTION PREDICTION IN VIDEO CODING	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

- (●) Assignee
- ( ) Legal Representative under 35 U.S.C. 117
- ( ) Joint Inventor
- ( ) Person to whom the inventor is obligated to assign.
- ( ) Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. [x]

Organization Name	Nokia Technologies Oy		
Mailing Address Information For Applicant:			
Address 1	Karakaari 7		
Address 2			
City	Espoo	**State/Province**	
Country	FI	Postal Code	02610
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	042933/74925-US-CNT5
	Application Number	

Title of Invention	MOTION PREDICTION IN VIDEO CODING

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	Nokia Technologies Oy

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	Karakaari 7		
Address 2			
City	Espoo	**State/Province**	
Country	FI	Postal Code	02610
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Guy R. Gosnell/			Date (YYYY-MM-DD)	2021-05-24
First Name	Guy	Last Name	Gosnell	Registration Number	34,610

Additional Signature may be generated within this form by selecting the Add button.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	042933/74925-US-CNT5
	Application Number	

Title of Invention	MOTION PREDICTION IN VIDEO CODING

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 records.

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 CooperationTreaty.

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.

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
17/328,750	05/24/2021		4860	042933/74925-US-CNT5	36	6

CONFIRMATION NO. 8335

FILING RECEIPT

10949
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
One South at The Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

Date Mailed: 06/02/2021

Receipt is acknowledged of this non-provisional utility 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 FIRST INVENTOR, 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 corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction 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 provided that the request is grantable.

Inventor(s)

Kemal Ugur, Tampere, FINLAND;
Jani Lainema, Tampere, FINLAND;
Antti Hallapuro, Tampere, FINLAND;

Applicant(s)

Nokia Technologies Oy, Espoo, FINLAND;

Assignment For Published Patent Application

Nokia Technologies Oy, Espoo, FINLAND

Power of Attorney: The patent practitioners associated with Customer Number 10949

Domestic Priority data as claimed by applicant

This application is a CON of 16/729,974 12/30/2019 PAT 11019354
which is a CON of 15/876,495 01/22/2018 PAT 10523960
which is a CON of 15/490,469 04/18/2017 PAT 9877037
which is a CON of 15/250,124 08/29/2016 PAT 9628816
which is a CON of 13/344,893 01/06/2012 PAT 9432693
which claims benefit of 61/430,694 01/07/2011

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 06/01/2021
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/328,750**
Projected Publication Date: 09/09/2021
Non-Publication Request: No
Early Publication Request: No
Title

MOTION PREDICTION IN VIDEO CODING

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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 (1-866-999-4258).

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).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

Substitute for form SB08 (Revised 07/09) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				**Complete if Known**	
				Application Number	17/328,750
				Filing Date	May 24, 2021
				First Named Inventor	Ugur et al.
				Art Unit	2488
				Examiner Name	To Be Assigned
Sheet	1	of	5	Attorney Docket Number	042933/560470

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
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Submitted June 7, 2021

LEGAL02/40683680v1

Substitute for form SB08 (Revised 07/09) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				**Complete if Known**	
				Application Number	17/328,750
				Filing Date	May 24, 2021
				First Named Inventor	Ugur et al.
				Art Unit	2488
				Examiner Name	To Be Assigned
Sheet	2	of	5	Attorney Docket Number	042933/560470

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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
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	40	WO 2008/048864 A2	04-24-2008	Qualcomm Inc.		
	41	WO 2008/067734 A1	06-12-2008	Huawei Technologies Co., Ltd.		Abstract

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Examiner Signature		Date Considered	

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Submitted June 7, 2021

LEGAL02/40683680v1

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(Use as many sheets as necessary)				Filing Date	May 24, 2021
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Submitted June 7, 2021

LEGAL02/40683680v1

Espacenet

Bibliographic data: WO2008067734 (A1) — 2008-06-12

AN ENCODING/DECODING METHOD AND DEVICE, A FRACTIONAL PIXEL INTERPOLATION PROCESSING METHOD AND DEVICE

Inventor(s): ZHOU JIANTONG [CN]; HU CHANGQI [CN]; XIE QINGPENG [CN]; LIN SIXIN [CN]; ZENG PENGXIN [CN]; XIONG LIANHUAN [CN] ± (ZHOU, JIANTONG, ; HU, CHANGQI, ; XIE, QINGPENG, ; LIN, SIXIN, ; ZENG, PENGXIN, ; XIONG, LIANHUAN)

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Classification: - international: *H04N7/32*
- cooperative: G06T3/4007 (EP); H04N19/105 (EP); H04N19/117 (EP); H04N19/136 (EP); H04N19/176 (EP); H04N19/192 (EP); H04N19/51 (EP); H04N19/523 (EP); H04N19/61 (EP)

Application number: WO2007CN03590 20071213 Global Dossier

Priority number(s): CN200610162131 20061205

Also published as: AT533305 (T) CN100551073 (C) CN101198063 (A) EP2091258 (A1) EP2091258 (A4) EP2091258 (B1) less

Abstract of WO2008067734 (A1)

An inter-frame predicting encoding method, a decoding method, an encoding device, a decoding device, and a fractional pixel interpolation processing method and device. In view of the effect of the distributing direction of an image texture on the precision of the fractional pixel reference samples, the inter-frame predicting encoding/decoding technology according to the present invention performs a fractional pixel interpolation on the integer pixel samples of an image block to be encoded many times to obtain a plurality of groups of the fractional pixel reference samples with different precision, then selects the reference samples with the highest precision from the integer pixel samples and each group of the fractional pixel reference samples, so the encoding rate of the encoding side is increased. The fractional pixel interpolation technology according to the present invention sets up at least two different interpolation directions and calculates the corresponding predicting values, then selects the best value from all of the predicting values as the best predicting value of the fractional pixel samples to be interpolate, so the precision of the fractional pixel samples is increased.

(12) 按照专利合作条约所公布的国际申请

(19) 世界知识产权组织
国 际 局

(43) 国际公布日
2008 年6 月12 日 (12.06.2008)

PCT

(10) 国际公布号
WO 2008/067734 A1

(51) 国际专利分类号:
H04N 7/32 (2006.01)

(21) 国际申请号: PCT/CN2007/003590

(22) 国际申请日: 2007 年12 月13 日 (13.12.2007)

(25) 申请语言: 中文

(26) 公布语言: 中文

(30) 优先权:
200610162131.5
2006 年12 月5 日 (05.12.2006) CN

(71) 申请人 (对除美国外的所有指定国): **华为技术有限公司(HUAWEI TECHNOLOGIES CO., LTD.)** [CN/CN]; 中国广东省深圳市龙岗区坂田华为总部办公楼, Guangdong 518129 (CN)。

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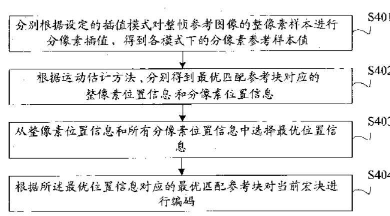
(81) 指定国 (除另有指明, 要求每一种可提供的国家保护): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG,

[见续页]

(54) Title: AN ENCODING/DECODING METHOD AND DEVICE, A FRACTIONAL PIXEL INTERPOLATION PROCESSING METHOD AND DEVICE

(54) 发明名称: 编解码方法及装置、分像素插值处理方法及装置



S401 PERFORM A FRACTIONAL PIXEL INTERPOLATION ON INTEGER PIXEL SAMPLES OF AN INTEGER FRAME REFERENCE IMAGE ACCORDING TO A PREDEFINDED INTERPOLATION MODE RESPECTIVELY, AND OBTAIN FRACTIONAL PIXEL SAMPLES IN EACH INTERPOLATION MODE
S402 OBTAIN INTEGER PIXEL LOCATION INFORMATION AND FRACTIONAL PIXEL LOCATION INFORMATION CORRESPONDING TO THE BEST MATCHING REFERENCE BLOCK RESPECTIVELY ACCORDING TO THE MOTION ESTIMATE METHOD
S403 SELECT THE BEST LOCATION INFORMATION FROM THE INTEGER PIXEL LOCATION INFORMATION AND ALL OF THE FRACTIONAL PIXEL LOCATION INFORMATION
S404 ENCODE THE PRESENT MACROBLOCK BASED ON THE BEST MATCHING REFERENCE BLOCK CORRESPONDING TO THE BEST LOCATION INFORMATION

(57) Abstract: An inter-frame predicting encoding method, a decoding method, an encoding device, a decoding device, and a fractional pixel interpolation processing method and device. In view of the effect of the distributing direction of an image texture on the precision of the fractional pixel reference samples, the inter-frame predicting encoding/decoding technology according to the present invention performs a fractional pixel interpolation on the integer pixel samples of an image block to be encoded many times to obtain a plurality of groups of the fractional pixel reference samples with different precision, then selects the reference samples with the highest precision from the integer pixel samples and each group of the fractional pixel reference samples, so the encoding rate of the encoding side is increased. The fractional pixel interpolation technology according to the present invention sets up at least two different interpolation directions and calculates the corresponding predicting values, then selects the best value from all of the predicting values as the best predicting value of the fractional pixel samples to be interpolate, so the precision of the fractional pixel samples is increased.

[见续页]

WO 2008/067734 A1

BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW。

(84) 指定国（除另有指明，要求每一种可提供的地区保护）：ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), 欧洲 (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)。

本国际公布：
— 包括国际检索报告。
— 包括关于请求恢复一项或多项优先权要求的信息。

(57) 摘要：

本发明公开一种帧间预测编码方法、解码方法、编码装置、解码装置，以及一种分像素插值处理方法和装置。本发明提供的帧间预测编解码技术方案，考虑到图像纹理分布方向对分像素参考样本精度的影响，通过调整插值方向的方法，对待编码图像块的整像素样本分别进行多次分像素插值，得到多组不同精度的分像素参考样本值，然后从整像素样本值和各分像素参考样本值中选择精度最高的参考样本值，所以提高了编码端的编码率。本发明提供的分像素插值技术方案，对于每一个待插值的分像素设定至少两个不同的插值方向并计算出对应的预测值，然后从所有的预测值中选择最优值作为待插值的分像素样本的最优预测值，从而提高了分像素参考样本值的精度。

编解码方法及装置、分像素插值处理方法及装置

技术领域

本发明涉及多媒体技术，特别涉及一种帧间预测编码方法、解码方法、编码装置、解码装置，以及一种分像素插值处理方法和装置。

背景技术

随着多媒体技术的发展和多媒体应用的迅速推广，视频图像压缩标准和技术得到了广泛的关注，目前的视频编码标准，H.26x和MPEG-x(MPEG，Motion picture experts group，运动图像专家组)以及由中国音视频编解码技术标准工作组制定的AVS（Audio video Standard，音视频编码标准）标准中的视频标准都是基于混合编码框架之上的。这种混合编码框架可以利用预测编码去除时域冗余度、利用变换编码去除空域冗余度以及利用熵编码去除统计冗余度。

预测编码可分为帧内预测编码和帧间预测编码，其中基于运动补偿的帧间预测编码是视频编码中的重要环节。帧间预测编码主要是利用运动补偿预测技术来减小时间冗余度的。物体运动具有连续性，而数字视频图像则是数字化离散的信号，在视频运动预测中，通常采用分像素插值技术来提高运动预测补偿的准确性。如在AVS1-P7基准档次视频编码标准中采用1/4像素的运动补偿预测。1/4像素插值过程分为两步进行，首先是对参考图像进行1/2像素插值，通过插值滤波器F1、F2将原图像在水平和垂直方向上进行插值，插值后的图像变为原图像的4倍，然后通过插值滤波器F3进行1/4像素插值，得到大小为原图像16倍的1/4像素插值参考图像。分像素插值技术大大改善了运动预

测的准确程度，进一步减小了当前编码图像和参考图像间的残差图像的能量。

如图 1 所示，为现有 AVS 亮度插值标准中，整数样本、1/2 样本和 1/4 样本的位置关系示意图，大写字母 A-X 表示图像中整数像素点的位置，小写字母 aa、b、j、t、hh、bb、cc、dd、h、m、ee、ff、gg 表示 1/2 像素点的位置，小写字母 a、c、d、e、f、g、i、k、n、p、q、r 表示 1/4 像素点的位置。

AVS1-P7 中亮度插值方法中，1/2 样本位置的预测值水平方向通过 8 抽头滤波器 F1(-1, 4, -12, 41,41,-12, 4, -1)/64，垂直方向通过 4 抽头滤波器 F2(-1,5,5,-1)/8 计算得到。1/4 样本位置的预测值通过线性滤波器 F3(1,1)/2 计算得到。

其中，1/2 样本的计算过程如下：

1/2 样本 *b*：首先用 8 抽头滤波器 F_1 对水平方向上最近的 8 个整数样本滤波，得到中间值 *b*'= (-C+4D-12E+41F+41G-12H+4I-J)；最终的预测值 *b*=Clip1((*b*'+32)>>6);

1/2 样本 *h*：首先用 F_2 对垂直方向上最近的 4 个整数样本滤波，得到中间值 *h*=(-*A*+5*F*+5*N*-*S*)；最终的预测值 *h*=Clip1((*h*+4)>>3);

1/2 样本 *j*：首先用 F_2 在垂直方向上对最近的 4 个 1/2 样本最终预测值滤波，得到中间值 *j*'=(-*aa*+5*b*+5*t*-*hh*)，其中 *aa*=Clip1((*aa*'+32)>>6)，*t*=Clip1((*t*'+32)>>6)，*hh*=Clip1((*hh*'+32)>>6)。标记为 *aa*'，*t*'和 *hh*'的 1/2 样本中间值可用 F_1 对水平方向滤波得到（与 *b*'的计算过程相同）。最终的预测值 *j*=Clip1((*j*'+4)>>3)。

1/4样本的计算过程如下：

1/4 样本 *a*：*a*=(F+*b*+1)>>1，其中 *b* 是相应位置 1/2 样本的最终预测值，F 是整数样本值;

1/4 样本 c：c=(G+b+1)>>1，其中 b 是相应位置 1/2 样本的最终预测值，G 是整数样本值；

1/4 样本 d：d=(F+h+1)>>1，其中 h 是相应位置 1/2 样本的最终预测值，F 是整数样本值；

1/4 样本 n：n=(N+h+1)>>1，其中 h 是相应位置 1/2 样本的最终预测值，N 是整数样本值；

1/4 样本 i：i=(h+j+1)>>1，其中 h 和 j 是相应位置 1/2 样本的最终预测值；

1/4 样本 k：k=(m+j+1)>>1，其中 m 和 j 是相应位置 1/2 样本的最终预测值；

1/4 样本 f：f=(b+j+1)>>1，其中 b 和 j 是相应位置 1/2 样本的最终预测值；

1/4 样本 q：q=(t+j+1)>>1，其中 t 和 j 是相应位置 1/2 样本的最终预测值；

1/4 样本 e，g，p 和 r：

$e = (\mathrm{F} + j + 1) >> 1;$

$g = (\mathrm{G} + j + 1) >> 1;$

$p = (\mathrm{N} + j + 1) >> 1;$

$r = (\mathrm{O} + j + 1) >> 1;$

其中F，G，N和O是整数样本值，j是相应位置1/2样本的最终预测值。

H.264 中的 1/4 像素插值过程和 AVS 类似，其 1/2 像素插值采用一个 6 抽头滤波器 F_1(1，-5，20，20，-5，1)/32，1/4 像素插值滤波器采用 2 抽头滤波器 F_2(1,1)/2。

无论是 AVS 还是 H.264 标准，其插值过程中仅仅使用了图像的水平和垂直插值方向，对于图像内容的纹理分布不同于水平方向或垂直方向的图像的插值精度较低，因此造成编码率低。

发明内容

本发明提供一种帧间预测编码方法、解码方法、编码装置、解码装置，以解决现有技术中仅仅使用图像的水平和垂直插值方向时导致的编码率低的问题；

本发明还提供一种分像素插值处理方法和装置，以解决现有技术中分像素参考样本值精度较低的问题。

为解决上述技术问题，本发明实施例提供如下技术方案：

一种帧间预测编码方法，包括如下步骤：

根据设定的至少两种插值模式对待编码图像块的整像素样本分别进行分像素插值，获取各插值模式对应的分像素参考样本值，其中任意两种插值模式中至少有一级分像素样本的插值方向不相同；

从参考帧中搜索定位帧间最优整像素匹配参考块对应的整像素位置信息，从各分像素参考样本值中搜索定位帧间最优分像素匹配参考块对应的各分像素位置信息；

在所述整像素位置信息和各分像素位置信息中选择最优位置信息，并根据该最优位置信息和对应的最优匹配参考块编码所述待编码图像块。

其中，当所述最优位置信息为一个分像素位置信息时，在进行编码时，将该最优位置信息对应的分像素参考样本值的插值模式指示信息编码到码流中。

其中，对每一个待插值的分像素，在插值方向上划一条穿过待插值分像素位置的直线，根据其它样本到该直线的垂直距离，从垂直距离最短的样本开始，按照垂直距离由短到长的顺序选择相应数量的插值样本计算该待插值分像素的预测值。

其中，对每一个待插值的分像素，在插值方向上划一条穿过待插值分像素位置的直线，根据其它样本到该直线的垂直距离，从垂直距离最短的样本

开始，按照垂直距离由短到长的顺序选择相应数量的插值样本计算该待插值分像素的预测值。

其中，对每一个待插值的分像素，先根据该待插值的分像素与其它样本之间的直线距离，从直线距离最短的样本开始，按照直线距离由短到长的顺序选择的备选插值样本，再在插值方向上划一条穿过待插值分像素位置的直线，根据所有备选插值样本到该直线的垂直距离，从垂直距离最短的备选插值样本开始，按照垂直距离由短到长的顺序选择相应数量的插值样本计算该待插值分像素的预测值。

一种帧间预测编码装置，包括：第一存储单元，用于缓存参考帧图像样本值；所述装置还包括：

第二存储单元，用于存储设定的至少两种插值模式中，各插值模式中每一个待插值分像素对应的一组插值样本的位置信息；

分像素插值单元，用于根据设定的至少两种插值模式，分别利用第二存储单元中存储的插值模式对应的分像素插值样本的位置信息对第一存储单元中缓存的整像素样本进行插值；

运动估计单元，用于根据运动估计方法，在参考帧中进行整像素搜索，定位最优整像素匹配参考块，得到对应的整像素位置信息；并根据运动估计方法，在每一个分像素参考样本值中定位最优分像素匹配参考块，分别得到对应的分像素位置信息；

选择单元，用于选择在所述整像素位置信息和各分像素位置信息中选择最优的位置信息；

编码单元，用于根据述最优位置信息对应的参考样本值对当前宏块进行编码，并输出编码后的码流。

进一步，当所述最优位置信息为一个分像素位置信息时，所述编码单元

还将该最优位置信息对应的分像素参考样本值的插值模式指示信息编码到码流中。

进一步，所述的装置还包括:

整像素样本搜索单元，用于从第一存储单元中存储的参考帧图像样本值中搜索出待编码图像块的参考图像块整像素样本。

基于同一技术构思，本发明还提供一种解码方法，包括如下步骤:

接收视频码流并从码流中解析出帧间最优匹配参考块对应的最优位置信息;

在根据最优位置信息确定出待解码图像块的帧间最优匹配参考块为分像素最优匹配参考块时，从所述码流中解析出插值模式指示信息;

根据插值模式指示信息对应的各分像素插值样本的位置信息和所述最优位置信息计算当前待解码图像块的帧间预测样本值;

根据所述待解码图像块的帧间预测样本值解码重建所述图像块。

其中，当确定所述图像块的帧间最优匹配参考块是整像素最优匹配参考块时，则根据整像素样本解码重建所述图像块。

以及一种解码装置，包括接收单元，用于接收待解码的码流；所述解码装置还包括:

判断单元，用于判断所述码流中当前待解码图像块的帧间最优匹配参考块是整像素最优匹配参考块或分像素最优匹配参考块，并输出判断结果;

解析单元，用于在待解码图像块的帧间最优匹配参考块是分像素最优匹配参考块时，从码流中解析出插值模式指示信息;

存储单元，用于存储设定的至少两种插值模式中，各插值模式中每一个待插值分像素对应的一组插值样本的位置信息;

解码单元，用于在待解码图像块的帧间最优匹配参考块为整像素最优匹配参考块时，根据整像素样本解码重建当前块图像；

或者，在待解码图像块的帧间最优匹配参考块为分像素最优匹配参考块时，在码流中解析出插值模式指示信息；并根据插值模式指示信息对应的各分像素插值样本的位置信息和所述最优位置信息计算当前待解码宏块的帧间预测样本值；然后解码重建当前图像块。

本发明还提供一种分像素插值方法，包括如下步骤：

根据设定的至少两个插值方向分别获得待插值分像素的各备选预测值；

对比所有备选预测值，并选择其中的最优值作为所述待插值的分像素样本的预测值。

以及一种分像素插值处理装置，包括：

存储器，用于存储每一个待插值分像素在设定的各插值方向上分别对应的一组插值样本的位置信息；

第一单元，用于根据设定的至少两个插值方向分别获得待插值分像素的各备选预测值；

第二单元，对比所述第一单元获得的所有备选预测值，选择其中的最优值作为所述待插值的分像素样本的预测值。

本发明实施例提供的帧间预测编解码技术方案，考虑到图像纹理分布方向对分像素参考样本精度的影响，通过调整插值方向的方法，对待编码图像块的整像素样本分别进行多次分像素插值，得到多组不同精度的分像素参考样本值，然后从整像素样本值和各分像素参考样本值中选择精度最高的参考样本值，参照该精度最高的参考样本值进行编码，与其它样本值相比，该精度最高的参考样本值的插值方向最符合图像块的纹理分布特性，因此与位于

参考帧中的参考图像块的差异应该最小，所以提高了编码端的编码率；

本发明实施例提供的分像素插值技术方案，对于每一个待插值的分像素设定至少两个不同的插值方向，并在每一个插值方向上计算出对应的预测值，然后从所有的预测值中选择最优值作为待插值的分像素样本的最优预测值，从而提高了分像素参考样本值的精度。

附图说明

图 1 为 AVS 标准中，整数样本、1/2 样本和 1/4 样本的位置关系示意图；

图 2 为本发明实施例所述的插值方向示意图；

图 3 为本发明实施中，使用 4 抽头滤波器计算 1/2 分像素样本预测值时，根据相关性选择插值样本的示意图；

图 4 为本发明实施例中，对整帧参考图像进行分像素插值时，编码端的帧间预测编码过程示意图；

图 5 为本发明实施例中，对整帧参考图像进行分像素插值时，一种编码端的主要结构示意图；

图 6 为本发明实施例中，对参考帧图像中的参考宏块进行分像素插值时，编码端的帧间预测编码过程示意图；

图 7 为本发明实施例中，对参考帧图像中的参考宏块进行分像素插值时，一种编码端的主要结构示意图；

图 8 为本发明实施例中，解码端进行解码时的主要流程示意图；

图 9 为本发明实施例中，一种解码端的主要结构示意图；

图 10 为本发明实施例中，一种分像素插值处理装置的主要结构示意图。

具体实施方式

本发明实施例为提高编码端的编码率，考虑到图像纹理分布方向对分像素参考样本精度的影响，通过调整插值方向的方法，对待编码图像块的整像素样本分别进行多次分像素插值，得到多组不同精度的分像素参考样本值，然后从整像素样本值和各分像素参考样本值中选择精度最高的参考样本值，参照该精度最高的参考样本值进行编码，与其它样本值相比，该精度最高的参考样本值的插值方向最符合图像块的纹理分布特性，因此与位于参考帧中的参考图像块的差异应该最小，所以提高了编码端的编码率。

本发明实施例中，每次调整分像素插值方向时，可以对每一级分像素的插值方向全部进行调整，也可以只调整其中部分级别或一个级别分像素的插值方向，每一种调整策略可以获得不同精度的分像素参考样本值。例如：在每一次分像素插值时，改变 1/2 像素的插值方向，保持其他级别像素的插值方向不变。

插值方向除现有的水平方向和垂直方向外，可以是其它任何一个方向，例如图 2 所示，分别和水平方向成 30°、45°、60°、120°、135°和 150°夹角的任何一个方向。

对于任何一个插值方向，可以根据插值样本与待插值分像素的相关性来选择，相关性主要表现在两个方面：

一、如果用一条穿过该待插值分像素的直线来表示插值方向，则插值样本到该直线的垂直距离反映了插值样本与待插值分像素在纹理分布特性的相关性，该垂直距离越近则相关性越高，反之，该垂直距离越大则相关性越低；

因此，根据该第一个相关性因素，对每一个待插值的分像素，可以在插值方向上划一条穿过待插值分像素位置的直线，根据其它样本到该直线的垂直距离，从垂直距离最短的样本开始，按照垂直距离由短到长的顺序选择相应数量的插值样本计算该待插值分像素的预测值。

二、其次，插值样本与该待插值分像素之间的直线距离反映了插值样本与待插值分像素在图像连续性方面的相关性，该直线距离越近则相关性越高，

反之该直线距离越大则相关性越低。

因此，根据第二个相关性因素，对每一个待插值的分像素，可以根据该待插值的分像素与其它样本之间的直线距离，从直线距离最短的样本开始，按照直线距离由短到长的顺序选择相应数量的插值样本计算该待插值分像素的预测值。

上述两个相关性也可以综合考虑，例如对每一个待插值的分像素，先根据该待插值的分像素与其它样本之间的直线距离，从直线距离最短的样本开始，按照直线距离由短到长的顺序选择的备选插值样本，再在插值方向上划一条穿过待插值分像素位置的直线，根据所有备选插值样本到该直线的垂直距离，从垂直距离最短的备选插值样本开始，按照垂直距离由短到长的顺序选择相应数量的插值样本计算该待插值分像素的预测值。

可以优先选择整像素样本作为插值样本，选出的插值样本可以全部分布在插值方向的一侧，也可以分布在插值方向的两侧，并不限定每一侧分布的具体数量。

当然，也可以根据其它相关性因素选择插值样本，例如图像的边界特性等，插值样本的选择方法并不限定本发明的保护范围。

根据插值样本的选择方法，在确定插值方向和插值滤波器后，可以为每一个待插值的分像素选出一组相应数量的插值样本，并将每一个待插值分像素对应的插值样本的位置信息分组保存到编码端和解码端备用。

下面以具体实施例并结合附图详细说明本发明。

为方便描述，本实施例将每一次分像素插值时各像素的插值方向的组合定义为一种插值模式，设定的插值模式越多，得到的参考样本值的精度可能越高。

本实施例定义如下三种插值模式，分别为：

一、模式 0:

1/2样本的计算过程如下：

1/2样本b：首先用F_1对水平方向上最近的4个整数样本滤波，得到中间值b =(-E+5F+5G-H)；最终的预测值b=Clip1((b+4)>>3)；

1/2样本h：首先用F_1对垂直方向上最近的4个整数样本滤波，得到中间值h=(-A+5F+5N-S)；最终的预测值h=Clip1((h+4)>>3)；

1/2样本j：首先用F_1在水平或垂直方向上对最近的4个1/2样本中间值滤波，得到中间值j=(-dd+5h+5m-ee)，或者j=(-aa+5b+5t-hh)。其中aa、hh和t是相应位置1/2样本中间值（用F_1在水平方向滤波得到），dd、ee和m是相应位置1/2样本中间值（用F_1在垂直方向滤波得到）。最终的预测值j=Clip1((j+32)>>6)。采用水平方向或垂直方向滤波得到的值相同。

1/4样本的计算过程如下：

1/4样本a：a=(F+b+1)>>1，其中b是相应位置1/2样本的最终预测值，F是整数样本值；

1/4 样本 c：c=(G+b+1)>>1，其中 b 是相应位置 1/2 样本的最终预测值，G 是整数样本值；

1/4 样本 d：d=(F+h+1)>>1，其中 h 是相应位置 1/2 样本的最终预测值，F 是整数样本值；

1/4 样本 n：n=(N+h+1)>>1，其中 h 是相应位置 1/2 样本的最终预测值，N 是整数样本值；

1/4 样本 i：i=(h+j+1)>>1，其中 h 和 j 是相应位置 1/2 样本的最终预测值；

1/4 样本 k：k=(m+j+1)>>1，其中 m 和 j 是相应位置 1/2 样本的最终预测值；

1/4 样本 f：f=(b+j+1)>>1，其中 b 和 j 是相应位置 1/2 样本的最终预测值；

1/4 样本 q：q=(t+j+1)>>1，其中 t 和 j 是相应位置 1/2 样本的最终预测值；

1/4 样本 e，g，p 和 r:

$e = (F + j + 1) >> 1;$

$g = (G + j + 1) >> 1;$

$p = (N + j + 1) >> 1;$

$r = (O + j + 1) >> 1;$

其中F、G、N和O是整数样本值，j是相应位置1/2样本的最终预测值。

二、模式 1:

例如图 3 所示，对于 1/2 样本 b，粗实线标识 b 与其它样本之间的垂直距离，粗虚线标识 b 与其它样本之间的直线距离。使用 4 抽头滤波器计算 1/2 分像素样本预测值时，根据相关性原则并优先选择整像素样本，在和水平方向成 45°夹角的插值方向上，可以选择 N、F、G 和 B 四个整像素样本作为插值样本计算 1/2 样本 b 的预测值，选择 M、N、G 和 F 四个整像素样本作为插值样本计算 1/2 样本 h 的预测值，选择 W、N、G 和 V 四个整像素样本作为插值样本计算 1/2 样本 j 的预测值，其他 1/2 分像素样本的插值样本选择方法相同。

则 1/2 样本的计算过程如下:

b=(-N+5F+5G-B); 最终的预测值 b=Clip1((b+4)>>3);

h=(-M+5N+5F-G); 最终的预测值 h=Clip1((h+4)>>3);

j=(-W+5N+5G-V)，最终的预测值 j=Clip1((j+4)>>3);

1/4 样本的计算过程和模式 1 相同。

模式 2:

参照图 3 所示，仍然根据相关性原则并优先选择整像素样本，选择出计算每一个 1/2 样本的插值样本。

则 1/2 样本的计算过程如下:

b=(-A+5F+5G-O)；最终的预测值 b=Clip1((b+4)>>3);

h=(-E+5F +5N-O)；最终的预测值 h=Clip1((h+4)>>3);

j=(-U+5F+5O-X)，最终的预测值 j=Clip1((j+4)>>3);

1/4 样本的计算过程和模式 1 相同。

分别完成上述三个模式的分像素插值后，获得三组分像素参考样本值，即模式 0 样本值、模式 1 样本值、模式 2 样本值。

基于获得的三组分像素参考样本值，下面以1个参考帧的宏块级帧间预测编码为例说明编码端的编码过程，对于待编码图像块为一个子块的处理方式完全相同。

如图4所示，该实施例中分像素插值是对整帧参考图像进行的，编码端的编码过程主要包括如下步骤:

S401、分别根据设定的插值模式对整帧参考图像的整像素样本进行分像素插值，得到各插值模式下的分像素参考样本值，即插值模式 0 的分像素参考样本值、插值模式 1 的分像素参考样本值、插值模式 2 的分像素参考样本值;

各插值模式的参考样本值中的每一个分像素预测值的具体计算过程如前所述，这里不再赘述。

S402、根据运动估计方法，在参考帧中进行整像素搜索，定位帧间最优整像素匹配参考块，得到对应的整像素位置信息，该整像素位置信息中包括一组运动矢量 MV;

根据运动估计方法，在每一个分像素参考样本值中定位帧间最优分像素匹配参考块，分别得到对应的分像素位置信息，各分像素位置信息分别包括根据对应参考样本计算出的最优运动矢量 MV_0，MV_1，MV_2;

S403、从整像素位置信息和所有分像素位置信息中选择最优位置信息;

本发明实施例中，通常可以根据已有的图像失真度判断准则在不同的插值精度间进行最优选择，如SAD（Sum of Absolute Difference）或者率失真最优准则RDO(Rate-Distortion Optimization)来进行判断。SAD准则是一种衡量图像差异程度的方法，是当前待编码图像块和参考帧中的参考图像块对应的位置像素值差值取绝对值的累加和，SAD值越大说明当前编码块和参考块之间的差异越大，反之，则差异小，最小SAD值对应的参考样本值即为精度最高的参考样本值。

S404、根据所述最优位置信息对应的最优匹配参考块对当前宏块进行编码，输出编码后的码流。

如果帧间最优匹配块是最优整像素匹配参考块，则解码端不需要分像素参考样本，则不用在码流中传递最优位置信息使用的插值模式指示信息，如果帧间最优匹配块是其中一个分像素匹配参考块，则将对应的插值模式指示信息记录到码流中，供解码端解码使用。

如图5所示，一种编码端的主要结构包括:

第一存储单元501，用于缓存参考帧图像样本值;

第二存储单元502，用于存储设定的至少两种插值模式中，各插值模式中每一个待插值分像素对应的一组插值样本的位置信息;

根据不同的插值模式，该第二存储单元502中可以包括相应数量的存储子单元，每一个存储子单元分别存储每一种插值模式下各分像素插值样本的位置信息，例如图5中所示的第一存储子单元5021、第二存储子单元5022……第N存储子单元502n。

分像素插值单元503，用于根据设定的至少两种插值模式，分别利用第二

存储单元502中存储的插值模式对应的分像素插值样本的位置信息对第一存储单元中缓存的整像素样本进行插值;

同样根据不同的插值模式，该分像素插值单元503中可以包括相应数量的插值子单元，每一个插值子单元分别用于执行一种插值模式的分像素插值处理，例如图5中所示的第一插值子单元5031、第二插值子单元5032......第N插值子单元503n。

运动估计单元 504，用于根据运动估计方法，在参考帧中进行整像素搜索，定位帧间最优整像素匹配参考块，得到对应的整像素位置信息，该整像素位置信息中包括一组运动矢量 MV;

并根据运动估计方法，在每一个分像素参考样本值中定位帧间最优分像素匹配参考块，分别得到对应的分像素位置信息，各分像素位置信息分别包括根据对应参考样本计算出的最优运动矢量 MV_0，MV_1，MV_2;

选择单元505，用于选择最优的位置信息;

编码单元 506，用于根据所述选择单元 505 选出的最优位置信息对应的匹配参考块对当前宏块进行编码，输出编码后的码流。

如果最优匹配参考块是整像素匹配参考块，则解码端不需要分像素参考样本，则不用在码流中传递最优位置信息使用的插值模式指示信息，如果最优匹配参考块是其中一个分像素匹配参考块，则将对应的插值模式指示信息编码到码流中，供解码端解码使用，最优位置信息可以携带在宏块头信息中。

如图6所示，如果对参考帧中的参考宏块进行分像素插值，则编码端的编码过程主要包括如下步骤:

S601、在参考帧中搜索待编码宏块的参考宏块整像素样本;

S602、分别根据设定的插值模式对参考宏块整像素样本进行分像素插值，

得到各模式下的分像素参考样本值，即插值模式 0 的分像素参考样本值、插值模式 1 的分像素参考样本值、插值模式 2 的分像素参考样本值；

S603、根据运动估计方法，在参考帧中进行整像素搜索，定位最优整像素匹配参考块，得到对应的整像素位置信息，该整像素位置信息中包括一组运动矢量 MV；

根据运动估计方法，在每一个分像素参考样本值中定位最优分像素匹配参考块，分别得到对应的分像素位置信息，各分像素位置信息分别包括根据对应参考样本计算出的最优运动矢量 MV_0，MV_1，MV_2；

S604、从整像素位置信息和所有分像素位置信息中选择最优位置信息；

S605、根据所述最优位置信息对应的参考样本值对当前宏块进行编码，输出编码后的码流。

如果最优匹配块是整像素匹配参考块，则解码端不需要参考分像素参考样本值，则不用在码流中传递最优位置信息使用的插值模式指示信息，如果最优匹配块是其中一个分像素匹配参考块，则将对应的插值模式指示信息记录到码流中，供解码端解码时使用。

如图7所示，除图5所示的结构外，编码端的结构中还包括：

整像素样本搜索单元507，用于从第一存储单元501中存储的参考帧图像样本值中搜索出待编码宏块的参考宏块整像素样本，后续处理基于该参考宏块整像素样本进行。

如图 8 所示，解码端的解码该宏块的过程包括如下步骤：

S801、解码端接收视频码流，从码流解析出最优匹配参考块的最优位置信息，最优位置信息可以携带在宏块头信息中；

S802、根据最优位置信息判断该宏块的帧间最优匹配参考块是整像素级

还是分像素级，如果待解码宏块的帧间最优匹配参考块是整像素匹配参考块时，则执行步骤 S806 直接根据整像素样本解码重建当前宏块图像，完成当前宏块解码。

如果帧间最优匹配参考块是分像素匹配参考块，则执行步骤 S803:

S803、在码流中解析出对应的插值模式指示信息;

S804、根据插值模式指示信息和对应最优位置信息计算当前待解码宏块的帧间预测样本值;

S805、根据该当前待解码宏块的帧间预测样本值解码重建当前宏块图像。

完成当前宏块的解码后，如果还有待解码宏块，则继续执行下一个宏块的解码。

如图 9 所示，解码端的主要结构包括:

接收单元 901，用于接收编码端发送的码流;

判断单元 902，用于判断待解码宏块的帧间最优匹配块是整像素级还是分像素级，并输出判断结果;

解析单元 903，用于在待解码宏块的帧间最优匹配块是分像素级时，从码流中解析出对应的插值模式指示信息;

存储单元 904，用于存储各插值模式中，每一个待插值分像素对应的一组插值样本的位置信息;

解码单元 905，用于在待解码宏块的帧间最优匹配参考块是整像素匹配参考块时，直接根据整像素样本重建当前图像块。

或者，待解码宏块的帧间最优匹配参考块是分像素匹配参考块时，根据插值模式指示信息从存储单元 904 中获取相应的插值样本位置信息，并和对应最优位置信息计算当前待解码宏块的帧间预测样本后，根据该帧间预测样

本值解码重建当前宏块。

基于同一发明构思，本发明还提供一种分像素插值方法，对于每一个待插值的分像素，都可以基于本发明实施例提供的技术构思，设定至少两个不同的插值方向，并在每一个插值方向上，选择一组与待插值的分像素样本相关的插值样本，计算出每一组插值样本对应的预测值，并从所有的预测值中选择最优值作为所述待插值的分像素样本的最优预测值。

对于每一个待插值的分像素，插值样本的选择方法和前述的编码方法中的选择方法一样，这里不再重述，举例说明如下：

对如图 1 所示的图像进行插值时，按照前面所述的插值原则，还可以有不同于图 3 的插值样本点取值方式。

以 b 点插值为例，当插值滤波器位四抽头插值滤波器时，对于 45°方向还可以由下列式子计算得到：

b=(-M+5F+5G-V); 最终的预测值 b=Clip1((b+4)>>3);

b=(-W+5j+5G-V); 最终的预测值 b=Clip1((b+4)>>3);

b=(-M+5F+5B-V); 最终的预测值 b=Clip1((b+4)>>3);

此时的插值滤波器还可以选用其它任意形式的系数组合，如：

b=(-W+3N+8G-2V); 最终的预测值 b=Clip1((b+4)>>3);

b=(-M+9F+9G-V); 最终的预测值 b=Clip1((b+8)>>4);

b=(M+7F+7G + V); 最终的预测值 b=Clip1((b+8)>>4);

如上扩展还可以应用于 6 抽头、8 抽头等对称和非对称插值滤波器。

上述方法可以提高每一个样本预测值的精度，因此也提高了整个分像素参考样本值的精度，依据该分像素参考样本值进行编码时，同样可以提高编码率。

当需要衡量当前编码块中一个像素点和参考块的一个参考样本点之间的差异时，可以通过 AD（Absolute Difference）值来衡量。率失真最优准则 RDO 相对于 SAD 判断，除了考虑图像的失真程度外，还考虑了编码图像所用的码

率，从而使得在当前块编码过程中选择最优编码模式时兼顾图像失真度和码率的双重因素，从而取得更好的编码效率，当然 RDO 方法的计算复杂度也要高于 SAD 方法。

如图 10 所示，相应的分像素插值处理装置中可以包括以下单元:

存储器 1001，用于存储每一个待插值分像素在设定的各插值方向上分别对应的一组插值样本的位置信息;

第一单元 1002，根据设定的至少两个插值方向分别获得待插值分像素的各备选预测值;

第二单元 1003，对比第一单元 1002 获得的所有备选预测值，选择其中的最优值作为所述待插值的分像素样本的预测值。

显然，本领域的技术人员可以对本发明进行各种改动和变型而不脱离本发明的精神和范围。这样，倘若本发明的这些修改和变型属于本发明权利要求及其等同技术的范围之内，则本发明也意图包含这些改动和变型在内。

权 利 要 求

1、一种帧间预测编码方法，其特征在于，包括如下步骤:

根据设定的至少两种插值模式对待编码图像块的整像素样本分别进行分像素插值，获取各插值模式对应的分像素参考样本值，其中任意两种插值模式中至少有一级分像素样本的插值方向不相同;

从参考帧中搜索定位帧间最优整像素匹配参考块对应的整像素位置信息，从各分像素参考样本值中搜索定位帧间最优分像素匹配参考块对应的各分像素位置信息;

在所述整像素位置信息和各分像素位置信息中选择最优位置信息，并根据该最优位置信息和对应的最优匹配参考块编码所述待编码图像块。

2、如权利要求1所述的方法，其特征在于，当所述最优位置信息为一个分像素位置信息时，在进行编码时，将该最优位置信息对应的分像素参考样本值的插值模式指示信息编码到码流中。

3、如权利要求1所述的方法，其特征在于，根据每一个待插值的分像素与其它样本之间的直线距离，从直线距离最短的样本开始，按照直线距离由短到长的顺序选择相应数量的插值样本计算该待插值分像素的预测值。

4、如权利要求1所述的方法，其特征在于，对每一个待插值的分像素，在插值方向上划一条穿过该待插值分像素位置的直线，根据其它样本到该直线的垂直距离，从垂直距离最短的样本开始，按照垂直距离由短到长的顺序选择相应数量的插值样本计算该待插值分像素的预测值。

5、如权利要求1所述的方法，其特征在于，对每一个待插值的分像素，先根据该待插值的分像素与其它样本之间的直线距离，从直线距离最短的样本开始，按照直线距离由短到长的顺序选择的备选插值样本，再在插值方向上划一条穿过待插值分像素位置的直线，根据所有备选插值样本到该直线的垂直距离，从垂直距离最短的备选插值样本开始，按照垂直距离由短到长的

顺序选择相应数量的插值样本计算该待插值分像素的预测值。

6、如权利要求 3、4 或 5 所述的方法，其特征在于，在插值方向的一侧选择所述插值样本；或者分别在插值方向的两侧选择所述插值样本。

7、如权利要求 6 所述的方法，其特征在于，优先选择整像素样本作为所述插值样本。

8、如权利要求 1 所述的方法，其特征在于，所述待编码图像块为宏块或子块。

9、如权利要求 2 所述的方法，其特征在于，所述的插值模式指示信息携带在图像块的块头信息中。

10、一种帧间预测编码装置，包括：第一存储单元，用于缓存参考帧图像样本值；其特征在于，所述装置还包括：

第二存储单元，用于存储设定的至少两种插值模式中，各插值模式中每一个待插值分像素对应的一组插值样本的位置信息；

分像素插值单元，用于根据设定的至少两种插值模式，分别利用第二存储单元中存储的插值模式对应的分像素插值样本的位置信息对第一存储单元中缓存的整像素样本进行插值；

运动估计单元，用于根据运动估计方法，在参考帧中进行整像素搜索，定位帧间最优整像素匹配参考块，得到对应的整像素位置信息；并在每一个分像素参考样本值中定位帧间最优分像素匹配参考块，分别得到对应的分像素位置信息；

选择单元，用于在所述整像素位置信息和各分像素位置信息中选择最优位置信息；

编码单元，用于根据所述最优位置信息对应的最优匹配参考块对当前图像块进行编码。

11、如权利要求 10 所述的装置，其特征在于，当所述最优位置信息为一个分像素位置信息时，所述编码单元还将该最优位置信息对应的分像素参考样本值的插值模式指示信息编码到码流中。

12、如权利要求 11 所述的装置，其特征在于，所述的装置还包括:

整像素样本搜索单元，用于从第一存储单元中存储的参考帧图像样本值中搜索出待编码图像块的参考图像块整像素样本。

13、如权利要求11所述的装置，其特征在于，所述第二存储单元中可以包括相应数量的存储子单元，每一个存储子单元分别用于存储一种插值模式下各分像素插值样本的位置信息。

14、如权利要求11所述的装置，其特征在于，所述分像素插值单元中可以包括相应数量的插值子单元，每一个插值子单元分别用于执行一种插值模式的分像素插值处理。

15、一种解码方法，其特征在于，包括如下步骤:

接收视频码流并从码流中解析出帧间最优匹配参考块对应的最优位置信息;

在根据最优位置信息确定出待解码图像块的帧间最优匹配参考块为分像素最优匹配参考块时，从所述码流中解析出插值模式指示信息;

根据插值模式指示信息对应的各分像素插值样本的位置信息和所述最优位置信息计算当前待解码图像块的帧间预测样本值;

根据所述待解码图像块的帧间预测样本值解码重建所述图像块。

16、如权利要求 15 所述的方法，其特征在于，所述方法还包括：当确定所述图像块的帧间最优匹配参考块是整像素最优匹配参考块时，则根据整像素样本解码重建所述图像块。

17、如权利要求 15 所述的方法，其特征在于，所述图像块为宏块或子块。

18、一种解码装置，包括接收单元，用于接收待解码的码流；其特征在于，所述解码装置还包括：

判断单元，用于判断所述码流中当前待解码图像块的帧间最优匹配参考块是整像素最优匹配参考块或分像素最优匹配参考块，并输出判断结果；

解析单元，用于在待解码图像块的帧间最优匹配参考块是分像素最优匹配参考块时，从码流中解析出插值模式指示信息；

存储单元，用于存储设定的至少两种插值模式中，各插值模式中每一个待插值分像素对应的一组插值样本的位置信息；

解码单元，用于在待解码图像块的帧间最优匹配参考块为整像素最优匹配参考块时，根据整像素样本解码重建当前图像块；

或者，在待解码图像块的帧间最优匹配参考块为分像素最优匹配参考块时，根据所述插值模式指示信息对应的各分像素插值样本的位置信息和所述最优位置信息计算当前待解码图像块的帧间预测样本值，并根据该帧间预测样本值解码重建当前图像块。

19、一种分像素插值方法，其特征在于，包括如下步骤：

根据设定的至少两个插值方向分别获得待插值分像素的各备选预测值；

对比所有备选预测值，并选择其中的最优值作为所述待插值的分像素样本的预测值。

20、一种分像素插值处理装置，其特征在于，包括：

存储器，用于存储每一个待插值分像素在设定的各插值方向上分别对应的一组插值样本的位置信息；

第一单元，用于根据设定的至少两个插值方向分别获得待插值分像素的

各备选预测值;

第二单元，对比所述第一单元获得的所有备选预测值，选择其中的最优值作为所述待插值的分像素样本的预测值。

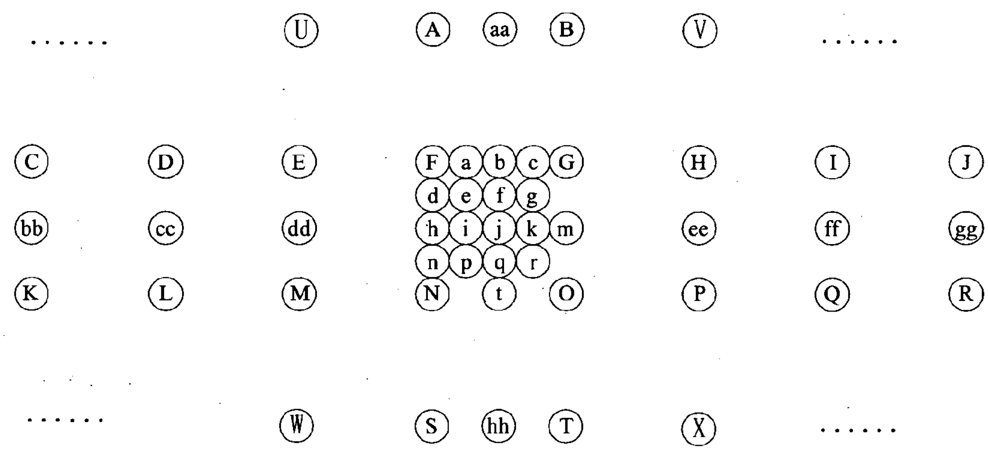

......
U
A
aa
B
V
......
C
D
E
F
a
b
c
G
H
I
J
d
e
f
g
bb
cc
dd
h
i
j
k
m
ee
ff
gg
n
p
q
r
K
L
M
N
t
O
P
Q
R
......
W
S
hh
T
X
......

图 1

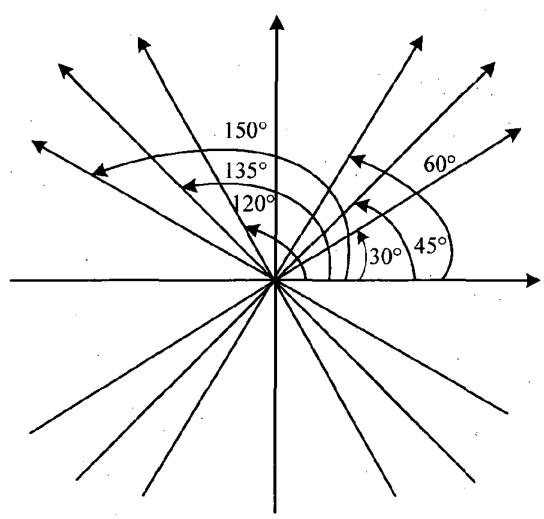

150°
135°
120°
60°
45°
30°

图 2

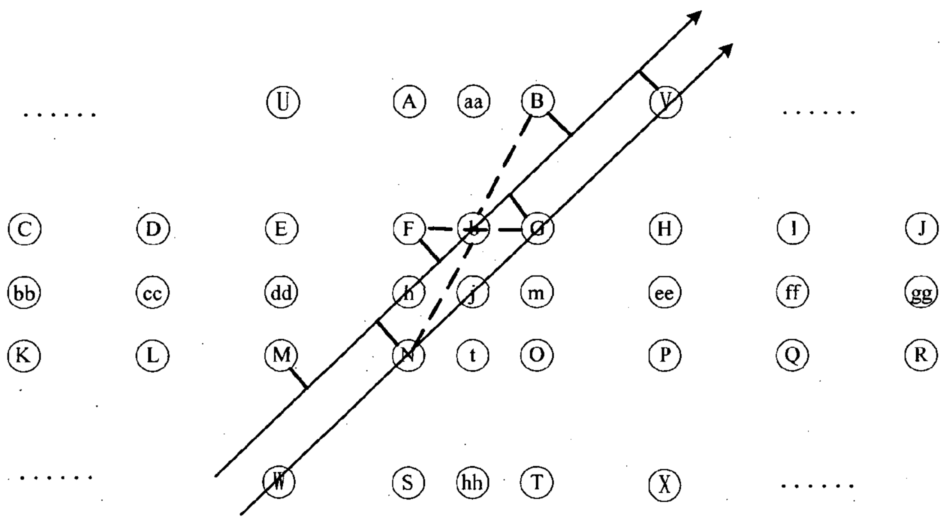

......
U
A
aa
B
V
......
C
D
E
F
G
H
I
J
bb
cc
dd
h
j
m
ee
ff
gg
K
L
M
N
t
O
P
Q
R
......
W
S
hh
T
X
......

图 3

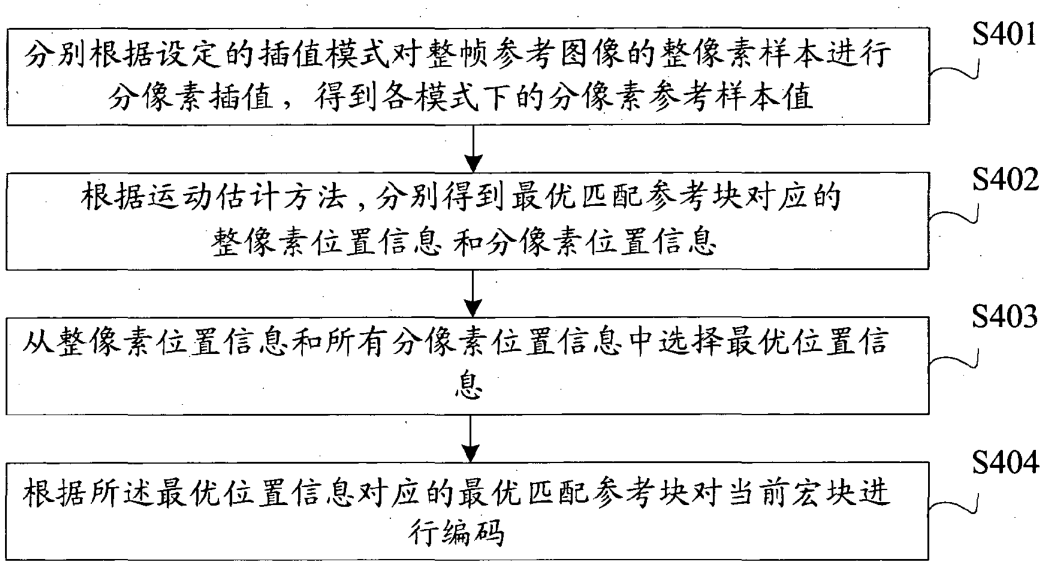

分别根据设定的插值模式对整帧参考图像的整像素样本进行分像素插值，得到各模式下的分像素参考样本值
S401
根据运动估计方法，分别得到最优匹配参考块对应的整像素位置信息和分像素位置信息
S402
从整像素位置信息和所有分像素位置信息中选择最优位置信息
S403
根据所述最优位置信息对应的最优匹配参考块对当前宏块进行编码
S404

图 4

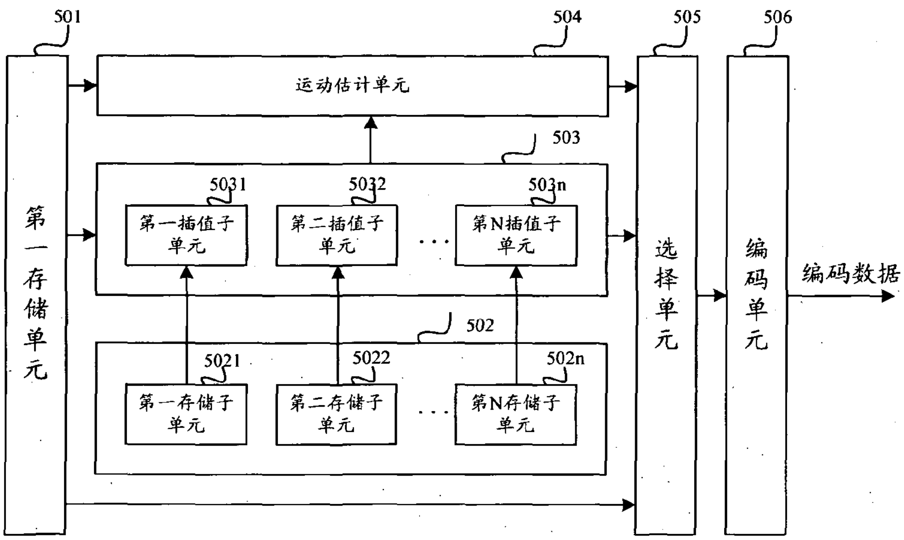

501
504
505
506
运动估计单元
503
5031
5032
503n
第一插值子单元
第二插值子单元
第N插值子单元
第一存储单元
选择单元
编码单元
编码数据
502
5021
5022
502n
第一存储子单元
第二存储子单元
第N存储子单元

图 5

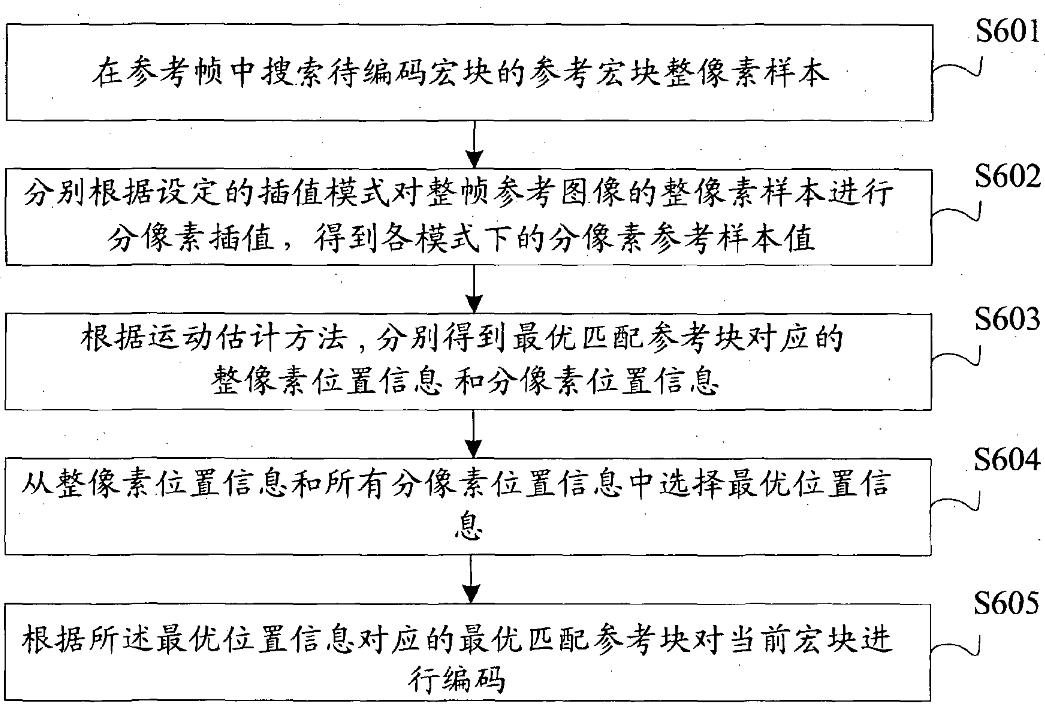

在参考帧中搜索待编码宏块的参考宏块整像素样本
S601
分别根据设定的插值模式对整帧参考图像的整像素样本进行分像素插值，得到各模式下的分像素参考样本值
S602
根据运动估计方法，分别得到最优匹配参考块对应的整像素位置信息和分像素位置信息
S603
从整像素位置信息和所有分像素位置信息中选择最优位置信息
S604
根据所述最优位置信息对应的最优匹配参考块对当前宏块进行编码
S605

图 6

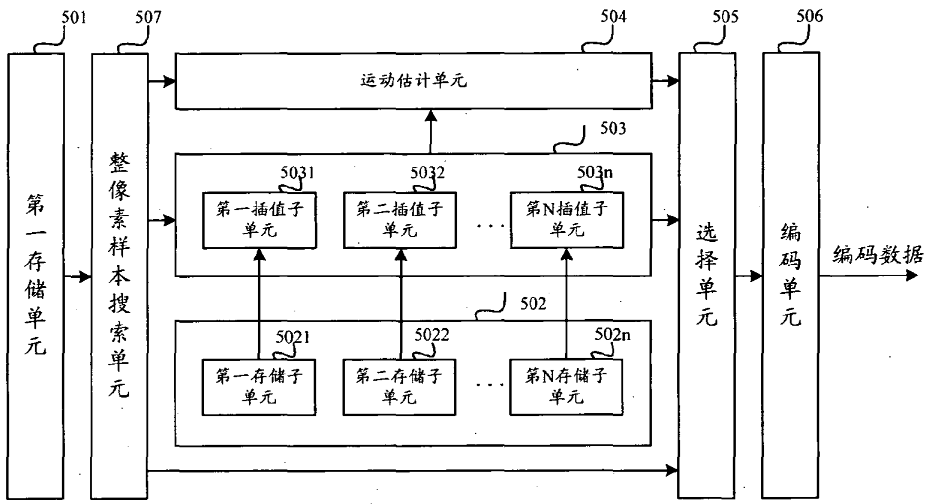

501
507
504
505
506
运动估计单元
503
5031
5032
503n
第一插值子单元
第二插值子单元
第N插值子单元
第一存储单元
整像素样本搜索单元
选择单元
编码单元
编码数据
502
5021
5022
502n
第一存储子单元
第二存储子单元
第N存储子单元

图 7

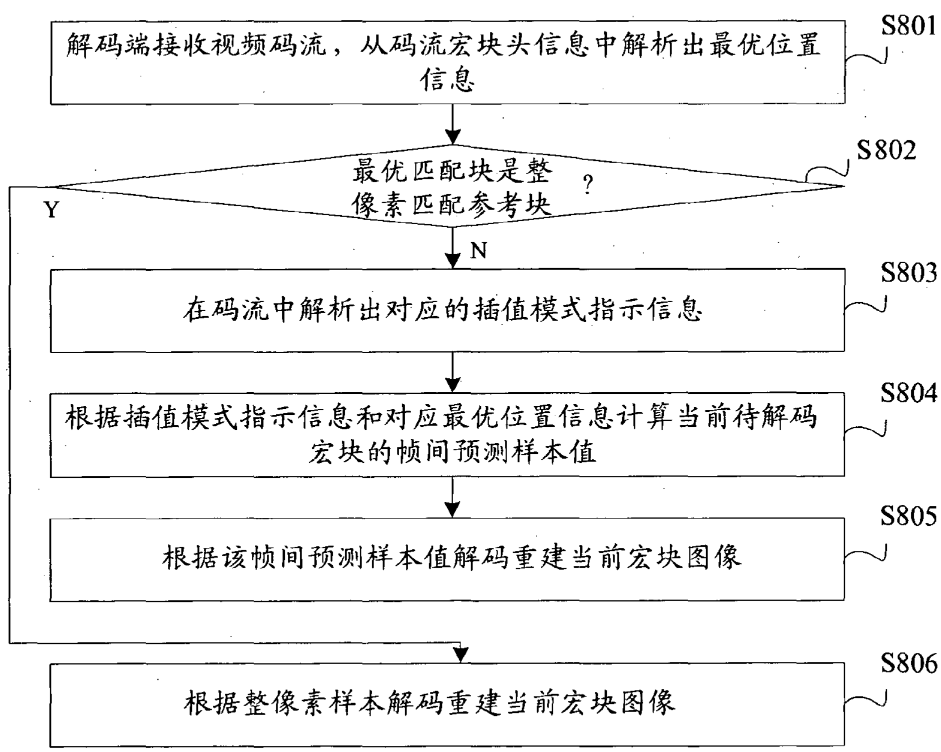

解码端接收视频码流，从码流宏块头信息中解析出最优位置信息
S801
最优匹配块是整像素匹配参考块？
S802
Y
N
在码流中解析出对应的插值模式指示信息
S803
根据插值模式指示信息和对应最优位置信息计算当前待解码宏块的帧间预测样本值
S804
根据该帧间预测样本值解码重建当前宏块图像
S805
根据整像素样本解码重建当前宏块图像
S806

图 8

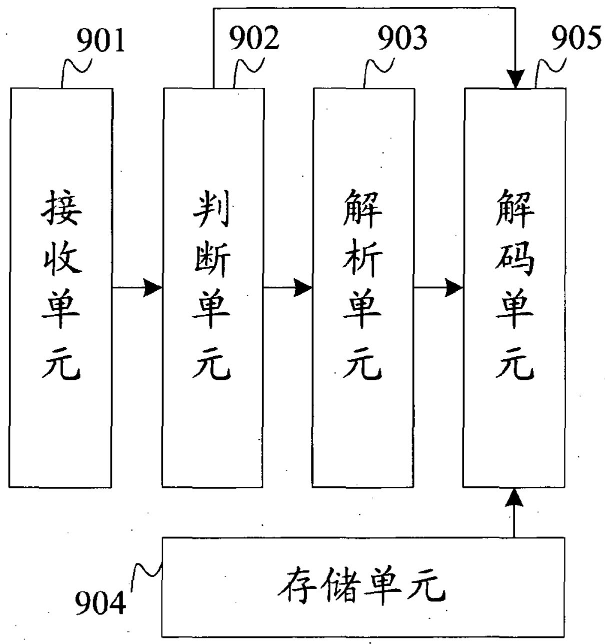

901
902
903
905
接收单元
判断单元
解析单元
解码单元
存储单元
904

图 9

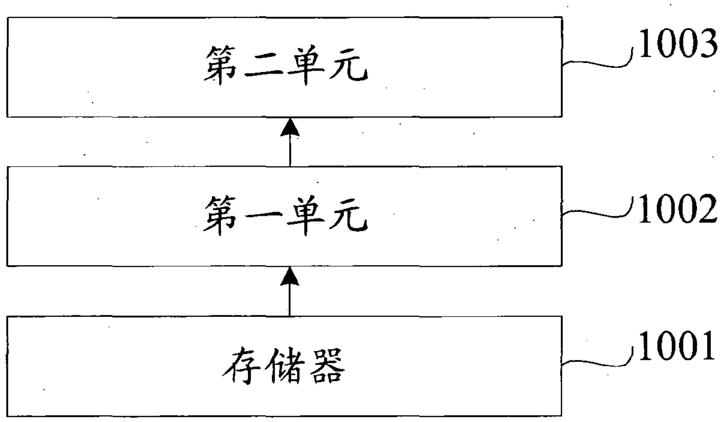

第二单元
1003
第一单元
1002
存储器
1001

图 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2007/003590

A. CLASSIFICATION OF SUBJECT MATTER

H04N7/32 (2006.01)i

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, G06F

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

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

WPI; EPODOC; PAJ; IEEE: interpolate, predict, inter, frame, code, compress, direct, match; CNKI; CNPAT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN1207634A (VICTOR CO OF JAPAN) 10 Feb. 1999 (10.02.1999) description page 4 paragraph 2	19,20
Y		1-18
Y	CN1453725A (MICROSOFT CORP) 05 Nov. 2003 (05.11.2003) description page 2 paragraph 6	1-18
A	WO2006033084A2(KONINK PHILIPS ELECTRONICS NV) 30 Mar. 2006 (30.03.2006) the whole document	1-20

☐ 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
27 Feb. 2008 (27.02.2008)	**13 Mar. 2008 (13.03.2008)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer WANG Ke Telephone No. (86-10)62411511

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2007/003590

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN1207634A	10.02.1999	EP0895424A2	03.02.1999
		JP11055678A	26.02.1999
		JP11075201A	16.03.1999
		KR19990014322A	25.02.1999
		US6157676A	05.12.2000
		KR100289899B	15.05.2001
		CN1501717A	02.06.2004
		CN1134991C	14.01.2004
		EP0895424B1	31.10.2007
		JP2900998B2	02.06.1999
		JP2900999B2	02.06.1999
		DE69838630D	13.12.2007
CN1453725A	05.11.2003	EP1353513A2	15.10.2003
		US2003194011A1	16.10.2003
		JP2003339050A	28.11.2003
		KR20030081119A	17.10.2003
		EP1353513B1	14.06.2006
		DE60306011D	27.07.2006
		DE60306011T2	05.10.2006
		US7116831B2	03.10.2006
		KR100593344B1	26.06.2006
		ES2266665T3	01.03.2007
		ES2269850T3	01.04.2007
		EP1353514A2	15.10.2003
		EP1353514B1	07.12.2005
		US2003194010A	16.10.2003
		US7116831B	03.10.2006
		US2003194009A	16.10.2003
		US7110459B	19.09.2006
		US2003202607A	30.10.2003

Form PCT/ISA/210 (patent family annex) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2007/003590

Supplemental patent family annex:

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
		EP1359763A2	05.11.2003
		EP1359768A1	05.11.2003
		CN1455349A	12.11.2003
		CN1238799C	25.01.2006
		CN1456999A	19.11.2003
		CN1456992A	19.11.2003
		CN1238798C	25.01.2006
		JP2003333599A	21.11.2003
		JP2003333604A	21.11.2003
		JP2003333603A	21.11.2003
		AT312479T	15.12.2005
		DE60302602D	12.01.2006
		ES2254811T	16.06.2006
		HK1059856A	23.06.2006
		DE60302602T	29.06.2006
		AT330430T	15.07.2006
		AT336144T	15.09.2006
		DE60307354D	21.09.2006
		HK1059857A	13.10.2006
		HK1060241A	01.12.2006
		DE60307354T	14.12.2006
		AT350860T	15.01.2007
		DE60310800D	15.02.2007
		HK1060242A	20.04.2007
		EP1359763B1	03.01.2007
		EP1359768B1	09.08.2006
WO2006033084A2	30.03.2006	EP1794715A2	13.06.2007
		KR20070068409A	29.06.2007
		CN101027691A	29.08.2007

Form PCT/ISA/210 (extra sheet) (April 2007)

国际检索报告	国际申请号 **PCT/CN2007/003590**

A. 主题的分类

H04N7/32 (2006.01)i

按照国际专利分类表(IPC)或者同时按照国家分类和 IPC 两种分类

B. 检索领域

检索的最低限度文献(标明分类系统和分类号)

IPC: H04N, G06F

包含在检索领域中的除最低限度文献以外的检索文献

在国际检索时查阅的电子数据库(数据库的名称，和使用的检索词（如使用）)

WPI; EPODOC; PAJ; IEEE: interpolate, predict, inter, frame, code, compress, direct, match

CNKI; CNPAT：插值，内插，预测，帧间，编码，压缩，方向，匹配

C. 相关文件

类 型*	引用文件，必要时，指明相关段落	相关的权利要求
X	CN1207634A（日本胜利株式会社）10.2 月 1999（10.02.1999）说明书第 4 页第 2 段	19,20
Y		1-18
Y	CN1453725A（微软公司）05.11 月 2003（05.11.2003）说明书第 2 页第 6 段	1-18
A	WO2006033084A2(KONINK PHILIPS ELECTRONICS NV)30.3 月 2006（30.03.2006）全文	1-20

☐ 其余文件在 C 栏的续页中列出。 ☒ 见同族专利附件。

* 引用文件的具体类型：

"A" 认为不特别相关的表示了现有技术一般状态的文件

"E" 在国际申请日的当天或之后公布的在先申请或专利

"L" 可能对优先权要求构成怀疑的文件，或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件

"O" 涉及口头公开、使用、展览或其他方式公开的文件

"P" 公布日先于国际申请日但迟于所要求的优先权日的文件

"T" 在申请日或优先权日之后公布，与申请不相抵触，但为了理解发明之理论或原理的在后文件

"X" 特别相关的文件，单独考虑该文件，认定要求保护的发明不是新颖的或不具有创造性

"Y" 特别相关的文件，当该文件与另一篇或者多篇该类文件结合并且这种结合对于本领域技术人员为显而易见时，要求保护的发明不具有创造性

"&" 同族专利的文件

国际检索实际完成的日期 27.2 月 2008（27.02.2008）	国际检索报告邮寄日期 **13.3 月 2008 (13.03.2008)**
中华人民共和国国家知识产权局(ISA/CN) 中国北京市海淀区蓟门桥西土城路 6 号 100088 传真号： (86-10)62019451	受权官员 王可 电话号码：(86-10) **62411511**

PCT/ISA/210 表(第 2 页) (2007 年 4 月)

检索报告中引用的专利文件	公布日期	同族专利	公布日期
CN1207634A	10.02.1999	EP0895424A2	03.02.1999
		JP11055678A	26.02.1999
		JP11075201A	16.03.1999
		KR19990014322A	25.02.1999
		US6157676A	05.12.2000
		KR100289899B	15.05.2001
		CN1501717A	02.06.2004
		CN1134991C	14.01.2004
		EP0895424B1	31.10.2007
		JP2900998B2	02.06.1999
		JP2900999B2	02.06.1999
		DE69838630D	13.12.2007
CN1453725A	05.11.2003	EP1353513A2	15.10.2003
		US2003194011A1	16.10.2003
		JP2003339050A	28.11.2003
		KR20030081119A	17.10.2003
		EP1353513B1	14.06.2006
		DE60306011D	27.07.2006
		DE60306011T2	05.10.2006
		US7116831B2	03.10.2006
		KR100593344B1	26.06.2006
		ES2266665T3	01.03.2007
		ES2269850T3	01.04.2007
		EP1353514A2	15.10.2003
		EP1353514B1	07.12.2005
		US2003194010A	16.10.2003
		US7116831B	03.10.2006
		US2003194009A	16.10.2003
		US7110459B	19.09.2006
		US2003202607A	30.10.2003
		EP1359763A2	05.11.2003
		EP1359768A1	05.11.2003
		CN1455349A	12.11.2003
		CN1238799C	25.01.2006
		CN1456999A	19.11.2003
		CN1456992A	19.11.2003
		CN1238798C	25.01.2006
		JP2003333599A	21.11.2003

续同族专利附件：

检索报告中引用的专利文件	公布日期	同族专利	公布日期
		JP2003333604A	21.11.2003
		JP2003333603A	21.11.2003
		AT312479T	15.12.2005
		DE60302602D	12.01.2006
		ES2254811T	16.06.2006
		HK1059856A	23.06.2006
		DE60302602T	29.06.2006
		AT330430T	15.07.2006
		AT336144T	15.09.2006
		DE60307354D	21.09.2006
		HK1059857A	13.10.2006
		HK1060241A	01.12.2006
		DE60307354T	14.12.2006
		AT350860T	15.01.2007
		DE60310800D	15.02.2007
		HK1060242A	20.04.2007
		EP1359763B1	03.01.2007
		EP1359768B1	09.08.2006
WO2006033084A2	30.03.2006	EP1794715A2	13.06.2007
		KR20070068409A	29.06.2007
		CN101027691A	29.08.2007

Electronic Acknowledgement Receipt	
EFS ID:	42921509
Application Number:	17328750
International Application Number:	
Confirmation Number:	8335
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Customer Number:	10949
Filer:	Guy Randall Gosnell/Kristen Mims
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/74925-US-CNT5
Receipt Date:	07-JUN-2021
Filing Date:	24-MAY-2021
Time Stamp:	21:15:31
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		560470_IDS.pdf	345836 e22783c5170d130a2a49a6438b7c14ed254baec0	yes	7

	Multipart Description/PDF files in .zip description				
	Document Description		Start		End
	Transmittal Letter		1		2
	Information Disclosure Statement (IDS) Form (SB08)		3		7
Warnings:					
Information:					
2	Foreign Reference	560470_WO2008067734A1_1.PDF	1990306 0e8f5ad2d6328239e40555e66647891259253ed6	no	38
Warnings:					
Information:					
3	Non Patent Literature	560470_Toivonen_1.PDF	1206613 a57ad243dd02bff084998318387a13c8d35b92f6	no	111
Warnings:					
Information:					
4	Non Patent Literature	560470_Alvarez_1.PDF	269017 c8ad15200ebf8bda3d8a4b61f9285008db1469c8	no	10
Warnings:					
Information:					
5	Non Patent Literature	560470_Lopez1_1.PDF	389291 8489afd80258098fbfa59842bd48ad77c8a235e5	no	7
Warnings:					
Information:					
6	Non Patent Literature	560470_Lopez2_1.PDF	322726 35be7e41fbdd836b9863000c73054de59d586b6d	no	6
Warnings:					
Information:					
7	Non Patent Literature	560470_Wang_1.PDF	622310 23e33ca6bdfab595c93e8015de9827dda2094531	no	25
Warnings:					

Information:					
8	Non Patent Literature	560470_Chen_1.PDF	770407 4bd25966b6d1a33ec57fb618315f1a22c9b23769	no	26
Warnings:					
Information:					
9	Non Patent Literature	560470_Chiu_1.PDF	626227 fb5a87e7ed6f57bcd8c114bda2bb8fbe398e8081	no	29
Warnings:					
Information:					
10	Non Patent Literature	560470_Tsung_1.PDF	327880 74a03989007d17f591a74277d77cae31ed9f04a3	no	4
Warnings:					
Information:					
11	Non Patent Literature	560470_Yang.pdf	111983 4fe47c18905e41b2403883f8d3b89141758876f8	no	4
Warnings:					
Information:					
			Total Files Size (in bytes):	6982596	

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. 042933/560470 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Ugur et al.	Confirmation No.:	8335
Appl. No.:	17/328,750	Group Art Unit:	2488
Filed:	May 24, 2021	Examiner:	To Be Assigned
For:	MOTION PREDICTION IN VIDEO CODING		

Submitted via EFS-Web
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT
CITATION UNDER 37 C.F.R. § 1.97

Attached is a list of documents on form PTO-SB08.

Copies of all listed documents (other than U.S. patents, U.S. patent application publications, or patents or publications otherwise determined cumulative) are attached, except those (if any) that were previously submitted to, or cited by, the Office during the prosecution of any application(s) upon which the present application directly relies for an earlier effective filing date under 35 U.S.C. § 120. It is noted that 37 C.F.R. § 1.98(d) establishes that copies of documents previously submitted to, or cited by, the Office during prosecution of the above application(s) are not required to be furnished; however, copies of such documents will be furnished upon request. Also attached 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.

In accordance with 37 C.F.R. § 1.98(d) the above application(s) are properly identified in the table below:

Application No.	Filing Date	Pub./Patent No.	Status
16/729,974	December 30, 2019	11,019,354	Issued
15/876,495	January 22, 2018	10,523,960	Issued
15/490,469	April 18, 2017	9,877,037	Issued
15/250,124	August 29, 2016	9,628,816	Issued
13/344,893	January 6, 2012	9,432,693	Issued

LEGAL02/40508380v1

Respectfully submitted,

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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
17/328,750	05/24/2021	Kemal Ugur	042933/74925-US-CNT5

CONFIRMATION NO. 8335

PUBLICATION NOTICE

OC000000128295053

10949
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
One South at The Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

Title:MOTION PREDICTION IN VIDEO CODING

Publication No.US-2021-0281869-A1
Publication Date:09/09/2021

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

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

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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.
17/328,750	05/24/2021	Kemal Ugur	042933/74925-US-CNT5	8335

10949 7590 11/07/2022
Nokia Corporation and Alston & Bird LLP
c/o Alston & Bird LLP
One South at The Plaza, 101 South Tryon Street
Suite 4000
Charlotte, NC 28280-4000

EXAMINER	
LE, PETER D	

ART UNIT	PAPER NUMBER
2488	

NOTIFICATION DATE	DELIVERY MODE
11/07/2022	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. 17/328,750	Applicant(s) Ugur et al.	
	Examiner PETER D LE	Art Unit 2488	AIA (FITF) 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 05/24/2021.
☐ 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) 1-36 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) 1-36 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 05/24/2021 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 06/07/2021.
3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date ______.
4) ☐ Other: ______.

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions

Claims 1-36, filed on 05/24/2021 are pending.

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

1. **Claims 1, 7, 13, 19, 25 and 31** are provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over **claim 1** of U.S Patent No. **11,019,354** (U.S Patent Application No. **16/729974**) and U.S Patent No. **10,523,960** (U.S Patent Application No. **15/876495**). Although the conflicting claims are not identical, they are not patentably distinct from each other because the instant claims are similar to the claims in the **U.S Patents** to meet the limitations claimed in the **instant application**. Table 1 shows comparison between the instant claims and the copending application claims

This is a provisional obviousness-type double patenting rejection because the conflicting claims have not in fact been patented.

Table 1: Claim Comparison: Appl. 17328750 v Appl. 16/729974 and Appl. 15/876495

Claims: Appl 17328750	**Claims: Application 16/729974 (US Pat. 11,019,354)**	**Claims: Application 15/876495 (US Pat. 10,523,960)**
1. A method for encoding a block of pixels, the method comprising: determining, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision; using said first reference block to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision; using said second reference block to obtain a second prediction, said second prediction having the second precision; obtaining a combined prediction based at least partly upon said first prediction and said second prediction; decreasing a precision of said combined prediction by shifting bits of the combined prediction to the right; and	1. A method for decoding or encoding a block of pixels, the method comprising: determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block, wherein the pixels have values with a first precision; 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; obtaining a combined prediction based at least partly upon said first prediction and said second prediction; and decreasing a precision of said combined prediction by shifting bits of the combined prediction to the right.	1. A method for decoding or encoding a block of pixels, the method comprising: for the block of pixels, determining a first reference pixel location in a first reference block and a second reference pixel location in a second reference block, wherein the pixels have values with a first precision, and wherein the first precision indicates a number of bits needed to represent the values of the pixels; 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, wherein the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction; obtaining a combined prediction based at least partly upon said first prediction and said second prediction; and decreasing a precision of said combined prediction by shifting bits of the combined prediction to the right.

encoding residual data in a bitstream, wherein the residual data is determined based upon a difference between the combined prediction and the block of pixels.		

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: 10AM-6:30PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

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/

Primary Examiner, Art Unit 2488

Search Notes	Application/Control No. 17/328,750	Applicant(s)/Patent Under Reexamination Ugur et al.
	Examiner PETER D LE	Art Unit 2488

CPC - Searched*		
Symbol	**Date**	**Examiner**
Update Search; Ref. Cases: 13344893; 15250124; 15490469; 15876495; 16729974	11/02/2022	PL

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
See Search History	11/02/2022	PL

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
	Limit To Text Search	11/02/2022	PL

Index of Claims	Application/Control No. 17/328,750	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

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	11/02/2022								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
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	31	✓								
	32	✓								
	33	✓								
	34	✓								
	35	✓								
	36	✓								

Bibliographic Data

Application No: 17/328,750

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☐ No ☐ Met After Allowance

Verified and Acknowledged: /PETER D LE/

Examiner's Signature | Initials

Title: MOTION PREDICTION IN VIDEO CODING

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
05/24/2021	375	2488	042933/74925-US-CNT5
RULE			

APPLICANTS

Nokia Technologies Oy, Espoo, FINLAND

INVENTORS

Kemal Ugur, Tampere, FINLAND

Jani Lainema, Tampere, FINLAND

Antti Hallapuro, Tampere, FINLAND

CONTINUING DATA

This application is a CON of 16729974 12/30/2019 PAT 11019354

16729974 is a CON of 15876495 01/22/2018 PAT 10523960

15876495 is a CON of 15490469 04/18/2017 PAT 9877037

15490469 is a CON of 15250124 08/29/2016 PAT 9628816

15250124 is a CON of 13344893 01/06/2012 PAT 9432693

13344893 has PRO of 61430694 01/07/2011

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

06/01/2021

STATE OR COUNTRY

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UNITED STATES

FILING FEE RECEIVED

$4,860

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L2	1	13/344893.app.	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:24 PM
L3	6190	(H04N19/42 OR H04N19/523 OR H04N19/577).CPC.	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:26 PM
L4	38055	(bit NEAR2 pixel)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:48 PM
L5	4413	(bit NEAR2 pixel) WITH (resolution)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:49 PM
L6	4897	(bit NEAR2 pixel) WITH (resolution precision)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:49 PM
L7	7265	((bit NEAR2 pixel) (bit NEAR2 depth)) WITH (resolution precision)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:35 PM
L8	160	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits)) WITH (resolution precision) WITH (predict$3))	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:37 PM
L9	8	("6512523"|"20100002770"|"20100086027"|"20090087111"|"6539058"|"20090257503"|"20080089417"|"20100086027"|"20130142262").PN.	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:48 PM
L10	1	L9 and L7	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:59 PM
L11	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	ON	2015/07/15 11:31 PM
L12	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	ON	2015/07/15 11:32 PM
L13	1	13/344893.app. AND (predict$3 WITH precision)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 11:51 PM
L14	90	(((bit NEAR2 pixel) (bit NEAR2 depth) (number	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 11:56 PM

		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)					
L15	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	ON	2015/07/16 12:44 AM
L16	716	L15 not L14	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 12:44 AM
L17	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	ON	2015/07/16 12:46 AM
L18	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	ON	2015/07/16 01:42 AM
L19	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	ON	2015/07/16 01:43 AM
L20	5180	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision))	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 01:53 AM
L21	219	(((bit NEAR2 pixel) (bit NEAR2 depth) (bit	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 01:54 AM

		NEAR2 length)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME (predict$3)						
L22	580	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME precision	(US-PGPUB; USPAT)	OR	ON	ON		2015/07/16 01:54 AM
L23	539	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) WITH precision	(US-PGPUB; USPAT)	OR	ON	ON		2015/07/16 01:55 AM
L24	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	ON		2015/07/16 02:02 AM
L25	1	"20100086027".pn.	(US-PGPUB; USPAT)	OR	ON	ON		2015/07/20 06:36 PM
L26	1	13/344893.app. and (precision)	(US-PGPUB; USPAT)	OR	ON	ON		2016/01/20 01:45 PM
L27	1	13/344893.app. and (precision WITH (predict$3 bi$2predict$3))	(US-PGPUB; USPAT)	OR	ON	ON		2016/01/20 01:55 PM
L28	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	ON		2016/01/20 03:39 PM
L29	231	(round$3 WITH (bit$2depth precision) WITH bit WITH (add$5 combin$5))	(US-PGPUB; USPAT)	OR	ON	ON		2016/04/14 11:43 AM
L34	21	("20020171737"|"20040028286"|"20040179738"|"20040212703"|"20060038826"|"20060164699"|"20080025630"|"20080266413"|"20080278607"|"20090021611"|"20110050969"|"20120075506"|"20120099001"|"4	(US-PGPUB; USPAT)	OR	ON	ON		2016/05/27 12:13 PM

		972260"|"5157732"|"5598482"|"5887084"|"5943170"|"6122314"|"6211515"|"7362911").PN.					
L35	5	("20100111182"|"20090257503"|"20100086027"|"6512523"|"6539058").PN.	(US-PGPUB; USPAT)	OR	ON	ON	2016/05/27 12:18 PM
L36	9	("6512523"|"20100002770"|"20100086027"|"20100111182"|"20090087111"|"6539058"|"20090257503"|"20080089417"|"20100086027"|"20130142262").PN.	(US-PGPUB; USPAT)	OR	ON	ON	2016/05/27 12:20 PM
L37	26	((encod$5 decod$5 cod$5) SAME (reference) SAME (fraction$5 pel interpolat$5) SAME (add$5 sum$5 combin$5) SAME (shift$5 WITH right))	(US-PGPUB; USPAT)	OR	ON	ON	2016/12/03 01:12 AM
L38	0	15/250124.app.	(US-PGPUB; USPAT)	OR	ON	ON	2016/12/03 01:14 AM
L41	1	15/490469.app.	(US-PGPUB; USPAT)	OR	ON	ON	2017/08/28 12:05 PM
L42	5	"13344893" "15250124"	(US-PGPUB; USPAT)	OR	ON	ON	2017/08/28 04:29 PM
L43	84	(predict$5 WITH interpolat$5 WITH (combin$8 add$5) WITH (shift$5 divi$8))	(US-PGPUB; USPAT)	OR	ON	ON	2017/09/04 06:37 PM
L46	7	"13344893" "15250124" "15490469" "15876495"	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 01:43 PM
L47	24	(deblock$5 de$2block$5) WITH (edge boundary) WITH (intra$2predict$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:04 PM
L48	252	(deblock$5 de$2block$5) WITH (edge boundary) WITH (intra$2predict$5 intra$2block intra$2frame intra$2picture intra)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:05 PM
L49	490	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:13 PM
L50	443	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double) WITH	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:14 PM

		(filter$5)					
L51	601	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double second) WITH (filter$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:14 PM
L52	520	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double second) WITH (filter$5) WITH (block$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:14 PM
L53	114	(deblock$5 de$2block$5) WITH (first NEAR2 (filter$5)) WITH (second NEAR2 (filter$3)) WITH (block$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:07 PM
L54	3	((deblock$5 de$2block$5) WITH (edge boundary across) WITH (filter$5) WITH (block$5)) SAME ((deblock$5 de$2block$5) WITH (edge NEAR2 (orientation$5 angle angular$5)) WITH (filter$5) WITH (block$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:19 PM
L55	24	((deblock$5 de$2block$5) WITH (edge boundary across) WITH (filter$5) WITH (block$5)) SAME ((deblock$5 de$2block$5) WITH (edge NEAR2 (orientation$5 angle angular$5 direction$5)) WITH (filter$5) WITH (block$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:20 PM
L56	1	14/336913.app.	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:48 PM
L57	550	((deblock$5 de$2block$5) WITH (orientation$5 direction$5 angle angular$3) WITH (filter$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:02 PM
L58	234	((deblock$5 de$2block$5) WITH (orientation$5 direction$5 angle angular$3) WITH	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:02 PM

		(filter$5) WITH (block))					
L59	8	((deblock$5 de$2block$5) WITH (orientation$5 angle angular$3) WITH (filter$5) WITH (block))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:10 PM
L60	4	"20050117653"	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:12 PM
L61	0	(deblock$5 de$2block$5) WITH (orientation$3 direction$3 angle angular) WITH (filter$3) WITH (cascad$3)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:34 PM
L62	67	(deblock$5 de$2block$5) WITH (orientation$3 direction$3 angle angular) WITH (filter$3) WITH (post)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:34 PM
L63	13	(deblock$5 de$2block$5) WITH (orientation$3 direction$3 angle angular) WITH (filter$3) WITH ("35" "45" "135")	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:38 PM
L64	942	(deblock$5 de$2block$5) WITH (horizontal WITH vertical)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:49 PM
L65	214	(deblock$5 de$2block$5) WITH (horizontal WITH vertical) WITH (filter$3) WITH (edge boundary) WITH block	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:49 PM
L67	7	"15876495" "13344893" "15250124" "15490469"	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 12:44 PM
L68	9	("20080089417"|"20090000871"|"20090257503"|"20100002770"|"20100086027"|"20100111182"|"20130142262"|"6512523"|"6539058").PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 02:05 PM
L69	8	L68 and (precision)	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 02:07 PM
L70	1	L68 and (precision WITH reference WITH pixel)	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 02:08 PM
L72	1	"15876495"	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/03/04 01:57 AM
L75	362	(reference SAME predict$5 SAME precision SAME (shift$5	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/08/19 11:58 AM

		divi$8) SAME (decod$5 encod$5 cod$5))					
L76	101	(reference SAME predict$5 SAME precision SAME (shift$5 divi$8) SAME (pixel) SAME (decod$5 encod$5 cod$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/08/19 12:00 PM
L79	1	16/729974.app.	(US-PGPUB; USPAT)	OR	ON	ON	2020/06/07 03:05 AM
L80	9	13/344893.app. 15/250124.app. 15/490469.app. 15/876495.app. 16/729974.app.	(US-PGPUB; USPAT)	OR	ON	ON	2021/01/06 01:42 AM
L81	0	(first WITH second WITH predict$3 WITH precission WITH decreas$5 WITH combined).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2021/01/06 02:00 AM
L82	3	(first WITH second WITH predict$3 WITH precision WITH decreas$5 WITH combined).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2021/01/06 02:01 AM
L83	5	17/328750.app. 16/729974.app. 15/876495.app.	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/01 03:08 AM
L84	10	(block SAME pixels SAME reference SAME precision SAME shift$3 SAME bit).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/02 11:57 PM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N30	26	(round$3 WITH (bit$2depth precision) WITH bit WITH (add$5 combin$5)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2016/04/14 12:01 PM
N31	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	ON	2016/04/14 12:04 PM
N32	0	(round$3 SAME (bit$2depth precision) SAME bit SAME (add$5 combin$5) SAME	(US-PGPUB; USPAT)	OR	ON	ON	2016/04/14 12:05 PM

		(high$3 low$3 second) SAME (interpolat$5)).clm.					
N33	0	(round$3 SAME (bit$2depth precision) SAME bit SAME (add$5 combin$5) SAME (interpolat$5)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2016/04/14 12:05 PM
N39	1	((encod$5 decod$5 cod$5) SAME (reference) SAME (fraction$5 pel interpolat$5) SAME (add$5 sum$5 combin$5) SAME (shift$5 WITH right)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2016/12/03 01:07 AM
N40	26	((encod$5 decod$5 cod$5) SAME (reference) SAME (fraction$5 pel interpolat$5) SAME (add$5 sum$5 combin$5) SAME (shift$5 WITH right))	(US-PGPUB; USPAT)	OR	ON	ON	2016/12/03 01:08 AM
N44	47	(predict$5 SAME interpolat$5 SAME (combin$8 add$5) SAME (shift$5 divi$8)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2017/09/04 06:31 PM
N45	84	(predict$5 WITH interpolat$5 WITH (combin$8 add$5) WITH (shift$5 divi$8))	(US-PGPUB; USPAT)	OR	ON	ON	2017/09/04 06:37 PM
N71	32	(pixel SAME precision SAME reference SAME predict$5 SAME (encod$3 decod$3)).clm.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 02:13 PM
N73	30	((decod$5 encod$5 cod$5) SAME pixel SAME (precision resolution) SAME (reference) SAME (decreas$5 decrement$5 reduc$5)).clm.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/03/04 01:00 PM
N74	18	((decod$5 encod$5 cod$5) SAME pixel SAME predict$5 SAME (precision resolution) SAME (reference) SAME (decreas$5 decrement$5 reduc$5)).clm.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/03/04 01:02 PM

N77	14	(reference SAME predict$5 SAME precision SAME (shift$5 divi$8) SAME (decod$5 encod$5 cod$5)).clm.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/08/19 11:49 AM
N78	362	(reference SAME predict$5 SAME precision SAME (shift$5 divi$8) SAME (decod$5 encod$5 cod$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/08/19 11:55 AM
N83	27	((decod$3 encod$3 cod$3) SAME (reference predict$5) SAME (precision resolution) SAME (decreas$5 decrement$5 reduc$5) SAME (shift$5 divid$3 division)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2021/01/10 12:27 AM
N84	10	(block SAME pixels SAME reference SAME precision SAME shift$3 SAME bit).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/02 11:57 PM
N85	71	(block WITH (reference (motion NEAR2 vector)) WITH shift$5 WITH bit WITH (decreas$5 lower$5 reduc$5))	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/03 12:02 AM
N86	50	(block WITH (reference (motion NEAR2 vector)) WITH shift$5 WITH bit WITH (decreas$5 lower$5 reduc$5)) SAME (encod$5 decod$5 cod$5)	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/03 12:02 AM

Substitute for form SB08 (Revised 07/09) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*	**Complete if Known**	
	Application Number	17/328,750
	Filing Date	May 24, 2021
	First Named Inventor	Ugur et al.
	Art Unit	2488
	Examiner Name	~~To Be Assigned~~ Peter Le
Sheet 1 of 5	Attorney Docket Number	042933/560470

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-2003/0202607 A1	10-30-2003	Srinivasan	
	2	US-2005/0105620 A1	05-19-2005	Fukushima	
	3	US-2005/0207496 A1	09-22-2005	Komiya et al.	
	4	US-2008/0089417 A1	04-17-2008	Bao et al.	
	5	US-2009/0087111 A1	04-02-2009	Noda et al.	
	6	US-2009/0232215 A1	09-17-2009	Park et al.	
	7	US-2009/0257499 A1	10-15-2009	Karczewicz et al.	
	8	US-2009/0257503 A1	10-15-2009	Ye et al.	
	9	US-2010/0002770 A1	01-07-2010	Motta et al.	
	10	US-2010/0086027 A1	04-08-2010	Panchal et al.	
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	12	US-2011/0032991 A1	02-10-2011	Sekiguchi et al.	
	13	US-2011/0200108 A1	08-18-2011	Joshi et al.	
	14	US-2012/0051431 A1	03-01-2012	Chien et al.	
	15	US-2012/0063515 A1	03-15-2012	Panchal et al.	
	16	US-2013/0142262 A1	06-06-2013	Ye et al.	
	17	US-2013/0182763 A1	07-18-2013	Yasuda et al.	
	18	US-6,404,815	06-11-2002	Sekiguchi et al.	
	19	US-6,512,523	01-28-2003	Gross	
	20	US-6,539,058	03-25-2003	Pearlstein et al.	
	21	US-6,950,469	09-27-2005	Karczewicz et al.	
	22	US-7,580,456	08-25-2009	Li et al.	
	23	US-8,005,137	08-23-2011	Han et al.	
	24	US-8,149,910	04-03-2012	Tanizawa et al.	
	25	US-8,284,835	10-09-2012	Iguchi	

Examiner Signature	/PETER D LE/	Date Considered	11/03/2022

*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.

Submitted June 7, 2021

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	26	US-8,428,133	04-23-2013	Ye et al.	
	27	US-8,498,336	07-30-2013	Tourapis et al.	
	28	US-8,660,174	02-25-2014	Fu et al.	
	29	US-8,676,000	03-18-2014	Alshina et al.	
	30	US-8,711,939	04-29-2014	Alshina et al.	
	31	US-8,750,378	06-10-2014	Karczewicz et al.	
	32	US-8,995,526	03-31-2015	Karczewicz et al.	
	33	US-9,014,280	04-21-2015	Ye et al.	
	34	US-9,161,057	10-13-2015	Karczewicz et al.	
	35	US-9,237,355	01-12-2016	Chien et al.	
	36	US-9,307,122	04-05-2016	Ugur et al.	
	37	US-9,432,693	08-30-2016	Ugur et al.	
	38	US-9,877,037	01-23-2018	Ugur et al.	

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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
	39	CA 2729615 A1	01-07-2010	Kabushiki Kaisha Toshiba		
	40	WO 2008/048864 A2	04-24-2008	Qualcomm Inc.		
	41	WO 2008/067734 A1	06-12-2008	Huawei Technologies Co., Ltd.		Abstract

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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
	42	"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	
	43	Alvarez, J., "Discrepancies in Documentation and Implementation of Sub-pel Interpolation in TML-8 (Draft 0)", ITU - Telecommunications Standardization Sector, Study Group 16 Question 6, Video Coding Experts Group (VCEG), 14th Meeting, Santa Barbara, CA (September 24-27, 2001), 10 pages.	
	44	Chen et al., "Bidirectional MC-EZBC with Lifting Implementation", IEEE Transactions on Circuits and Systems for Video Technology, Volume 14, Issue 10, (October 2004), 26 pages.	
	45	Chiu et al., "Description of Video Coding Technology Proposal: Self Derivation of Motion Estimation and Adaptive (Wiener) Loop Filtering", Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 1st Meeting, (April 15-23, 2010), 29 pages.	
	46	Chujoh, T. et al., “Bidirectional prediction for stored B-slice,” ITU-T SG16 contribution, VCEG-AI20, Berlin, Germany, July 2008	
	47	Extended European Search Report from corresponding European Patent Application No. 12731927.5 dated May 6, 2016	
	48	Final Office Action for U.S. Patent Application No. 13/344,893 dated January 23, 2015, 20 pages.	
	49	International Search Report and Written Opinion received for corresponding Patent Cooperation Treaty Application No. PCT/IB2012/050089 dated May 09, 2012, 14 pages	
	50	Lopez et al., "A Flexible Template for H.264/AVC Block Matching Motion Estimation Architectures" IEEE Transactions on Consumer Electronics, Vol. 54, No. 2, (May 2008), 7 pages.	
	51	Lopez et al., "A High Quality/Low Computational Cost Technique for Block Matching Motion Estimation", IEEE Computer Society, Proceedings of the Design, Automation and Test in Europe Conference and Exhibition, (March 7-11, 2005), 6 pages.	
	52	Non-Final Office Action for U.S. Patent Application No. 13/344,893 dated July 16, 2014, 24 pages.	
	53	Non-Final Office Action for U.S. Patent Application No. 13/344,893 dated July 28, 2015, 17 pages.	
	54	Notice of Allowance for U.S. Application No. 13/344,893, dated June 14, 2016, 3 pages.	
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Examiner Signature	/PETER D LE/	Date Considered	11/03/2022

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OTHER DOCUMENTS

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	56	Notice of Allowance for U.S. Application No. 15/490,469, dated September 15, 2017, 13 pages	
	57	Notice of Allowance for U.S. Application No. 15/876,495 dated August 23, 2019	
	58	Notice of Allowance for U.S. Application No. 16/729,974 dated January 25, 2021	
	59	Notice of Allowance for U.S. Patent Application No. 13/344,893 dated April 27, 2016, 20 pages.	
	60	Notice of Allowance for U.S. Patent Application No. 15/250,124 dated December 13, 2016, 13 pages.	
	61	Office Action for Chinese Patent Application No. 2012800096959 dated March 20, 2017, with English summary, 7 pages.	
	62	Office Action for European Application No. 12 731 927.5 dated November 20, 2019	
	63	Office Action for India Application No. 6227/CHENP/2013, dated April 02, 2018, 5 pages	
	64	Office Action for U.S. Application No. 15/876,495 dated March 08, 2019	
	65	Office Action from Korean Patent Application No. 2013-7020731, dated August 26, 2015	
	66	Office Action from Korean Patent Application No. 2013-7020731, dated July 31, 2014	
	67	Office Action from Russian Patent Application No. 2013136693, dated November 28, 2014	
	68	Office Action from Vietnamese Patent Application No. 1-2013-02120 dated January 23, 2017, with English Language translation, 2 pages.	
	69	Summons to Attend Oral Proceedings for European Application No. 12731927.5 dated October 12, 2020, 9 pages.	
	70	Toivonen, T., "Efficient Methods for Video Coding and Processing", University of Oulu, Acta Universitatis Ouluensis, C Technica 290, (December 2007), 111 pages.	
	71	Tsung et al., "Single-Iteration Full-Search Fractional Motion Estimation for Quad Full HD H.264/AVC Encoding", 2009 IEEE International Conference on Multimedia and Expo, (June 28-July 3, 2009), 4 pages.	
	72	UGUR et al., "High precision bi-directional averaging", Joint Collaborative Team on Video Coding (JCT.VC) of ITV-T WP3 and ISO/IEC JTC1/SC29NVG11, 4th Meeting, January 20-28, 2011, pp. 1-3	
	73	UGUR et al., "On clipping in bi-directional averaging", Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T WP3 and ISO/IEC JTC1/SC29/WG11, 5th Meeting, March 16-23, 2011, pp. 1-4	

Examiner Signature	/PETER D LE/	Date Considered	11/03/2022

*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.

Submitted June 7, 2021

LEGAL02/40683680v1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.D.L/

Substitute for form SB08 (Revised 07/09)	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*	Application Number	17/328,750
	Filing Date	May 24, 2021
	First Named Inventor	Ugur et al.
	Art Unit	2488
	Examiner Name	Peter Le ~~To Be Assigned~~
Sheet 5 of 5	Attorney Docket Number	042933/560470

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
	74	Wang et al., "Motion Estimation and Mode Decision for Low-Complexity H.264 Decoder", Tech. Rep. 210-2005-4, Columbia University DVMM Group, (2005), 25 pages.	
	75	Yang et al., "Prediction-Based Directional Fractional Pixel Motion Estimation for H.264 Video Coding", IEEE International Conference on Acoustics, Speech, and Signal Processing, (March 23, 2005), 4 pages.	
	76	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	
	77	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	11/03/2022

*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.

Submitted June 7, 2021

LEGAL02/40683680v1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.D.L/

Substitute for form SB08 (Revised 07/09) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*	**Complete if Known**	
	Application Number	17/328,750
	Filing Date	May 24, 2021
	First Named Inventor	Ugur et al.
	Art Unit	2488
	Examiner Name	Peter D. Le
Sheet 1 of 1	Attorney Docket Number	042933/560470

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

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

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	Extended European Search Report for European Application No. 22173168.0 dated October 26, 2022, 11 pages.	

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.

Submitted January 26, 2023

LEGAL02/42516954v1

Electronic Acknowledgement Receipt

EFS ID:	47435509
Application Number:	17328750
International Application Number:	
Confirmation Number:	8335
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Customer Number:	10949
Filer:	Guy Randall Gosnell/Kristen Mims
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/560470
Receipt Date:	26-JAN-2023
Filing Date:	24-MAY-2021
Time Stamp:	17:27:37
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		560470_IDS.pdf	271036 7ed12b712b89f12705d6202f6d2123c607aee080	yes	3

	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Form (SB08)		3	3	
Warnings:					
Information:					
2	Other reference-Patent/Application/ Search Documents	560470_EESR.PDF	363925 233e265884a6f3cb63f3dd49b8ead84899dd0da9	no	11
Warnings:					
Information:					
			Total Files Size (in bytes):	634961	

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. 042933/560470 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Ugur et al.	Confirmation No.:	8335
Appl. No.:	17/328,750	Group Art Unit:	2488
Filed:	May 24, 2021	Examiner:	Peter D. Le
For:	MOTION PREDICTION IN VIDEO CODING		

Submitted via EFS-Web
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. § 1.97(c)

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.

Attached is a list of documents on form PTO-SB08.

Copies of all listed documents (other than U.S. patents, U.S. patent application publications, or patents or publications otherwise determined cumulative) are attached, except those (if any) that were previously submitted to, or cited by, the Office during the prosecution of any application(s) upon which the present application directly relies for an earlier effective filing date under 35 U.S.C. § 120. It is noted that 37 C.F.R. § 1.98(d) establishes that copies of documents previously submitted to, or cited by, the Office during prosecution of the above application(s) are not required to be furnished; however, copies of such documents will be furnished upon request.

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.

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 Information Disclosure 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 Information Disclosure Statement.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610

CUSTOMER NO. 10949
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 17/328,750	Filing Date 05/24/2021	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		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 $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $480 =	
☐ 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

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	05/08/2023	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 36	Minus	** 36	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 6	Minus	*** 6	= 0		x $480 =	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

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ 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.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/ROCHELLE C. GETER/
*** 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.	

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.

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	17328750
Filing Date	24-May-2021
First Named Inventor	Kemal Ugur
Attorney Docket Number	042933/560470
Title of Invention	MOTION PREDICTION IN VIDEO CODING

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
NOKIA TECHNOLOGIES OY	100%

The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

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11019354

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

- [x] Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.
- [ ] I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.

Applicant claims the following fee status:

- [ ] Small Entity
- [ ] Micro Entity
- [x] Regular Undiscounted

I hereby declare that all statements made herein of my own knowledge are true and that all statements made 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 so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

- [x] An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

  Registration Number 34610

- [ ] A sole inventor
- [ ] A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application
- [ ] A joint inventor; all of whom are signing this request

Signature	/Guy R. Gosnell/
Name	Guy R. Gosnell

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	17328750
Filing Date:	24-May-2021
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Filer:	Guy Randall Gosnell/Torrey Wyatt
Attorney Docket Number:	042933/560470

Filed as Large Entity

Filing Fees for **Utility under 35 USC 111(a)**

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	1814	1	170	170
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**170**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 17328750

Filing Date: 24-May-2021

Applicant/Patent under Reexamination: Ugur

Electronic Terminal Disclaimer filed on May 8, 2023

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt

EFS ID:	47964393
Application Number:	17328750
International Application Number:	
Confirmation Number:	8335
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Customer Number:	10949
Filer:	Guy Randall Gosnell/Torrey Wyatt
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/560470
Receipt Date:	08-MAY-2023
Filing Date:	24-MAY-2021
Time Stamp:	16:20:44
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$170
RAM confirmation Number	E202358G20437102
Deposit Account	
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	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	41211 2eaa3b883df9e949e53286276a14fd98040 40e47	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	37865 2832fc2e6161322cc6dc5db9e099e729f84c f6ea	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	79076	

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.:	17/328,750	Confirmation No.: 8335
Inventor(s):	Kemal Ugur et al.	
Filed:	May 24, 2021	
Art Unit:	2488	
Examiner:	PETER D LE	
Title:	MOTION PREDICTION IN VIDEO CODING	

Docket No.:	042933/560470
Customer No.:	10949

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT

In response to the Non-Final Office Action, please amend the above-identified application as follows:

Amendments to the Claims are presented in the listing of claims beginning on page 2 of this paper.

Remarks begin on page 11 of this paper.

Amendments to the Claims:

1. (Original) A method for encoding a block of pixels, the method comprising:

determining, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

using said second reference block to obtain a second prediction, said second prediction having the second precision;

obtaining a combined prediction based at least partly upon said first prediction and said second prediction;

decreasing a precision of said combined prediction by shifting bits of the combined prediction to the right; and

encoding residual data in a bitstream, wherein the residual data is determined based upon a difference between the combined prediction and the block of pixels.

2. (Original) The method according to claim 1, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

3. (Original) The method according to claim 2, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

4. (Original) The method according to claim 2, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

5. (Original) The method according to claim 1, wherein said decreasing said precision of said combined prediction by shifting bits of the combined prediction to the right, further comprises:

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

6. (Original) The method according to claim 1, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

7. (Currently Amended) An apparatus for encoding a block of pixels, the 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 at least one processor, cause the apparatus to:

determine, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

use said second reference block to obtain a second prediction, said second prediction having the second precision;

obtain a combined prediction based at least partly upon said first prediction and said second prediction;

decrease a precision of said combined prediction by shifting bits of the combined prediction to the right; and

encode residual data in a bitstream, wherein the residual data is determined based upon a difference between the combined prediction and the block of pixels.

8. (Original) The apparatus according to claim 7, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

9. (Original) The apparatus according to claim 8, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

10. (Original) The apparatus according to claim 8, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

11. (Original) The apparatus according to claim 7, wherein the at least one memory and computer code are configured to cause the apparatus to decrease said precision of said combined prediction by shifting bits of the combined prediction to the right, by:

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

12. (Original) The apparatus according to claim 7, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

13. (Original) A computer program product for encoding a block of pixels, the 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, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

use said second reference block to obtain a second prediction, said second prediction having the second precision;

obtain a combined prediction based at least partly upon said first prediction and said second prediction;

decrease a precision of said combined prediction by shifting bits of the combined prediction to the right; and

encode residual data in a bitstream, wherein the residual data is determined based upon a difference between the combined prediction and the block of pixels.

14. (Original) The computer program product according to claim 13, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

15. (Original) The computer program product according to claim 14, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

16. (Original) The computer program product according to claim 14, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

17. (Original) The computer program product according to claim 13, wherein the program code instructions configured to decrease said precision of said combined prediction by shifting bits of the combined prediction to the right, further comprise program code instructions configured to:

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

18. (Original) The computer program product according to claim 13, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

19. (Original) A method for decoding a block of pixels, the method comprising:

determining, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

using said second reference block to obtain a second prediction, said second prediction having the second precision;

obtaining a combined prediction based at least partly upon said first prediction and said second prediction;

decreasing a precision of said combined prediction by shifting bits of the combined prediction to the right; and

reconstructing the block of pixels based on the combined prediction.

20. (Original) The method according to claim 19, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

21. (Original) The method according to claim 20, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

22. (Original) The method according to claim 20, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

23. (Original) The method according to claim 19, wherein said decreasing said precision of said combined prediction by shifting bits of the combined prediction to the right, further comprises:

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

24. (Original) The method according to claim 19, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

25. (Currently Amended) An apparatus for decoding a block of pixels, the 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 <u>at least one</u> processor, cause the apparatus to:

determine, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

use said second reference block to obtain a second prediction, said second prediction having the second precision;

obtain a combined prediction based at least partly upon said first prediction and said second prediction;

decrease a precision of said combined prediction by shifting bits of the combined prediction to the right; and

reconstruct the block of pixels based on the combined prediction.

26. (Original) The apparatus according to claim 25, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

27. (Original) The apparatus according to claim 26, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

28. (Original) The apparatus according to claim 26, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

29. (Original) The apparatus according to claim 25, wherein the at least one memory and computer code are configured to cause the apparatus to decrease said precision of said combined prediction by shifting bits of the combined prediction to the right, by:

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

30. (Original) The apparatus according to claim 25, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

31. (Original) A computer program product for decoding a block of pixels, the 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, for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, and the second reference block have values with a first precision;

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

use said second reference block to obtain a second prediction, said second prediction having the second precision;

obtain a combined prediction based at least partly upon said first prediction and said second prediction;

decrease a precision of said combined prediction by shifting bits of the combined prediction to the right; and

reconstruct the block of pixels based on the combined prediction.

32. (Original) The computer program product according to claim 31, wherein in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.

33. (Original) The computer program product according to claim 32, wherein said first prediction is obtained by interpolation using values of said first reference block by:

right shifting a sum of a P-tap filter using values of said first reference block.

34. (Original) The computer program product according to claim 32, wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.

35. (Original) The computer program product according to claim 31, wherein the program code instructions configured to decrease said precision of said combined prediction by

shifting bits of the combined prediction to the right, further comprise program code instructions configured to:

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

36. (Original) The computer program product according to claim 31, wherein the first precision indicates a number of bits needed to represent the values of the pixels, and the second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.

REMARKS

Claims 1, 7, 13, 19, 25 and 31 were provisionally rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claim 1 of U.S Patent No. 11,019,354 (U.S Patent Application No. 16/729974) and U.S Patent No. 10,523,960 (U.S Patent Application No. 15/876495). Without comment as to the propriety of the rejection but in an effort to expedite examination of the present application, a Terminal Disclaimer is filed concurrent herewith relative to U.S. Patent Nos. 11,019, 354 and 10,523,960. As noted by the Official Action, a Terminal Disclaimer may be utilized to overcome a nonstatutory obviousness-type double patenting rejection such that the provisional rejection of Claims 1, 7, 13, 19, 25 and 31 is overcome. Claims 7 and 25 have also been amended to improve their clarity.

In view of the submission of the Terminal Disclaimer, it is respectfully submitted that the claims of the present application are in condition for allowance. It is respectfully requested that a Notice of Allowance be issued in due course. The Examiner is requested to contact Applicants' undersigned representative 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,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610

Customer No. 10949
ALSTON & BIRD LLP

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Tel Charlotte Office (704) 444-1000
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ELECTRONICALLY FILED USING THE EFS-WEB ELECTRONIC FILING SYSTEM OF THE UNITED STATES PATENT & TRADEMARK OFFICE ON May 8, 2023.

PTO/AIA/22 (10-20)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)

Docket Number (Optional): 042933/560470

Application Number: 17/328,750
Filed: May 24, 2021

For: MOTION PREDICTION IN VIDEO CODING

Art Unit: 2488
Examiner: PETER D LE

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	Micro Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$220	$110	$55	$
☐ Two months (37 CFR 1.17(a)(2))	$640	$320	$160	$
☑ Three months (37 CFR 1.17(a)(3))	$1,480	$740	$370	$ 1,480
☐ Four months (37 CFR 1.17(a)(4))	$2,320	$1,160	$580	$
☐ Five months (37 CFR 1.17(a)(5))	$3,160	$1,580	$790	$

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 16-0605.

☑ Payment made via EFS-Web.

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.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 34,610.

☐ attorney or agent acting under 37 CFR 1.34. Registration number ______.

/Guy R. Gosnell/
Signature

May 8, 2023
Date

Guy R. Gosnell
Typed or printed name

(704) 444-1000
Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of ______ forms are submitted.

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.

Electronic Patent Application Fee Transmittal

Application Number:	17328750
Filing Date:	24-May-2021
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Filer:	Guy Randall Gosnell/Torrey Wyatt
Attorney Docket Number:	042933/560470

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 $0 paid	1253	1	1480	1480
Miscellaneous:				
		Total in USD ($)		**1480**

Electronic Acknowledgement Receipt

EFS ID:	47965765
Application Number:	17328750
International Application Number:	
Confirmation Number:	8335
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Customer Number:	10949
Filer:	Guy Randall Gosnell/Torrey Wyatt
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/560470
Receipt Date:	08-MAY-2023
Filing Date:	24-MAY-2021
Time Stamp:	16:22:55
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1480
RAM confirmation Number	E202358G23187140
Deposit Account	
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		560470_Response_to_OA_dtd_11-07-2022.pdf	157215 5382c00aa0ea2c0f3fa0ef0449db7473d8efb4d0	yes	12

Multipart Description/PDF files in .zip description

Document Description	Start	End
Amendment/Request for Reconsideration-After Non-Final Rejection	1	1
Claims	2	10
Applicant Arguments/Remarks Made in an Amendment	11	12

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Extension of Time	560470_EOT_1.pdf	1346030 18b1b153364941a124d614952bc5aaa858d5ad5e	no	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	38316 bf406c653c7c5e31f5795a74f43e00bc7813aeca	no	2

Warnings:

Information:

Total Files Size (in bytes):	1541561

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.

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 05/23/2023

Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street
Suite 300
Charlotte, NC 28203-6818

EXAMINER	
LE, PETER D	
ART UNIT	**PAPER NUMBER**
2488	

DATE MAILED: 05/23/2023

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/328,750	05/24/2021	Kemal Ugur	042933/560470	8335

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	$1200	$0.00	$0.00	$1200	08/23/2023

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 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted 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. 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: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (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 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. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

10949 7590 05/23/2023

Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street
Suite 300
Charlotte, NC 28203-6818

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/328,750	05/24/2021	Kemal Ugur	042933/560470	8335

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	$1200	$0.00	$0.00	$1200	08/23/2023

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/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or 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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). 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. Fees submitted: ❑Issue Fee ❑Publication Fee (if required)

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via Patent Center or EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. __________

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. ____________________

PTOL-85 Part B (08-18) Approved for use through 01/31/2020 OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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.
17/328,750	05/24/2021	Kemal Ugur	042933/560470	8335

10949 7590 05/23/2023

Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street
Suite 300
Charlotte, NC 28203-6818

EXAMINER	
LE, PETER D	
ART UNIT	**PAPER NUMBER**
2488	

DATE MAILED: 05/23/2023

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 30 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.

Notice of Allowability	**Application No.** 17/328,750	**Applicant(s)** Ugur et al.	
	Examiner PETER D LE	**Art Unit** 2488	**AIA (FITF) 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 05/08/2023.
   ☐ 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 1-36 . 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 01/26/2023.
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/
Primary Examiner, Art Unit 2488

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions

The response filed on 05/08/2023 has been entered and made of record.

Claims 1-36 are pending.

Terminal Disclaimer

The terminal disclaimer filed on 05/08/2023 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of U.S Patent Application No. 15/876495 (which is now U.S Patent 10523960) and U.S Patent Application No. 16/729974 (which is now U.S Patent 11,019,354) has been reviewed and is accepted. The terminal disclaimer has been recorded.

REASON FOR ALLOWANCE

[1] The invention is related to a method/apparatus for decoding and encoding a block of pixels. The claims comprise claim limitations set forth similar to the claim limitations of the parent cases which are now U.S Patents 10,523,960 and 11,019,354.

[1] 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.”

[2] **Claims 1-36** 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: 10AM-6:30PM.

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/

Primary Examiner, Art Unit 2488

Search Notes	Application/Control No. 17/328,750	Applicant(s)/Patent Under Reexamination Ugur et al.
	Examiner PETER D LE	**Art Unit** 2488

CPC - Searched*		
Symbol	**Date**	**Examiner**
Update Search; Ref. Cases: 13344893; 15250124; 15490469; 15876495; 16729974	11/02/2022	PL
Update Search	05/14/2023	PL

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
See Search History	11/02/2022	PL
See Search History	05/14/2023	PL

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
	Limit To Text Search	11/02/2022	PL
	Limit To Text Search	05/14/2023	PL

Index of Claims	Application/Control No. 17/328,750	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

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	11/02/2022	05/14/2023							
	1	✓	=							
	2	✓	=							
	3	✓	=							
	4	✓	=							
	5	✓	=							
	6	✓	=							
	7	✓	=							
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	9	✓	=							
	10	✓	=							
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	27	✓	=							
	28	✓	=							
	29	✓	=							
	30	✓	=							
	31	✓	=							
	32	✓	=							
	33	✓	=							
	34	✓	=							
	35	✓	=							
	36	✓	=							

Issue Classification	Application/Control No. 17/328,750	Applicant(s)/Patent Under Reexamination Ugur et al.
	Examiner PETER D LE	Art Unit 2488

CPC						
Symbol					Type	Version
H04N	/	19	/	50	F	2014-11-01
H04N	/	19	/	42	I	2014-11-01
H04N	/	19	/	523	I	2014-11-01
H04N	/	19	/	577	I	2014-11-01
H04N	/	19	/	105	I	2014-11-01
H04N	/	19	/	176	A	2014-11-01
H04N	/	19	/	182	A	2014-11-01
H04N	/	19	/	184	A	2014-11-01

CPC Combination Sets								
Symbol					Type	Set	Ranking	Version
	/		/					

NONE (Assistant Examiner) (Date)	Total Claims Allowed: 36	
/PETER D LE/ Primary Examiner, Art Unit 2488 14 May 2023 (Primary Examiner) (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 10

U.S. Patent and Trademark Office Part of Paper No.: 20230514

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/328,750	Ugur et al.
	Examiner	**Art Unit**
	PETER D LE	2488

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04N	/	19	/	50
NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 36	
/PETER D LE/ Primary Examiner, Art Unit 2488 (Primary Examiner)	14 May 2023 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 10

Issue Classification	**Application/Control No.** 17/328,750	**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

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10		19		28								
	2		11		20		29								
	3		12		21		30								
	4		13		22		31								
	5		14		23		32								
	6		15		24		33								
	7		16		25		34								
	8		17		26		35								
	9		18		27		36								

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 36	
/PETER D LE/ Primary Examiner, Art Unit 2488 (Primary Examiner)	14 May 2023 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 10

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L2	1	13/344893.app.	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:24 PM
L3	6190	(H04N19/42 OR H04N19/523 OR H04N19/577).CPC.	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:26 PM
L4	38055	(bit NEAR2 pixel)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:48 PM
L5	4413	(bit NEAR2 pixel) WITH (resolution)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:49 PM
L6	4897	(bit NEAR2 pixel) WITH (resolution precision)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:49 PM
L7	7265	((bit NEAR2 pixel) (bit NEAR2 depth)) WITH (resolution precision)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:35 PM
L8	160	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits)) WITH (resolution precision) WITH (predict$3))	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:37 PM
L9	8	("6512523"|"20100002770"|"20100086027"|"20090087111"|"6539058"|"20090257503"|"20080089417"|"20100086027"|"20130142262").PN.	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:48 PM
L10	1	L9 and L7	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:59 PM
L11	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	ON	2015/07/15 11:31 PM
L12	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	ON	2015/07/15 11:32 PM
L13	1	13/344893.app. AND (predict$3 WITH precision)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 11:51 PM
L14	90	(((bit NEAR2 pixel) (bit NEAR2 depth) (number	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 11:56 PM

		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)					
L15	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	ON	2015/07/16 12:44 AM
L16	716	L15 not L14	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 12:44 AM
L17	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	ON	2015/07/16 12:46 AM
L18	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	ON	2015/07/16 01:42 AM
L19	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	ON	2015/07/16 01:43 AM
L20	5180	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision))	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 01:53 AM
L21	219	(((bit NEAR2 pixel) (bit NEAR2 depth) (bit	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 01:54 AM

		NEAR2 length)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME (predict$3)						
L22	580	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME precision	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 01:54 AM	
L23	539	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) WITH precision	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 01:55 AM	
L24	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	ON	2015/07/16 02:02 AM	
L25	1	"20100086027".pn.	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/20 06:36 PM	
L26	1	13/344893.app. and (precision)	(US-PGPUB; USPAT)	OR	ON	ON	2016/01/20 01:45 PM	
L27	1	13/344893.app. and (precision WITH (predict$3 bi$2predict$3))	(US-PGPUB; USPAT)	OR	ON	ON	2016/01/20 01:55 PM	
L28	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	ON	2016/01/20 03:39 PM	
L29	231	(round$3 WITH (bit$2depth precision) WITH bit WITH (add$5 combin$5))	(US-PGPUB; USPAT)	OR	ON	ON	2016/04/14 11:43 AM	
L34	21	("20020171737"|"20040028286"|"20040179738"|"20040212703"|"20060038826"|"20060164699"|"20080025630"|"20080266413"|"20080278607"|"20090021611"|"20110050969"|"20120075506"|"20120099001"|"4	(US-PGPUB; USPAT)	OR	ON	ON	2016/05/27 12:13 PM	

		972260"|"5157732"|"5598482"|"5887084"|"5943170"|"6122314"|"6211515"|"7362911").PN.					
L35	5	("20100111182"|"20090257503"|"20100086027"|"6512523"|"6539058").PN.	(US-PGPUB; USPAT)	OR	ON	ON	2016/05/27 12:18 PM
L36	9	("6512523"|"20100002770"|"20100086027"|"20100111182"|"20090087111"|"6539058"|"20090257503"|"20080089417"|"20100086027"|"20130142262").PN.	(US-PGPUB; USPAT)	OR	ON	ON	2016/05/27 12:20 PM
L37	26	((encod$5 decod$5 cod$5) SAME (reference) SAME (fraction$5 pel interpolat$5) SAME (add$5 sum$5 combin$5) SAME (shift$5 WITH right))	(US-PGPUB; USPAT)	OR	ON	ON	2016/12/03 01:12 AM
L38	0	15/250124.app.	(US-PGPUB; USPAT)	OR	ON	ON	2016/12/03 01:14 AM
L41	1	15/490469.app.	(US-PGPUB; USPAT)	OR	ON	ON	2017/08/28 12:05 PM
L42	5	"13344893" "15250124"	(US-PGPUB; USPAT)	OR	ON	ON	2017/08/28 04:29 PM
L43	84	(predict$5 WITH interpolat$5 WITH (combin$8 add$5) WITH (shift$5 divi$8))	(US-PGPUB; USPAT)	OR	ON	ON	2017/09/04 06:37 PM
L46	7	"13344893" "15250124" "15490469" "15876495"	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 01:43 PM
L47	24	(deblock$5 de$2block$5) WITH (edge boundary) WITH (intra$2predict$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:04 PM
L48	252	(deblock$5 de$2block$5) WITH (edge boundary) WITH (intra$2predict$5 intra$2block intra$2frame intra$2picture intra)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:05 PM
L49	490	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:13 PM
L50	443	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double) WITH	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:14 PM

		(filter$5)					
L51	601	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double second) WITH (filter$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:14 PM
L52	520	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double second) WITH (filter$5) WITH (block$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:14 PM
L53	114	(deblock$5 de$2block$5) WITH (first NEAR2 (filter$5)) WITH (second NEAR2 (filter$3)) WITH (block$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:07 PM
L54	3	((deblock$5 de$2block$5) WITH (edge boundary across) WITH (filter$5) WITH (block$5)) SAME ((deblock$5 de$2block$5) WITH (edge NEAR2 (orientation$5 angle angular$5)) WITH (filter$5) WITH (block$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:19 PM
L55	24	((deblock$5 de$2block$5) WITH (edge boundary across) WITH (filter$5) WITH (block$5)) SAME ((deblock$5 de$2block$5) WITH (edge NEAR2 (orientation$5 angle angular$5 direction$5)) WITH (filter$5) WITH (block$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:20 PM
L56	1	14/336913.app.	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:48 PM
L57	550	((deblock$5 de$2block$5) WITH (orientation$5 direction$5 angle angular$3) WITH (filter$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:02 PM
L58	234	((deblock$5 de$2block$5) WITH (orientation$5 direction$5 angle angular$3) WITH	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:02 PM

		(filter$5) WITH (block))						
L59	8	((deblock$5 de$2block$5) WITH (orientation$5 angle angular$3) WITH (filter$5) WITH (block))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:10 PM
L60	4	"20050117653"	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:12 PM
L61	0	(deblock$5 de$2block$5) WITH (orientation$3 direction$3 angle angular) WITH (filter$3) WITH (cascad$3)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:34 PM
L62	67	(deblock$5 de$2block$5) WITH (orientation$3 direction$3 angle angular) WITH (filter$3) WITH (post)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:34 PM
L63	13	(deblock$5 de$2block$5) WITH (orientation$3 direction$3 angle angular) WITH (filter$3) WITH ("35" "45" "135")	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:38 PM
L64	942	(deblock$5 de$2block$5) WITH (horizontal WITH vertical)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:49 PM
L65	214	(deblock$5 de$2block$5) WITH (horizontal WITH vertical) WITH (filter$3) WITH (edge boundary) WITH block	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:49 PM
L67	7	"15876495" "13344893" "15250124" "15490469"	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 12:44 PM
L68	9	("20080089417"|"20090000871"|"20090257503"|"20100002770"|"20100086027"|"20100111182"|"20130142262"|"6512523"|"6539058").PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 02:05 PM
L69	8	L68 and (precision)	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 02:07 PM
L70	1	L68 and (precision WITH reference WITH pixel)	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 02:08 PM
L72	1	"15876495"	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/03/04 01:57 AM
L75	362	(reference SAME predict$5 SAME precision SAME (shift$5	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/08/19 11:58 AM

		divi$8) SAME (decod$5 encod$5 cod$5))					
L76	101	(reference SAME predict$5 SAME precision SAME (shift$5 divi$8) SAME (pixel) SAME (decod$5 encod$5 cod$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/08/19 12:00 PM
L79	1	16/729974.app.	(US-PGPUB; USPAT)	OR	ON	ON	2020/06/07 03:05 AM
L80	9	13/344893.app. 15/250124.app. 15/490469.app. 15/876495.app. 16/729974.app.	(US-PGPUB; USPAT)	OR	ON	ON	2021/01/06 01:42 AM
L81	0	(first WITH second WITH predict$3 WITH precission WITH decreas$5 WITH combined).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2021/01/06 02:00 AM
L82	3	(first WITH second WITH predict$3 WITH precision WITH decreas$5 WITH combined).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2021/01/06 02:01 AM
L83	5	17/328750.app. 16/729974.app. 15/876495.app.	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/01 03:08 AM
L84	10	(block SAME pixels SAME reference SAME precision SAME shift$3 SAME bit).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/02 11:57 PM
L85	11	13/344893.app. 15/250124.app. 15/490469.app. 15/876495.app. 16/729974.app. 17/328750.app.	(US-PGPUB; USPAT)	OR	ON	ON	2023/05/14 04:41 PM
L86	27	(reference SAME block SAME motion SAME vector SAME (precision resolution) SAME (combin$5 add$5) SAME (predict$5) SAME (residual difference)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/05/14 05:05 PM

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N30	26	(round$3 WITH (bit$2depth precision) WITH bit WITH (add$5	(US-PGPUB; USPAT)	OR	ON	ON	2016/04/14 12:01 PM

		combin$5)).clm.					
N31	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	ON	2016/04/14 12:04 PM
N32	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	ON	2016/04/14 12:05 PM
N33	0	(round$3 SAME (bit$2depth precision) SAME bit SAME (add$5 combin$5) SAME (interpolat$5)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2016/04/14 12:05 PM
N39	1	((encod$5 decod$5 cod$5) SAME (reference) SAME (fraction$5 pel interpolat$5) SAME (add$5 sum$5 combin$5) SAME (shift$5 WITH right)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2016/12/03 01:07 AM
N40	26	((encod$5 decod$5 cod$5) SAME (reference) SAME (fraction$5 pel interpolat$5) SAME (add$5 sum$5 combin$5) SAME (shift$5 WITH right))	(US-PGPUB; USPAT)	OR	ON	ON	2016/12/03 01:08 AM
N44	47	(predict$5 SAME interpolat$5 SAME (combin$8 add$5) SAME (shift$5 divi$8)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2017/09/04 06:31 PM
N45	84	(predict$5 WITH interpolat$5 WITH (combin$8 add$5) WITH (shift$5 divi$8))	(US-PGPUB; USPAT)	OR	ON	ON	2017/09/04 06:37 PM
N71	32	(pixel SAME precision SAME reference SAME predict$5 SAME (encod$3 decod$3)).clm.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 02:13 PM
N73	30	((decod$5 encod$5 cod$5) SAME pixel	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/03/04 01:00 PM

		SAME (precision resolution) SAME (reference) SAME (decreas$5 decrement$5 reduc$5)).clm.					
N74	18	((decod$5 encod$5 cod$5) SAME pixel SAME predict$5 SAME (precision resolution) SAME (reference) SAME (decreas$5 decrement$5 reduc$5)).clm.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/03/04 01:02 PM
N77	14	(reference SAME predict$5 SAME precision SAME (shift$5 divi$8) SAME (decod$5 encod$5 cod$5)).clm.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/08/19 11:49 AM
N78	362	(reference SAME predict$5 SAME precision SAME (shift$5 divi$8) SAME (decod$5 encod$5 cod$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/08/19 11:55 AM
N83	27	((decod$3 encod$3 cod$3) SAME (reference predict$5) SAME (precision resolution) SAME (decreas$5 decrement$5 reduc$5) SAME (shift$5 divid$3 division)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2021/01/10 12:27 AM
N84	10	(block SAME pixels SAME reference SAME precision SAME shift$3 SAME bit).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/02 11:57 PM
N85	71	(block WITH (reference (motion NEAR2 vector)) WITH shift$5 WITH bit WITH (decreas$5 lower$5 reduc$5))	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/03 12:02 AM
N86	50	(block WITH (reference (motion NEAR2 vector)) WITH shift$5 WITH bit WITH (decreas$5 lower$5 reduc$5)) SAME (encod$5 decod$5 cod$5)	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/03 12:02 AM
N87	27	(reference SAME block SAME motion SAME vector SAME (precision resolution) SAME (combin$5 add$5) SAME (predict$5)	(US-PGPUB; USPAT)	OR	ON	ON	2023/05/14 05:06 PM

		SAME (residual difference)).clm.					
N88	4	(reference SAME block SAME motion SAME vector SAME (precision resolution) SAME (combin$5 add$5) SAME (predict$5) SAME (residual difference) SAME (shift$5 multipl$8)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/05/14 05:06 PM
N89	1	(reference SAME block SAME motion SAME vector SAME (precision resolution) SAME (combin$5 add$5) SAME (predict$5) SAME (residual difference) SAME (shift$5)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/05/14 05:08 PM
N90	1	(reference SAME block SAME motion SAME vector SAME (precision resolution) SAME (combin$5 add$5) SAME (predict$5) SAME (residual difference) SAME (shift$5)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/05/14 05:08 PM

Substitute for form SB08 (Revised 07/09) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*	**Complete if Known**	
	Application Number	17/328,750
	Filing Date	May 24, 2021
	First Named Inventor	Ugur et al.
	Art Unit	2488
	Examiner Name	Peter D. Le
Sheet 1 of 1	Attorney Docket Number	042933/560470

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

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

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	Extended European Search Report for European Application No. 22173168.0 dated October 26, 2022, 11 pages.	

Examiner Signature	/PETER D LE/	Date Considered	05/14/2023

*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.

Submitted January 26, 2023

LEGAL02/42516954v1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.D.L/

Doc code: RCEX
Doc description: Request for Continued Examination (RCE)

PTO/SB/30EFS (01-22)
Approved for use through 05/31/2024. OMB 0651-0031
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	17/328,750	Filing Date	2021-05-24	Docket Number (if applicable)	042933/560470	Art Unit	2488
First Named Inventor	Ugur et al.			Examiner Name	Peter D. Le		

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. The Instruction Sheet for this form is located at WWW.USPTO.GOV

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).

☐ 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.

☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on ____________

☐ Other ____________

☒ Enclosed

☐ Amendment/Reply

☒ Information Disclosure Statement (IDS)

☐ Affidavit(s)/ Declaration(s)

☐ Other ____________

MISCELLANEOUS

☐ 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)

☐ Other ____________

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 160605

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature
Applicant Signature

Signature of Registered U.S. Patent Practitioner			
Signature	/Guy R. Gosnell/	Date (YYYY-MM-DD)	2023-06-02
Name	Guy R. Gosnell	Registration Number	34610

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 records.

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.

Attorney's Docket No. 042933/560470 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re:	Ugur et al.	Confirmation No.:	8335
Appl. No.:	17/328,750	Group Art Unit:	2488
Filed:	May 24, 2021	Examiner:	Peter D. Le
For:	MOTION PREDICTION IN VIDEO CODING		

Submitted via EFS-Web
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT
CITATION UNDER 37 C.F.R. § 1.97

Attached is a list of documents on form PTO-SB08. Copies of all listed documents (other than U.S. patents, U.S. patent application publications, or patents or publications otherwise determined cumulative) are attached, except those (if any) that were previously submitted to, or cited by, the Office during the prosecution of any application(s) upon which the present application directly relies for an earlier effective filing date under 35 U.S.C. § 120. It is noted that 37 C.F.R. § 1.98(d) establishes that copies of documents previously submitted to, or cited by, the Office during prosecution of the above application(s) are not required to be furnished; however, copies of such documents will be furnished upon request. Also attached 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.

Respectfully submitted,

/Guy R. Gosnell/

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LEGAL02/43010810v1

Substitute for form SB08 (Revised 07/09)				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*				Application Number	17/328,750
				Filing Date	May 24, 2021
				First Named Inventor	Ugur et al.
				Art Unit	2488
				Examiner Name	Peter D. Le
Sheet	1	of	2	Attorney Docket Number	042933/560470

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-2004/0208247 A1	10-21-2004	Barrau et al.	
	2	US-2008/0075169 A1	03-27-2008	Ugur et al.	
	3	US-2009/0092188 A1	04-09-2009	Lee et al.	
	4	US-2011/0090966 A1	04-21-2011	Chujoh 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
	5	CN 101523922 A	09-02-2009	Qualcomm Inc.		Abstract; corresponds to US-2008/0089417 A1 (previously cited)
	6	CN 101816183 A	08-25-2010	Samsung Electronics Co Ltd		Abstract; corresponds to US-2009/0092188 A1
	7	RU 2004103743 A	06-10-2005	Koninkleike Philips Electronics N.V.		Abstract only; corresponds to US-2004/0208247 A1
	8	RU 2008138706 A	04-10-2010	Kabusyki Kaysia Tosyba		Abstract; corresponds to US-2009/0087111 A1 (previously cited)
	9	WO 2010/001832 A1	01-07-2010	Toshiba KK		

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
	10	Decision to Grant for Chinese Application No. 201280009695.9 dated June 21, 2017, 4 pages.	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.

Submitted June 2, 2023

LEGAL02/43010790v1

Substitute for form SB08 (Revised 07/09) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*				**Complete if Known**	
				Application Number	17/328,750
				Filing Date	May 24, 2021
				First Named Inventor	Ugur et al.
				Art Unit	2488
				Examiner Name	Peter D. Le
Sheet	2	of	2	Attorney Docket Number	042933/560470

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
	11	Decision to Grant for Russian Application No. 2013136693/08 dated June 4, 2015, 12 pages.	Yes
	12	Minutes of the Oral Proceedings for European Application No. 12731927.5 dated December 9, 2021, 27 pages.	
	13	Notice of Allowance for Vietnamese Application No. 1-2013-02120 dated August 31, 2017, 2 pages.	Yes
	14	Office Action for Chinese Application No. 201280009695.9 dated February 15, 2016, 10 pages.	Yes
	15	Yoshino et al., "Enhanced Switching of Interpolation Filter for HEVC", Joint Collaborative Team on Video Coding (JCT-VC) or ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 3rd Meeting, JCTVC-C183, (October 7-15, 2010), 4 pages.	

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.

Submitted June 2, 2023

LEGAL02/43010790v1

Espacenet

Bibliographic data: CN101523922 (A) — 2009-09-02

Video coding with adaptive filtering for motion compensated prediction

Inventor(s): YAN YE [US]; YILIANG BAO [US] + (YE YAN, ; BAO YILIANG)

Applicant(s): QUALCOMM INC [US] + (QUALCOMM INC)

Classification:
- international: *H04N7/36*
- cooperative: **H04N19/117 (EP, KR, US); H04N19/14 (EP, US); H04N19/172 (EP, US); H04N19/174 (EP, US); H04N19/176 (EP, US); H04N19/187 (EP, US); H04N19/30 (KR); H04N19/46 (EP, US); H04N19/51 (KR); H04N19/523 (EP, US); H04N19/61 (EP, US); H04N19/82 (EP, US)**

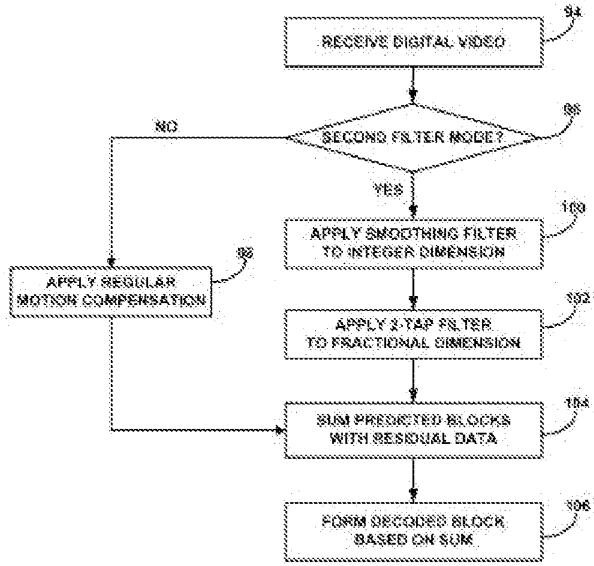
Application number: CN20078038000 20071011

Priority number(s): WO2007US81145 20071011 ; US20060829494P 20061013 ; US20070938151P 20070515 ; US20070869062 20071009

Also published as: CN101523922 (B) EP2092753 (A2) JP2010507286 (A) JP2014039289 (A) JP5450073 (B2) KR101065227 (B1) KR20090079939 (A) TW200835349 (A) TWI399099 (B) US2008089417 (A1) US9014280 (B2) WO2008048864 (A2) WO2008048864 (A3) less

Abstract of CN101523922 (A)

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.


RECEIVE DIGITAL VIDEO
94
SECOND FILTER MODE?
98
NO
YES
APPLY SMOOTHING FILTER TO INTEGER DIMENSION
100
APPLY REGULAR MOTION COMPENSATION
APPLY 2-TAP FILTER TO FRACTIONAL DIMENSION
102
SUM PREDICTED BLOCKS WITH RESIDUAL DATA
104
FORM DECODED BLOCK BASED ON SUM
106

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
H04N 7/36 (2006.01)

[12] 发明专利申请公布说明书

[21] 申请号 200780038000.9

[43] 公开日 2009 年 9 月 2 日

[11] 公开号 CN 101523922A

[22] 申请日 2007.10.11

[21] 申请号 200780038000.9

[30] 优先权

[32] 2006.10.13 [33] US [31] 60/829,494
[32] 2007. 5.15 [33] US [31] 60/938,151
[32] 2007.10. 9 [33] US [31] 11/869,062

[86] 国际申请 PCT/US2007/081145 2007.10.11

[87] 国际公布 WO2008/048864 英 2008.4.24

[85] 进入国家阶段日期 2009.4.10

[71] 申请人 高通股份有限公司

地址 美国加利福尼亚州

[72] 发明人 叶 琰 鲍易亮

[74] 专利代理机构 北京律盟知识产权代理有限责任公司

代理人 刘国伟

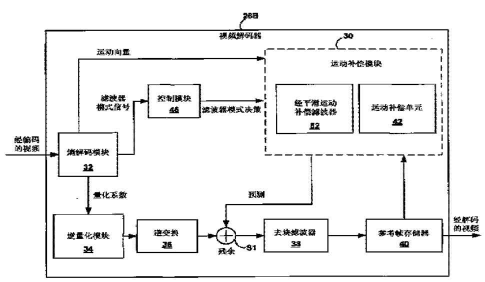
权利要求书 4 页 说明书 26 页 附图 13 页

[54] 发明名称

具有用于经运动补偿预测的自适应滤波的视频编码

[57] 摘要

本发明是针对支持正常单层视频编码或具有例如信噪比(SNR)可缩放性和空间可缩放性等特征的可缩放视频编码的视频编码技术。视频编码装置可在包含运动补偿模块和滤波器的视频解码器中实施这些技术。所述运动补偿模块从数字视频信号解码预测帧，其中所述运动补偿模块从编码在所述数字视频信号中的运动向量确定帧间编码帧的每一区块。所述滤波器基于从所述数字视频信号编码或推断的信号自适应地对帧间编码区块中的一者或一者以上进行滤波。在一些情况下，所述视频解码器可基于所述信号自适应地应用不同滤波器功能，一者在水平方向上，且另一者在垂直方向上。通过实施这些技术，所述视频解码器可增加所得经解码数字视频信号的视觉质量，同时降低复杂性。



1. 一种方法，其包括：

将运动补偿应用于视频帧内的区块，以产生预测视频区块；以及

自适应地调整所述运动补偿，以基于滤波器模式决策将第一滤波器模式或第二滤波器模式应用于所述区块中的每一者。

2. 根据权利要求 1 所述的方法，其进一步包括针对指向整数像素位置的运动向量，将 3 分接头滤波器应用于所述区块。

3. 根据权利要求 1 所述的方法，其进一步包括基于编码在视频位流中的信号或所述视频帧的一个或一个以上特性中的一者而产生所述滤波器模式决策。

4. 根据权利要求 1 所述的方法，其中所述区块包括可缩放视频编码帧的增强层中的区块。

5. 根据权利要求 1 所述的方法，其进一步包括在所述第一滤波器模式下应用运动补偿滤波器，且在所述第二滤波器模式下应用 3 分接头滤波器。

6. 根据权利要求 5 所述的方法，其进一步包括在所述第二滤波器模式下应用所述 3 分接头滤波器和所述运动补偿滤波器，其中所述运动补偿滤波器包含 2 分接头滤波器。

7. 根据权利要求 5 所述的方法，其进一步包括在所述第二滤波器模式下应用组合所述 3 分接头滤波器与内插滤波器的滤波器。

8. 根据权利要求 7 所述的方法，其中所述内插滤波器包含 2 分接头滤波器，所述方法进一步包括，在所述第二滤波器模式下，在水平维度和垂直维度的一者中应用所述 3 分接头滤波器，且在所述水平维度和所述垂直维度的另一者中应用所述 2 分接头滤波器。

9. 根据权利要求 7 所述的方法，其中所述内插滤波器包含 2 分接头滤波器，所述方法

进一步包括，在所述第二滤波器模式下：

当运动向量在所述水平维度中指向整数像素位置且在所述垂直维度中指向分数像素位置时，在所述水平维度中应用所述3分接头滤波器，且在所述垂直维度中应用所述2分接头滤波器；以及

当运动向量在所述垂直维度中指向整数像素位置且在所述水平维度中指向分数像素位置时，在所述垂直维度中应用所述3分接头滤波器，且在所述水平维度中应用所述2分接头滤波器。

10. 根据权利要求1所述的方法，其进一步包括在逐区块、逐宏区块、逐程序片或逐帧中的一者的基础上自适应地调整所述运动补偿。

11. 一种视频编码装置，其包括：

运动补偿模块，其将运动补偿应用于视频帧内的区块以产生预测视频区块；以及

控制模块，其自适应地调整所述运动补偿，以基于滤波器模式决策将第一滤波器模式或第二滤波器模式应用于所述区块中的每一者。

12. 根据权利要求11所述的装置，其中所述控制模块针对指向整数像素位置的运动向量将3分接头滤波器应用于所述区块。

13. 根据权利要求11所述的装置，其中所述控制模块基于编码在视频位流中的信号或所述视频帧的一个或一个以上特性中的一者而产生所述滤波器模式决策。

14. 根据权利要求11所述的装置，其中所述区块包括可缩放视频编码帧的增强层中的区块。

15. 根据权利要求11所述的装置，其中所述运动补偿模块在所述第一滤波器模式下应用运动补偿滤波器，且在所述第二滤波器模式下应用3分接头滤波器。

16. 根据权利要求15所述的装置，其中所述运动补偿模块在所述第二滤波器模式下应用所述3分接头滤波器和所述运动补偿滤波器，其中所述运动补偿滤波器包含2分接头滤波器。

17. 根据权利要求 15 所述的装置，其中所述运动补偿模块在所述第二滤波器模式下应用组合所述 3 分接头滤波器与内插滤波器的滤波器。

18. 根据权利要求 17 所述的装置，其中所述内插滤波器包含 2 分接头滤波器，且其中所述运动补偿模块在所述第二滤波器模式下，在水平维度和垂直维度的一者中应用所述 3 分接头滤波器，且在所述水平维度和所述垂直维度的另一者中应用所述 2 分接头滤波器。

19. 根据权利要求 17 所述的装置，其中所述内插滤波器包含 2 分接头滤波器，且其中所述运动补偿模块在所述第二滤波器模式下，当运动向量在所述水平维度中指向整数像素位置且在所述垂直维度中指向分数像素位置时，在所述水平维度中应用所述 3 分接头滤波器且在所述垂直维度中应用所述 2 分接头滤波器，且当运动向量在所述垂直维度中指向整数像素位置且在所述水平维度中指向分数像素位置时，在所述垂直维度中应用所述 3 分接头滤波器且在所述水平维度中应用所述 2 分接头滤波器。

20. 根据权利要求 11 所述的装置，其中所述控制模块在逐区块、逐宏区块、逐程序片或逐帧中的一者的基础上自适应地调整所述运动补偿。

21. 根据权利要求 11 所述的装置，其中所述装置为无线通信装置手持机或集成电路装置中的一者。

22. 一种视频编码装置，其包括：

用于将运动补偿应用于视频帧内的区块以产生预测视频区块的装置；以及

用于自适应地调整所述运动补偿以基于滤波器模式决策将第一滤波器模式或第二滤波器模式应用于所述区块中的每一者的装置。

23. 根据权利要求 22 所述的装置，其进一步包括用于针对指向整数像素位置的运动向量将 3 分接头滤波器应用于所述区块的装置。

24. 一种包括计算机可读媒体的计算机程序产品，所述计算机可读媒体包括致使处理器

执行以下操作的指令：

将运动补偿应用于视频帧内的区块以产生预测视频区块；以及

自适应地调整所述运动补偿以基于滤波器模式决策将第一滤波器模式或第二滤波器模式应用于所述区块中的每一者。

25. 根据权利要求 24 所述的计算机程序产品，其进一步包括针对指向整数像素位置的运动向量致使所述处理器将 3 分接头滤波器应用于所述区块的指令。

具有用于经运动补偿预测的自适应滤波的视频编码

本申请案主张2006年10月13日申请的第60/829,494号美国临时申请案和2007年5月15日申请的第60/938,151号美国临时申请案的权益，所述临时申请案的每一者的完整内容以引用的方式并入本文中。

技术领域

本发明涉及数字视频，且更明确地说，涉及数字视频的编码。

背景技术

可将数字视频能力并入较宽范围的装置中，包含数字电视、数字直播系统、无线通信装置、个人数字助理（PDA）、膝上型计算机、桌上型计算机、数码相机、数字记录装置、视频游戏装置、蜂窝式或卫星无线电电话等。数字视频装置通常实施视频压缩技术，例如MPEG-2、MPEG-4或H.264/MPEG-4第10部分（高级视频编码（AVC）），以便更高效地传输和接收数字视频信号。视频压缩技术执行空间和时间预测以减少或去除视频信号中固有的冗余。可缩放视频编码技术经由基础层和一个或一个以上增强层来实现额外特征，例如空间、时间和/或信噪比（SNR）可缩放性。

在视频编码中，视频压缩大体上包含运动估计和运动补偿。运动估计追踪视频对象在连续视频帧之间的移动。运动估计产生运动向量，所述运动向量指示视频区块相对于一个或一个以上参考帧中的相应视频区块的位移。运动补偿使用运动向量来从一个或一个以上参考帧产生一预测视频区块。另外，运动补偿通过从原始视频区块减去预测视频区块来形成残余视频区块。视频编码器应用变换、量化和熵编码处理来进一步减小残余区块的位速率。视频解码器执行逆操作以使用所述区块中的每一者的运动向量和残余信息来重构经编码的视频。

发明内容

一般来说，本发明是针对支持视频解码器中的经运动补偿预测区块的自适应滤波的视频编码技术。可应用经运动补偿预测区块的自适应滤波来提高预测准确性。另外或替代地，可应用自适应滤波来降低复杂性。

在一个方面中，本发明提供一种视频编码装置，其包括：运动补偿模块，其将运动补偿应用于视频帧内的区块以产生预测视频区块；以及控制模块，其自适应地调整所述运动补偿以基于滤波器模式决策将第一滤波器模式或第二滤波器模式应用于所述区块中的每一者。

在另一方面中，本发明提供一种方法，其包括：将运动补偿应用于视频帧内的区块以产生预测视频区块；以及自适应地调整所述运动补偿以基于滤波器模式决策将第一滤波器模式或第二滤波器模式应用于所述区块中的每一者。

在另一方面中，本发明提供一种视频编码装置，其包括运动补偿模块，所述运动补偿模块对视频帧内的区块执行运动补偿以产生视频区块，其中所述运动补偿模块包含滤波器，且所述运动补偿模块针对指向整数像素位置的运动向量将所述滤波器应用于区块。

在一额外方面中，本发明提供一种集成电路装置，其包括：运动补偿模块，其将运动补偿应用于视频帧内的区块以产生预测视频区块；以及控制模块，其自适应地调整所述运动补偿以基于滤波器模式决策将第一滤波器模式或第二滤波器模式应用于所述区块中的每一者。

在另一方面中，本发明提供一种无线通信装置手持机，其包括：运动补偿模块，其将运动补偿应用于视频帧内的区块以产生预测视频区块；以及控制模块，其自适应地调整所述运动补偿以基于滤波器模式决策将第一滤波器模式或第二滤波器模式应用于所述区块中的每一者。

在另一方面中，本发明提供一种方法，其包括：对视频帧内的区块执行运动补偿以产生预测视频区块；以及针对指向整数像素位置的运动向量将滤波器应用于区块。

在另一方面中，本发明提供一种集成电路装置，其包括运动补偿模块，所述运动补偿模块对视频帧内的区块执行运动补偿以产生预测视频区块，其中所述运动补偿模块包含滤波器，且所述运动补偿模块针对指向整数像素位置的运动向量将所述滤波器应用于区块。

在另一方面中，本发明提供一种无线通信装置手持机，其包括运动补偿模块，所述运动补偿模块对视频帧内的区块执行运动补偿以产生预测视频区块，其中所述运动补偿模块包含滤波器，且所述运动补偿模块针对指向整数像素位置的运动向量将所述滤波器应用于区块。

本发明中所描述的技术可在硬件、软件、固件或其任何组合中实施。如果在软件中实施，那么可在一个或一个以上处理器（例如微处理器、专用集成电路（ASIC）、现场

可编程门阵列（FPGA）或数字信号处理器（DSP））中执行所述软件。执行所述技术的软件可最初存储在计算机可读媒体中，且加载在处理器中并在处理器中执行。因此，本发明还涵盖一种包括计算机可读媒体的计算机程序产品，所述计算机可读媒体包括用以执行如本发明中所描述的技术的指令。

附图和以下描述中陈述本发明的一个或一个以上方面的细节。其它特征、目标和优势将从所述描述和图式且从权利要求书中显而易见。

附图说明

图 1 是说明视频编码与解码系统的框图。

图 2 是说明视频编码器的实例的框图。

图 3 是说明通过具有不同运动向量的较小子区块形成一预测区块的图。

图 4 是说明经配置以支持自适应滤波以产生预测区块的视频解码器的实例的框图。

图 5 是说明经配置以支持自适应滤波以产生预测区块的视频解码器的另一实例的框图。

图 6 是说明经配置以支持使用自适应滤波来产生预测区块的可缩放视频编码（SVC）的视频解码器的实例的框图。

图 7 是说明经平滑参考处理在 SVC 增强层编码中的应用的图。

图 8 是说明使用自适应运动补偿的经平滑参考处理在 SVC 增强层编码中的应用的图。

图 9 是说明用于亮度½像素内插的一维、六分接头滤波器的实例特性的图。

图 10 是说明经配置以支持不同自适应滤波器在预测区块的垂直和水平维度中应用以适应具有整数或分数像素精确度的运动向量分量的视频解码器的实例的框图。

图 11 是说明视频解码器在以帧间编码帧的区块级执行自适应运动补偿的过程中的示范性操作的流程图。

图 12 是说明视频解码器在以帧间编码帧的区块级使用组合式经平滑运动补偿单元来执行平滑和运动补偿的过程中的示范性操作的流程图。

图 13 是说明视频解码器在于垂直和水平维度中用不同滤波器来执行自适应运动补偿的过程中的示范性操作的流程图。

具体实施方式

大体上，本发明是针对支持视频解码器中的经运动补偿预测区块的自适应滤波的视

频编码技术。可应用经运动补偿预测区块的自适应滤波来提高预测准确性且/或降低复杂性。可动态地调整滤波模式，例如，以帧级、程序片级、宏区块（MB）级或区块级。滤波模式决策可由编码器在经编码的位流中明确地表明。或者，可基于视频序列的统计数据和/或特性在解码器侧确定模式决策。

在第一滤波模式下，视频解码器可应用规则运动补偿以形成经运动补偿预测区块。在第二滤波模式下，视频解码器可将规则运动补偿加上额外滤波器应用于所述经运动补偿预测区块。额外滤波器可具有不同特性。举例来说，所述额外滤波器可为低通滤波器，在以下论述中，其也可被称为平滑滤波器。在一些情况下，平滑滤波器可为 3 分接头滤波器。在第二滤波模式下，视频解码器可应用与规则运动补偿滤波器级联的额外滤波器或通过使用组合所述规则运动补偿滤波器与所述额外滤波器的不同滤波器。

在一些情况下，可在经运动补偿预测区块的水平和垂直方向上应用不同滤波器。举例来说，对于具有整数像素精确度的运动向量分量，可应用例如 3 分接头滤波器的平滑滤波器，而对于具有分数像素精确度的运动向量分量，可应用例如 2 分接头滤波器的内插滤波器（例如，双线性滤波器）。所述不同滤波器可以是分离的或形成组合式滤波器的一部分。

自适应滤波可提高视觉质量和编码效率。举例来说，可以 MB 或区块级来应用自适应滤波，从而提供个别区块的精调谐滤波。宏区块（MB）可指代视频帧的 16 乘 16 像素区域，而区块或子区块可用于指代较小区域。而且，当需要时（而非全部时间），可应用额外或不同滤波，从而降低复杂性。

另外，可将视频编码技术应用于单层视频或多层可缩放视频。如上文所提及，运动补偿滤波器与额外滤波器可被组合，而不是被级联地应用，从而进一步降低复杂性。举例来说，对于可缩放视频编码，经组合的运动补偿滤波器模块可代替经级联的运动补偿滤波器与额外滤波器（例如，平滑滤波器）。

图 1 是说明视频编码与解码系统 10 的框图。如图 1 中所示，系统 10 包含源装置 12，其经由通信信道 16 向接收装置 14 传输经编码的视频。源装置 12 可包含视频源 18、视频编码器 20 和传输器 22。在一些方面中，传输器 22 可为无线传输器。接收装置 14 可包含接收器 24、视频解码器 26 和视频显示装置 28。在一些方面中，接收器 24 可为无线接收器，例如无线通信装置手持机中的无线接收器。系统 10 可经配置以支持经运动补偿预测区块的自适应滤波以改进视觉质量和处理效率两者。

视频解码器 26 可将运动补偿应用于视频帧内的区块以产生预测视频区块，且自适应地调整运动补偿以基于滤波器模式决策将第一滤波器模式或第二滤波器模式应用于

所述区块中的每一者。在第二滤波器模式下，视频解码器 26 可自适应地将额外滤波应用于一些视频区块。在第一滤波器模式下，视频解码器 26 可应用规则运动补偿，其可包含内插滤波（如果运动向量在垂直维度、水平维度或两者中参考分数像素位置）。在第二滤波器模式下，视频解码器 26 可将运动补偿加上额外滤波器应用于经运动补偿预测区块。举例来说，额外滤波器可为平滑滤波器。或者，在第二滤波器模式下，视频解码器 26 可应用不同的滤波器，所述滤波器组合规则运动补偿与额外滤波（例如，平滑）。

视频解码器 26 可在逐区块、逐宏区块、逐程序片或逐帧基础上自适应地调整运动补偿。滤波器模式决策可基于（例如，由视频编码器 20）编码在视频帧中的信号。举例来说，视频编码器 20 可在经编码的视频中包含指示视频解码器 26 应调整运动补偿以应用第一滤波器模式还是第二滤波器模式的旗标、命令或其它指令。或者，视频解码器 26 可基于对视频帧的一个或一个以上特性的分析做出滤波器模式决策。举例来说，视频解码器 26 可分析在解码后获得的经重构的视频区块，以确定是否应应用第二滤波模式。

在第一滤波器模式下，对于具有分数像素值的运动向量，视频解码器 26 可（例如）用内插滤波来应用规则运动补偿。举例来说，在 H.264/MPEG-4 第 10 部分（高级视频编码（AVC））方案中，用于在½像素位置处内插一像素的运动补偿滤波器可包括 6 分接头滤波器。分接头的数目通常指示数学上表示滤波器所需的系数的数目。与具有较低分接头数目的滤波器相比，具有较高分接头数目的滤波器通常包括较复杂的滤波器。因此，与 2 分接头滤波器或 3 分接头滤波器相比，6 分接头滤波器包括较复杂的滤波器。

在第二滤波器模式下，视频解码器 26 可应用额外滤波器，例如平滑滤波器。举例来说，所述平滑滤波器可包括 3 分接头滤波器。可在第二滤波器模式下提供所述平滑滤波器作为额外滤波器，例如，除运动补偿滤波器之外。或者，可将平滑滤波器与用于规则运动补偿的内插滤波器组合。运动补偿中所使用的组合式滤波器因此表示不同的滤波器（例如，2 分接头滤波器），用于在局部像素位置处内插一像素。示范性 2 分接头滤波器为双线性滤波器。因此，视频解码器 26 所应用的第二滤波器模式可包含通过使用运动补偿滤波器和额外平滑滤波器，或通过使用组合运动补偿与平滑的不同滤波器，而应用运动补偿滤波器和平滑滤波器两者。在每一情况下，例如平滑的额外滤波是在第二滤波器模式下提供的。

在第二滤波器模式下，视频解码器 26 可将平滑滤波器应用于两个分量都具有整数像素精确度的运动向量的两个维度。或者，对于在水平维度和垂直维度中具有整数像素精确度的运动向量，可在水平维度或垂直维度或两者中应用例如 3 分接头滤波器的平滑滤波器。如果运动向量在此些维度中具有分数精确度，那么可应用例如双线性滤波器的

2 分接头运动补偿滤波器以在所述维度的至少一者中进行内插。对于在两个维度中都具有分数像素精确度的运动向量，可针对垂直维度和水平维度两者应用 2 分接头内插滤波器。类似地，对于在两个维度中都具有整数像素精确度的运动向量，可在垂直维度和水平维度两者中应用平滑滤波器。

举例来说，当运动向量在水平维度中指向整数像素位置且在垂直维度中指向分数像素位置时，视频解码器 26 可在水平维度中应用平滑滤波器，且在垂直维度中应用例如双线性滤波器的 2 分接头滤波器。或者，当运动向量在垂直维度中指向整数像素位置且在水平维度中指向分数像素位置时，视频解码器 26 可在垂直维度中应用平滑滤波器，且在水平维度中应用例如双线性滤波器的 2 分接头滤波器。或者，视频解码器 26 可在两个维度中都应用平滑滤波器或内插滤波器，视运动向量的整数精确度或分数精确度而定。

自适应滤波器调整（例如，以帧级、程序片级、宏区块（MB）级或区块级）可提高编码效率和处理效率两者。通过自适应滤波，当需要时（而不是以全部时间为基础），可将额外或不同滤波应用于帧、程序片、MB 或区块，从而减少处理额外开销。明确地说，第一滤波模式可省略额外滤波器，而第二滤波模式可能需要额外滤波器来提高编码效率。如上文所提及，在一些方面中，额外滤波器可为平滑滤波器。平滑滤波器可对减少或消除来自经运动补偿预测区块的量化噪声或其它假影有用。

视频解码器 26 可将自适应滤波技术应用于单层视频或多层可缩放视频。在一些情况下，视频解码器 26 可组合运动补偿滤波器与平滑滤波器，而不是应用级联的滤波器，从而进一步降低复杂性。举例来说，对于可缩放视频编码（SVC），视频解码器 26 可经配置以应用支持简化处理的组合式经平滑运动补偿滤波器模块。

在图 1 的实例中，通信信道 16 可包括任何无线或有线通信媒体，例如射频（RF）频谱或一个或一个以上物理传输线，或者无线与有线媒体的任何组合。信道 16 可形成基于分组的网络（例如，局域网络、广域网络或例如因特网的全局网络）的一部分。通信信道 16 通常表示任何合适的通信媒体或者不同通信媒体的集合，用于将视频数据从源装置 12 传输到接收装置 14。

源装置 12 产生用于传输到目的装置 14 的视频。然而，在一些情况下，装置 12、14 可以大体上对称的方式操作。举例来说，装置 12、14 中的每一者可包含视频编码和解码组件。因此，系统 10 可支持视频装置 12、14 之间的单路或双路视频传输，以（例如）用于视频流式传输、视频广播或视频电话。

视频源 18 可包含视频捕捉装置，例如一个或一个以上视频相机、含有先前捕捉到

的视频的视频档案或者来自视频内容提供者的直播视频馈入。作为另一替代方案，视频源 18 可产生基于计算机图形的数据作为源视频，或直播视频与计算机产生的视频的组合。在一些情况下，如果视频源 18 是相机，那么源装置 12 和接收装置 14 可形成所谓的相机电话或视频电话，包含卫星或移动无线电话，或其它无线通信装置。因此，在一些方面中，本发明中所描述的技术可在移动无线通信装置手持机（例如，移动电话手持机）内实施。在每一情况下，被捕捉到、预捕捉到或计算机产生的视频可由视频编码器 20 编码，以用于经由传输器 22、信道 16 和接收器 24 从视频源装置 12 传输到视频接收装置 14 的视频解码器 26。显示装置 28 可包含多种显示装置中的任一者，例如液晶显示器（LCD）、等离子显示器或有机发光二极管（OLED）显示器。

在本发明的一些方面中，视频编码器 20 和视频解码器 26 可经配置以支持可缩放视频编码以获得空间、时间和/或信噪比（SNR）可缩放性。编码器 20 和解码器 26 可通过支持基础层和一个或一个以上可缩放增强层的编码、传输和解码，来支持各种程度的可缩放性。对于可缩放编码，基础层携载具有最小质量级的视频数据。一个或一个以上增强层携载额外位流以支持较高的空间、时间或 SNR 级。

视频编码器 20 和视频解码器 26 可根据例如 MPEG-2、MPEG-4、ITU-T H.263 或 ITU-T H.264/MPEG-4 第 10 部分（AVC）等视频压缩标准而操作。尽管图 1 中未展示，但在一些方面中，视频编码器 20 和视频解码器 22 可分别与音频编码器和解码器整合，且包含适当的 MUX-DEMUX 单元或其它硬件和软件，以处置共用数据流或单独数据流中的音频和视频两者的编码。如果适用的话，MUX-DEMUX 单元可遵照 ITU H.223 多路复用器协议或其它协议（例如，用户数据报协议（UDP））。

H.264 标准由 ITU-T 视频编码专家组和 ISO/IEC 运动图像专家组（MPEG）开发，作为被称为联合视频团队（JVT）的合作组织的产品。日期为 2005 年 3 月的 ITU-T 建议 H.264“一般视听服务的高级视频编码（Advanced video coding for generic audiovisual services）”中描述 H.264 标准，所述标准在本文中可被称为 H.264 标准或 H.264 规范，或者 H.264/AVC 标准或规范。在一些方面中，本发明中所描述的技术可应用于大体遵照 H.264 标准的装置，或者并不大体遵照 H.264 标准的其它装置。

联合视频团队（JVT）继续从事对 H.264/MPEG-4 AVC 的可缩放视频编码（SVC）扩展。H.264/MPEG-4AVC 和演进式 SVC 扩展两者的规范呈联合草案（JD）的形式。由 JVT 创建的联合可缩放视频模型（JSVM）实施供可缩放视频中使用的工具，所述工具可在系统 10 内用于本发明中所描述的各种编码任务。关于 SVC 的详细信息可在联合草案文献中找到，且明确地说，在联合草案 7（JD7）中找到，JD7 的作者是托马斯·韦根

(Thomas Wiegand)、加里·沙利文(Gary Sullivan)、朱利安·赖歇(Julien Reichel)、黑寇·施瓦茨(Heiko Schwarz)和马蒂亚斯·维恩(Mathias Wien)("SVC修订的联合草案7(第2版)(Joint Draft 7 of SVC Amendment (revision 2))",JVT-T201r2,2006年7月,克拉根福,奥地利)。

在一些方面中,对于视频广播,本发明涵盖对增强型H.264视频编码的应用,以使用待作为技术标准TIA-1099("FLO规范")出版的仅前向链路(FLO)空中接口规范("用于地面移动多媒体多播的仅前向链路空中接口规范(Forward Link Only Air Interface Specification for Terrestrial Mobile Multimedia Multicast)")来在地面移动多媒体多播(TM3)系统中传递实时视频服务。FLO规范包含界定适合FLO空中接口的位流语法和语义以及解码处理的实例。或者,可根据例如DVB-H(数字视频广播-手持型)、ISDB-T(整合服务数字广播-地面型)或DMB(数字媒体广播)等其它标准来广播视频。因此,在一些情况下,源装置12可以是移动无线终端,例如无线通信装置手持机、视频流式传输服务器或视频广播服务器。然而,本发明中所描述的技术不限于任何特定类型的广播、多播或点对点系统。

可将视频编码器20和视频解码器26每一者实施为一个或一个以上微处理器、数字信号处理器(DSP)、专用集成电路(ASIC)、现场可编程门阵列(FPGA)、离散逻辑、软件、硬件、固件或其任何组合。因此,本文中所描述的技术可在一个或一个以上集成电路装置内实施,所述一个或一个以上集成电路装置被总称为集成电路装置。此集成电路装置可提供于通信装置(例如,无线通信装置手持机)内。视频编码器20和视频解码器26中的每一者可包含在一个或一个以上编码器或解码器中,其任一者可作为组合式编码器/解码器(CODEC)的一部分整合在相应的移动装置、订户装置、广播装置、服务器或类似物中。另外,视频源装置12和视频接收装置14每一者可根据情况包含用于传输和接收经编码视频的适当调制、解调、频率转换、滤波和放大器组件,包含足以支持无线通信的射频(RF)无线组件和天线。然而,为了易于说明,图1中未展示此些组件。

视频序列包含一系列视频帧。视频编码器20对个别视频帧内的像素区块进行操作,以便对视频数据进行编码。视频区块可具有固定或变化的大小,且可根据指定的编码标准在大小上有所不同。举例来说,ITU-T H.264标准支持各种区块大小(例如,对于亮度分量为16乘16、8乘8、4乘4,且对于色度分量为8×8)的帧内预测,以及各种区块大小(例如,对于亮度分量为16乘16、16乘8、8乘16、8乘8、8乘4、4乘8及4乘4,且对于色度分量为对应的经按比例缩放的大小)的帧间预测。较小的视频区块可

提供较佳的分辨率，且可用于视频帧的包含较高细节等级的位置。一般来说，可将宏区块和各种较小区块视为视频区块。在一些情况下，较小区块可被称为子区块。在预测后，如果使用帧内_16×16 预测模式，那么可对 8×8 残余区块或 4×4 残余区块执行变换，且可将额外变换应用于色度分量或亮度分量的 4×4 区块的 DC 系数。

图 2 是说明视频编码器 20 的实例的框图。视频编码器 20 可执行视频帧内的区块的帧内编码和帧间编码。内部编码依靠空间预测来减少或去除给定视频帧内的视频中的空间冗余。帧间编码依靠时间预测来减少或去除邻近帧内的视频中的时间冗余。对于帧间编码，视频编码器 20 执行运动估计以跟踪匹配视频区块在两个或两个以上邻近帧之间的移动。

如图 2 中所示，视频编码器 20 接收待编码的视频帧内的当前视频区块 21。在图 2 的实例中，视频编码器 20 包含运动估计单元 23、参考帧存储器 25、运动补偿单元 27、区块变换单元 29、量化单元 31、逆量化单元 33、逆变换单元 35 和熵编码单元 37。视频编码器 20 还包含加法器 39 和加法器 41。图 2 说明用于视频区块的帧间编码的视频编码器 20 的时间预测组件。尽管为了易于说明在图 2 中未展示，但视频编码器 20 还可包含用于一些视频区块的帧内编码的空间预测组件。

运动估计单元 23 将视频区块 21 与一个或一个以上邻近视频帧中的区块进行比较以产生一个或一个以上运动向量。可从参考帧存储器 25 检索所述邻近帧。对于可变大小（例如，16×16、16×8、8×16、8×8 或更小的区块大小）的区块，可执行运动估计。运动估计单元 23（例如）基于速率失真模型而识别邻近帧中最接近匹配当前视频区块 21 的区块，且确定所述区块之间的位移。在此基础上，运动估计单元 23 产生指示所述位移的量值和轨线的运动向量。

运动向量可具有半像素或四分之一像素精确度，或者甚至更细的精确度，从而允许视频编码器 20 跟踪具有高于整数像素位置的精确度的运动，且获得较佳的预测区块。当使用具有分数像素值的运动向量时，可在运动补偿单元 27 中进行内插操作。举例来说，在 AVC/H.264 标准中，为了获得半像素位置处的亮度信号，可使用具有系数（1, -5, 20, 20, -5, 1）/32 的 6 分接头维纳（Wiener）滤波器。为了获得四分之一像素位置处的亮度信号，可使用对整数像素位置处的值和半像素位置处的内插值的双线性滤波。双线性滤波器还可用于对色度分量的分数像素内插中，色度分量可具有至多达 1/8 像素精确度。

运动估计单元 23 使用速率失真模型来识别用于视频区块的最佳运动向量。使用所得的运动向量，运动补偿单元 27 通过运动补偿而形成预测视频区块。在加法器 39 处，视频编码器 20 通过从原始当前视频区块 21 减去由运动补偿单元 27 产生的预测视频区

块而形成残余视频区块。区块变换单元 29 将变换应用于残余区块。量化单元 31 量化变换系数以进一步减小位速率。熵编码单元 37 对经量化的系数进行熵编码以更进一步减小位速率。视频解码器 26 执行逆操作以重构经编码的视频。

逆量化单元 33 和逆变换单元 35 分别应用逆量化和逆变换，以重构残余区块。加法器 41 使经重构的残余区块与由运动补偿单元 27 产生的经运动补偿的预测区块相加，以产生经重构视频区块以存储在参考帧存储器 25 中。所述经重构视频区块由运动估计单元 23 和运动补偿单元 27 用来对后续视频帧中的区块进行编码。

当对当前视频帧 21 中的给定区块执行运动补偿时，运动补偿单元 27 可使用一组固定的滤波器来内插来自参考帧的参考区块。如果当前区块是被单向预测的，那么需要一个参考区块，或者如果当前区块是被双向预测的，那么需要两个参考区块。在 H.264 中，在一些情况下，可使用前向和后向方向上的多个参考帧。运动补偿单元 27 中所使用的实际滤波器视运动向量的分数部分而定。举例来说，如果运动向量指向给定维度中的参考帧中的半像素位置，那么为了获得所述半像素位置的值，在所述具有半像素运动向量的维度中使用例如（1, -5, 20, 20, -5, 1）/32 的 6 分接头滤波器。如果两个运动向量分量都指向整数位置，那么可在不执行任何内插滤波操作的情况下，直接使用来自参考帧存储器 25 中的参考帧的像素值。

图 3 是说明通过具有不同运动向量的区块形成一预测区块的图。在图 3 的实例中，8×16 预测区块 43 由来自参考帧 49 的两个 8×8 子区块 45、47 的组合形成，每一子区块具有不同的运动向量（MV）。举例来说，8×8 区块 45 具有子区块运动向量（0, -6），且 8×8 子区块 47 具有区块运动向量（-2, -6）。

如上文所论述，通过取得由运动补偿单元 27 产生的经运动补偿预测视频区块与由逆量化单元 33 和逆变换单元 35 产生的经重构残余区块的总和来形成经重构的视频区块，其中如果有必要的话，执行额外的剪裁（clipping）操作。经重构的区块接着存储在参考帧存储器 25 中，以供未来预测使用。经重构的区块在直接用于产生预测视频区块时，可能含有量化噪声和不合需要的假影。

对预测视频区块应用平滑操作可减轻此些假影。而且，预测视频区块可由以不同运动向量运动补偿的子区块形成，（例如）如图 3 中所示。因此，沿这些子区块的边界可能存在不连续性。在解块滤波器参数视运动信息而定的情况下，应用环内去块滤波器（例如，如在 AVC/H.264 中）可减轻经重构区块内的不连续性问题。然而，去块滤波器可能具有较高的计算复杂性。另外，例如 H.264 中的去块滤波器经设计以用于改进当前帧的视觉质量而不是更改所述帧以使得可较佳地预测未来帧。因此，将平滑操作应用于从运

动补偿获得的预测区块（例如，经由低通滤波器）可提供对当前区块的较佳预测。

视可能存在于个别预测区块中的噪声的性质和量值而定，应用额外平滑滤波可能是有益的或可能是无益的。如果为了更改参考区块以使其更接近地匹配当前区块而应用平滑滤波器，那么上述情况也是真的，因为参考帧中且当前帧中的对象可能经历不同的空间变换。因此，依据区块的实际内容，平滑可对编码处理具有不同影响。

根据本发明的各个方面，有可能自适应地决定应使用规则预测区块还是经滤波（经平滑）的预测区块。根据第一滤波器模式，规则预测区块的使用可涉及运动补偿的应用。如果相关运动向量指定分数像素值，那么第一滤波器模式可涉及内插滤波器的应用。根据第二滤波器模式，预测区块的平滑可涉及额外滤波器的应用。滤波器模式决策可经编码且在经编码的视频位流中发送。或者，可使用接收到的视频的统计数据和/或特性在视频解码器处推断出滤波器模式决策。

在一些情况下，额外滤波（例如用于对预测性区块进行平滑的低通滤波）可改进数字视频（当显示于显示装置 28 上时）的所得视觉质量。举例来说，平滑滤波器（例如 3 分接头[1, 2, 1]滤波器）的应用可减少出现在预测性帧中的量化噪声和假影数目。而且，此平滑滤波器的应用可产生运动模糊的效应，使得参考帧与当前帧较佳地相互匹配。

系统 10 可经配置以支持经补偿以产生预测区块的运动的自适应滤波，其改进视觉质量和处理效率两者。举例来说，视频解码器 26 可自适应地调整运动补偿以在无额外滤波的情况下应用第一滤波器模式或在具有额外滤波的情况下应用第二滤波器模式。可在逐区块、逐宏区块、逐程序片或逐帧基础上调适滤波器模式，且滤波器模式可基于编码于视频帧中的信号或对视频帧的一个或一个以上特性的分析。在一些情况下，视频解码器 26 可组合运动补偿滤波器与平滑滤波器，而不是应用级联的滤波器，从而进一步降低复杂性。

图 4 是说明经配置以支持自适应滤波以产生预测区块的视频解码器 26a 的实例的框图。在图 4 的实例中，视频解码器 26a 基于由编码在视频位流中的滤波器模式信号指示的滤波器模式决策而实施自适应滤波。如图 4 中所示，视频解码器 26A 包含运动补偿模块 30、熵解码模块 32、逆量化模块 34、逆变换模块 36、加法器 S1、去块滤波器 38、参考帧存储器 40、运动补偿单元 42、平滑滤波器 44 和控制模块 46。

在第一滤波器模式下，视频解码器 26A 执行规则运动补偿，其可包含对分数像素值的内插滤波。在第二滤波器模式下，视频解码器 26A 用额外滤波来执行运动补偿。平滑滤波器 44 表示将在第二滤波器模式下应用的示范性额外滤波器。然而，本发明不应限于平滑滤波器 44，而是可包含包括不同滤波特性的其它额外滤波器。尽管图 4 中未展示，

但视频解码器 26A 还支持经帧内编码（I）区块的解码。然而，为了易于说明，图 4 集中在经帧间编码（P 或 B）区块的解码。

在图 4 的实例中，熵解码模块 32 将熵解码应用于经编码的视频以产生经量化的变换系数、运动向量和滤波器模式信号。逆量化模块 34 和逆变换模块 36 将变换系数转换为残余区块信息。运动补偿模块 30 形成预测性区块，其与所述残余区块信息求和，如由加法器 S1 表示。去块滤波器 38 对所得的经求和区块进行滤波以去除“块状”假影。“块状”假影常以较低的位速率出现。示范性逆量化、逆变换和去块滤波器技术在 H.264/MPEG-4 第 10 部分 AVC 标准中被描述，尽管本发明中所描述的技术可与其它视频压缩标准或技术一起使用。由去块滤波器 38 滤波的视频帧存储于参考帧存储器 40 中。参考帧存储器 40 可包括能够存储用于进一步预测的参考帧的存储器。

运动补偿模块 30 包括运动补偿单元 42，其从熵解码模块 32 接收运动向量且从参考帧存储器 40 接收参考帧以产生预测性区块。举例来说，运动补偿单元 42 将运动向量应用于参考帧以选择匹配区块，且提供所选择的区块作为预测性区块，以用于与逆变换模块 36 所产生的残余信息求和，如由加法器 S1 表示。在一些情况下，运动补偿单元 42 可应用内插滤波器来从参考帧中的区块产生预测性区块。举例来说，为了获得分数像素位置处的视频数据，运动补偿单元 42 可包含内插滤波器。因此，第一滤波器模式可以是在具有或不具有内插滤波（视适用的运动向量指向整数像素值还是分数像素值而定）的情况下执行规则运动补偿的模式。运动补偿模块 30 可直接在第一滤波器模式下提供预测性区块，或在第二滤波器模式 44 下将平滑滤波器 44 应用于预测性区块。因此，第二滤波器模式可以是大体上与第一滤波器模式相同的模式，但外加了平滑滤波器 44 或其它滤波器。

控制模块 46 从熵解码模块 32 接收滤波器模式信号，且控制运动补偿模块 30 内的切换器 50 以选择不应用额外平滑滤波器 44 的第一滤波器模式或将额外平滑滤波器 44 应用于由运动补偿单元 42 产生的预测性区块的第二滤波模式。控制模块 46 从经解码的位流检索滤波器模式信号，以确定编码器已指示第一滤波器模式还是第二滤波器模式，并做出适当的滤波器模式决策。

尽管出于说明的目的，第一滤波器模式或第二滤波器模式的选择由切换器 50 表示，但所述选择可以是软件功能且无需由实际切换器实现。另外，尽管在图 4 的实例中，控制模块 46 从经熵解码的位流检索滤波器模式信号，但可在逆量化或逆变换之前或之后，从经解码的视频信号的统计数据和/或特性确定滤波器模式信号。

熵解码模块 32 将运动向量传输到运动补偿单元 42，运动补偿单元 42 执行运动补偿

技术以从存储在参考帧存储器 40 中的参考帧产生预测性区块。如上文所述的平滑滤波器 44 是可根据本发明的原理自适应地应用的额外滤波器的实例。在一些方面中，视频解码器 26A 可基于滤波器模式决策以经预测帧的区块级自适应地应用平滑滤波器 44。换句话说，编码器 20 可在逐区块基础上调整滤波器模式信号。或者，可在逐帧、逐程序片或逐宏区块基础上调整滤波器模式信号。因此，运动补偿模块 30 可以帧、程序片、宏区块或区块级自适应地应用平滑滤波器 44。

视频编码器 20 可基于对正被编码的数字视频的一个或一个以上特性的分析而产生滤波器模式决策。预测性区块的特定统计数据可用于确定将使用的滤波器模式。举例来说，预测性区块中的低通频率分量和高通频率分量的量可用于导出滤波器模式。如果预测性区块中存在大量的高通频率分量，那么可应用第二滤波器模式，（例如）以提供平滑。或者，如果预测性区块中的高频分量的量并不大，那么可应用第一滤波器模式。可使用预测性区块和/或相邻视频区块的其它统计数据或特性。举例来说，如果预测性区块在运动补偿期间由较小的（例如，4×4）区块分区形成，那么可应用第二滤波器模式。或者，如果预测性区块并非由较小的区块分区形成，那么可应用第一滤波器模式。

当经编码的位流中未传输滤波器模式信号时，解码器侧的控制模块 46 可使用源装置 12 中的编码器在视频的编码期间可用来决定滤波器模式的视频信号的大体上相同的统计数据/或特性（如上所述），基于对经由信道 16 接收到的经编码视频的分析而推断出滤波器模式信号。因此，如同编码器，解码器 26A 可分析预测性区块以确定高频分量和低频分量的存在，且/或确定区块是否由较小的区块分区组成。在此基础上，解码器 26 以与编码器大体上相同的方式选择适当的滤波器模式。一般来说，编码器 20 和解码器 26 应使用相同的信息，且遵循同一逻辑以导出滤波器模式，以便防止解码器中的漂移。

图 5 是说明视频解码器 26B 的另一示范性方面的框图。视频解码器 26B 可大体上类似于图 4 的视频解码器 26A。然而，视频解码器 26B 进一步包含经平滑运动补偿模块 52，所述模块组合与规则运动补偿相关联的内插滤波与额外的平滑。当控制模块 46 产生指示第一滤波器模式的滤波器模式决策时，运动补偿模块 30 选择运动补偿单元 42 以在无额外滤波的情况下产生预测性区块。在此情况下，运动补偿单元 42 执行规则运动补偿，其可包含对具有分数像素精确度的运动向量的内插滤波。然而，当控制模块 46 产生指示第二滤波器模式的滤波器模式决策时，运动补偿模块 30 选择经平滑运动补偿滤波器 52。因此，控制模块 46 选择应使用规则预测区块还是经平滑预测区块。

实际上，经平滑运动补偿滤波器 52 可组合运动补偿单元 42 与平滑滤波器的特征。以此方式，在第二滤波器模式下，平滑可结合内插滤波而应用，而不是以级联的方式。

在具有单个滤波器模块而不是两个或两个以上滤波器模块的情况下，可降低处理复杂性。为了获得分数像素位置处的视频，运动补偿单元 42 可包含内插滤波器的功能性。当应用例如平滑滤波器的额外滤波器时，可将其与运动补偿单元 42 中的内插滤波器组合以形成经平滑运动补偿滤波器 48，且从而降低系统复杂性。经平滑运动补偿模块 52 基于多个假定和近似法（将在下文对其进行描述）而组合运动补偿单元 42 与平滑滤波器的功能性。

检视内插滤波器与平滑滤波器的此组合的替代方式为，当将产生经平滑预测区块时，运动补偿模块 30 在第二滤波器模式下调用不同的经修改滤波器，即，经平滑运动补偿滤波器 52。换句话说，用以产生 S（MC（参考区块，运动向量）的平滑滤波器 S 与运动补偿 MC 的级联由为数学近似法 S（MC()）的组合式滤波器 MC'（参考区块，运动向量）代替。

此数学近似法可在用于在需要平滑时在第二滤波器模式下应用的经平滑运动补偿滤波器 52 中实施。如何形成在经平滑运动补偿滤波器 52 的 MC'中使用的滤波器的实例可从对 H.264/AVC 的可缩放视频编码（SVC）扩展的框架获得。在本发明中，对经运动补偿的预测执行额外滤波的方法可被称为自适应运动补偿。在一些情况下，滤波器模式信号可为 H.264/AVC 标准中所指定的经平滑预测（smoothedPred）旗标。明确地说，控制模块 46 可将经平滑预测（smoothedPred）旗标的状态理解为滤波器模式决策的指示。

图 6 到图 8 说明实例经平滑运动补偿滤波器 52 的导出的情况。然而，所述技术不应限于此示范性导出，且可应用于上文所论述的一般框架。经平滑运动滤波器 52 可大体上类似于下文参看图 6 而论述的经平滑运动滤波器 52。

图 6 是说明另一示范性视频解码器 26C 的框图。在图 6 中，视频解码器 26C 可经配置以支持可缩放视频编码（SVC）。举例来说，视频解码器 26C 可遵从 H.264/MPEG-4 第 10 部分 AVC 标准的 SVC 扩展。视频解码器 26C 可大体上类似于图 5 的视频解码器 26B，但进一步经配置以支援 SVC。如在图 5 的实例中，图 6 的实例中的滤波器模式信号可为 H.264/MPEG-4 第 10 部分 AVC 标准中所指定的经平滑预测（smoothedPred）旗标。在此实例中，控制模块 46 可将经平滑预测（smoothedPred）旗标的状态理解为滤波器模式决策的指示。在图 6 的实例中，视频解码器 26C 进一步包含切换器 54 的功能性，切换器 54 可根据对 AVC/H.264 的 SVC 扩展将残余预测（ResPred）旗标作为输入而接收，如下文更详细地描述。

由来自 ISO/IEC MPEG 和 ITU-T VCEG 的视频编码专家组成的联合视频团队（JVT）目前正从事于对 H.264/AVC 的 SVC 扩展。被称为 JSVM（联合可缩放视频模型）的常

见软件正由参与者使用。JSVM 支持经组合的可缩放性。位流可具有 SNR 可缩放性、细粒度可缩放性（FGS）、空间可缩放性和时间可缩放性。空间可缩放性允许视频解码器 26C 通过对来自 SVC 位流的增强层位流进行解码来重构和显示较高空间分辨率的视频信号，例如，共用中间格式（CIF），而不是四分之一共用中间格式（QCIF）。

SVC 支持用以改进编码性能的许多层间预测技术。举例来说，当对增强层宏区块进行编码时，可使用来自基础或先前层的对应的宏区块模式、运动信息和残余信号。明确地说，可添加 BL 跳过（BLskip）旗标作为宏区块（MB）级语法元素。如果当前 MB 是中间 MB，且 BL 跳过（BLskip）旗标被设置为 1，那么增强层 MB 将继承来自对应的基础或先前层 MB 的 MB 模式、运动向量和参考图片索引。

当使用空间可缩放性时，增强层表示空间分辨率高于基础或先前层位流的空间分辨率的视频信号。在此情况下，在将基础或先前层 MB 信息用于层间预测中之前，对所述信息进行上取样。举例来说，当空间可缩放性因子为 2:1（二元空间可缩放性）时，在每一维度中通过因子 2 对基础或先前层 MB 信息进行上取样。如果基础或先前层 MB 具有模式_8×8（MODE_8×8）（具有四个 8×8 区块的经层间预测的宏区块），那么经上取样的视频信号在对应位置处将具有四个宏区块（其具有模式_16×16）。

SVC 中还支持另一层间预测方法，残余预测。可使基础或先前层中的一些残余区块与对应的增强层残余区块相关。对于这些区块，应用残余预测可减小增强层残余能量并改进编码性能。在 SVC 中，使用一位旗标残余预测（ResPred）来指示残余预测是否被使用。如同 BL 跳过（BLskip），残余预测（ResPred）也被编码为宏区块级语法元素。如果残余预测（ResPred）=1，那么在从增强层残余减去基础或先前层残余区块之后对增强层残余进行编码。

因此，为了适当地对增强层进行解码，视频解码器 26C 可将基础或先前层残余区块添加到增强层。参看图 6，举例来说，如果残余预测（ResPred）=1，那么切换器 54 将基础或先前层残余（图 6 中的“基础层残余”）提供到加法器 S1，加法器 S1 对增强层残余（图 6 中的“残余”）与预测区块（图 6 中的“预测”）进行求和。与 SVC 情况对比，图 5 展示类似的技术，但不包含用以将基础层残余提供给此加法器的切换器 58 的表示。然而，类似于图 4 的切换器 50，切换器 54 仅用于说明的目的，且是否提供基础层残余的选择可为软件功能，且无需由实际切换器实现。

如果使用空间可缩放性，那么在将基础或先前层残余信号用于层间预测之前，对所述信号进行上取样。在二元空间可缩放性的情况下，SVC 使用双线性滤波器来对残余信号进行上取样。关于 SVC 中所使用的层间预测的更多细节可（例如）在托马斯·韦根

（Thomas Wiegand）、加里·沙利文（Gary Sullivan）、朱利安·赖歇（Julien Reichel）、黑寇·施瓦茨（Heiko Schwarz）和马蒂亚斯·维恩（Mathias Wien）的“SVC 修订的联合草案 7（第 2 版）（Joint Draft 7 of SVC Amendment (revision 2))”（JVT-T201r2，2006 年 7 月，克拉根福，奥地利）（JD7）中找到。

基于残余预测，被称为经平滑参考（SR）的技术可应用于视频解码器中以进一步改进编码性能以获得空间可缩放性。韩振宇（Woo-Jin Han）的“经修改的使用经平滑参考的内 BL 设计（Modified IntraBL design using smoothed reference）”（JVT-R091r1，2006 年 1 月，曼谷，泰国）中描述 SR 技术的实例。如本发明中所描述的支持经运动补偿预测区块的自适应滤波的视频编码技术可实现类似于 SR 技术的编码增益，但具有显著较低的复杂性。针对上下文，下文结合图 7 而描述实例 SR 技术，图 7 是说明 SVC 增强层编码中的经平滑参考（SR）处理的应用的图。

现在将参考 H.264/MPEG-4 第 10 部分 AVC 标准来描述根据本发明某些方面的经平滑运动补偿滤波器 52 的实例实施方案的导出。首先，以下等式（1）将对 H.264/MPEG-4 第 10 部分 AVC 标准的 SVC 扩展的经平滑参考运算部分地描述为：

$$O-S(P+U_R(R_b)) \tag{1}$$

其中 O 表示当前编码层中的原始区块，S 表示平滑滤波器的应用，P 表示预测性区块，U_R 表示当前层与基础或先前层之间的上取样运算，且 R_b 表示经重构的残余区块。根据本发明，通过典型的数学运算，可如下简化等式（1），从而得出以下等式（2）：

$$O-S(P)-S(U_R(R_b)) \tag{2}$$

通过注意到如果有视觉质量的任何改进，那么使经上取样的经重构残余区块平滑的效应或者等式（2）的 $S(U_R(R_b))$部分常得出较小值，等式（2）可被进一步简化为以下等式（3）。已用实验方法观察到，通过仅使预测信号 P 平滑，可保持来自 SR 处理的性能增益。因此，基于 $S(U_R(R_b))$可充分表示为 $U_R(R_b)$的假定，得出以下等式（3）：

$$O-S(P)-U_R(R_b)。 \tag{3}$$

根据以上等式（3），可将 SVC 中的经平滑参考视为图 4 的视频解码器 26A 的示范

性方面中所示的较一般框架的特殊情况。与应用经级联的运动补偿 MC()与平滑 S()的 SR 技术相反，平滑运动补偿滤波器 52 可经配置以支持经修改的运动补偿 MC'()，其在本文中被称为经平滑运动补偿。

图 7 是说明 SVC 增强层编码中的经平滑参考（SR）处理的示范性应用的图。更明确地说，图 7 展示视频解码器中的运动补偿处理，其涉及增强层（层 N）中的前向参考帧 51A、当前帧 51B 和后向参考帧 51C，以及基础或先前层（层 N-1）中的前向参考帧 53A、当前帧 53B 和后向参考帧 53C。图 7 说明双向预测。然而，可使用一个方向上的预测。

首先，当为增强层中的给定 MB 55B 设置残余预测（ResPred）旗标和 BL 跳过（BLskip）旗标两者时，额外旗标经平滑参考（SmoothedRef）由编码器 20 发送。当经平滑参考（SmoothedRef）=1 时，来自基础或先前层（层 N-1）中的对应宏区块 57B 的可能经上取样的运动向量 $U_{mv}(MVb)$用于对增强层（层 N）中的当前视频区块 55B 进行编码，其中 $U_{mv}()$是对运动向量的上取样运算。将此步骤指示为图 7 的图中的“运动再使用”59A、59B。如果增强层的分辨率与基础层的分辨率相同，那么 $U_{mv}(MVb)=MVb$。或者，需要上取样运算 $U_{mv}()$以从基础层（或先前层）的空间分辨率上取样到适用的增强层的分辨率。

第二，使用运动再使用运算 59A、59B 中所导出的运动向量，经由通过规则运动补偿滤波 68 进行的运动补偿，来产生预测区块（P）61。第三，对来自基础或先前层（层 N-1）的对应的经重构残余区块 57B（Rb）进行上取样以获得 $U_R(Rb)$，其中 $U_R()$为对残余的上取样运算。从指向基础或先前层 N-1 中的参考帧 53A、53C 中的对应区块 57A、57C 的运动向量获得经重构的残余区块 57B。如果未使用空间可缩放性，那么 $U_R(r)=r$。将经上取样的区块 $U_R(Rb)$添加到预测区块 61（P）。此添加因为残余预测（ResPred）旗标被设置而发生，从而致使切换器（例如，图 6 的切换器 54）将基础层残余（其在此情况下为经上取样的区块 $U_R(Rb)$）提供给加法器 S1。

第四，将平滑滤波器 63（S）应用于区块 $P+U_R(Rb)$以获得经平滑区块 65（$S(P+U_R(Rb))$）。举例来说，可将具有系数[1, 2, 1]的 3 分接头低通滤波器用作平滑滤波器 63。首先在水平方向上且接着在垂直方向上对宏区块（MB）进行滤波。第五，预测残差 $O-S(P+U_R(Rb))$（其中 O 为当前层（层 N）中的原始区块）为预测残余，且在例如变换、量化和熵编码 67 等典型步骤中进行编码。如在 SVC 中的 SR 处理可带来较高复杂性。SR 将额外滤波操作（例如，平滑滤波器 63）添加在运动补偿中所使用的任何分数像素内插滤波器之上，从而呈现非常高的计算复杂性。

对于不同的预测区块，假若噪声的量和类型不同，额外平滑滤波的应用并不总是必需的。根据本发明的各个方面，有可能自适应地决定应使用规则预测区块还是经滤波（经平滑）的预测区块。根据第一滤波器模式，规则预测区块的使用可涉及运动补偿的应用。如果相关运动向量指定分数像素值，那么第一滤波器模式可涉及内插滤波器的应用。根据第二滤波器模式，预测区块的平滑可涉及额外滤波器的应用。如本发明中所描述，第一滤波器模式或第二滤波器模式的选择可基于滤波器模式决策。通过选择性地应用第一滤波器模式或第二滤波器模式，可为一些区块降低计算复杂性。

图 8 是说明使用自适应运动补偿的经平滑参考（SR）处理在 SVC 增强层编码中的示范性应用的图。更明确地说，图 8 展示视频解码器中的另一运动补偿处理，其涉及增强层（层 N）中的前向参考帧 51A、当前帧 51B 和后向参考帧 51C，以及基础或先前层（层 N-1）中的前向参考帧 53A、当前帧 53B 和后向参考帧 53C。图 8 说明双向预测。然而，可使用一个方向上的预测。图 8 中所示的运动补偿处理可大体上类似于图 7 中所示的运动补偿处理。然而，在图 8 中，运动补偿处理包括自适应运动补偿（MC）滤波 69，其替代图 7 的规则运动补偿滤波 68 和平滑滤波器 63。

如上文所述，自适应运动补偿滤波 69 可应用不同的滤波器，其表示两个（例如，内插滤波器与平滑滤波器滤波器）的组合。举例来说，可将由自适应运动补偿滤波 69 提供的不同滤波器用作图 5 或图 6 的实例中的经平滑运动补偿滤波器 52。数学上，在图 8 的实例中，用以产生 S(MC(参考区块，运动向量)的平滑滤波器 63 与规则运动补偿滤波 68 的级联由为数学近似法 S(MC())的组合式滤波器 MC'(参考区块，运动向量)或高级运动补偿滤波 69 或者经级联的规则运动补偿滤波 68 与平滑滤波器 63 代替。通过组合这两个滤波器的应用，可降低视频解码器的复杂性，同时仍可能产生与以上参看图 7 而产生的相同预测视觉区块 61 相比，视觉质量相等和更高的预测视频区块 61。

可通过对实例情况（二元空间可缩放性）的考虑，进一步描述应用经平滑运动补偿滤波器 52 的自适应运动补偿滤波 69。在二元空间可缩放性中，基础或任何先前层中的¼像素运动向量经上取样以变为增强层中的½像素运动向量。对于½像素精确度运动向量，在 H.264/MPEG-4 第 10 部分 AVC 和 SVC 运动补偿处理 MC()中使用 6 分接头滤波器。

图 9 是用于亮度½像素内插的一维、六分接头滤波器的实例的图。在图 9 中，灰色框表示整数像素位置，黑色框表示½像素位置，且白色框表示¼像素位置。为了内插由 *a*、*b* 和 *c* 表示的½像素位置，可使用以下等式（4）：

$$
\begin{aligned}
a &= (A - 5*B + 20*C + 20*D - 5*E + F + 16) >> 5 \\
b &= (B - 5*C + 20*D + 20*E - 5*F + G + 16) >> 5 \\
c &= (C - 5*D + 20*E + 20*F - 5*G + H + 16) >> 5
\end{aligned}
\tag{4}
$$

其中，A、B、C、D、E、F、G 和 H 表示整数像素位置。

通过假定使用具有系数[1, 4, 1]的略有不同的平滑滤波器来代替 SVC 扩展中所界定的常规[1, 2, 1]滤波器，中心½像素位置或 b 的等式缩减为以下等式（5）：

$$
\begin{aligned}
b' &= (a + 4*b + c + 3)/6 \\
&= (A - B + C + 95*D + 95*E + F - G + H + 16 + 96)/192 \\
&\cong (D + E + 1) >> 1
\end{aligned}
\tag{5}
$$

在以上等式（5）以及以下等式（6）和（7）中，省略了舍入偏差以不失一般性地简化论述内容。在实际实施方案中，可在等式（5）到（7）的每一者中执行除法之前使用舍入偏差。等式（5）导致低复杂性 2 分接头滤波器：$(D + E)/2$。此 2 分接头滤波器可在组合式经平滑运动补偿滤波器 MC'()中用于½像素内插。对于整数像素运动向量，经平滑运动补偿滤波器 MC'()可应用 3 分接头[1, 2, 1]平滑滤波器以获得平滑效应。以此方式，MC'()中所使用的滤波器（即，经平滑运动补偿滤波器 52）的复杂性可显著小于与额外平滑操作（即，平滑滤波器 44）级联的正常运动补偿滤波器 MC()（即，位于运动补偿单元 42 中）的组合复杂性。总之，经平滑运动补偿模块 52 中的经平滑运动补偿滤波器 MC'()可经配置以提供以下滤波器功能：

（1）如果基础运动向量的两个分量（垂直和水平）（在上取样之后）都具有整数精确度，那么在垂直方向和水平方向上应用平滑滤波器；

（2）如果基础运动向量的一个分量具有整数精确度且另一分量具有分数（例如，½）像素精确度，那么使用 2 分接头滤波器（例如双线性滤波器）的内插首先对½像素分量进行，其结合平滑滤波器对另一维度中的另一分量的应用；以及

（3）如果基础运动向量的两个分量都具有分数像素精确度，那么在两个维度（即，垂直和水平）中都执行使用 2 分接头滤波器的内插。

SVC 还可支持经扩展的空间可缩放性（ESS），其中基础与增强层视频维度之间的比例缩放因子可以是任意的。对于 ESS，基础或先前层运动向量通过比例缩放因子而上取样，且被舍入到最近的¼像素位置。对于具有¼像素精确度的运动向量，可在内插中使用双线性滤波器。类似于以上等式（5），根据以下等式（6），MC()中的双线性滤波器与

S()中的平滑滤波器的组合可大致由 MC'()中经加权的平均滤波器近似表示。因为平滑滤波器可与½像素内插中的双线性滤波器组合，所以平滑滤波器可与¼像素内插中的双线性滤波器组合，从而得出以下等式（6）中所界定的 MC'()中的经加权平均滤波器：

$$
\begin{aligned}
e' &= (d+4*e+f+3)/6 \\
&= (223*D+127*E+33*C+F-B-G+A+H+192)/384 \\
&\cong (7*D+4*E+C+6)/12 \\
&\cong (2*D+E+3)/6
\end{aligned} \tag{6}
$$

其中 e'表示将近似表示的¼像素位置，且 d、e 和 f 表示¼像素位置。此外，可通过使用 2 分接头滤波器的内插来近似表示经级联的滤波操作。尽管此经加权平均滤波器可改进视觉质量，但此改进可能不准许由经加权平均滤波器引入的增加的复杂性。因此，在一些情况下，经平滑运动补偿模块 52 不能实施此经加权平均滤波器。相反，经平滑运动补偿模块 52 可实施具有较低实施复杂性的 2 分接头滤波器，例如由以下等式（7）界定的双线性滤波器：

$$
e' \cong (3*D+E)/4 \tag{7}
$$

在此情况下，在 ESS 的情况下，用于在局部像素位置处进行内插的 2 分接头滤波器变为用于½像素位置和¼像素位置两者的双线性滤波器。注意，SVC 中的空间可缩放性的以上实例仅充当用以说明可用于经平滑补偿模块 52 的组合 MC'()中的滤波器（如图 5 和图 6 中所示）的实例，且无意限制本发明的范围。上文所论述的局部自适应运动补偿滤波器和具有特殊特性的滤波器的概念可应用于一般单层或多层视频编码系统。

图 10 是说明经配置以支持不同滤波器在预测区块的垂直维度和水平维度中的应用以适应具有整数像素精确度或分数像素精确度的运动向量分量的视频解码器 26D 的另一示范性方面的框图。在图 10 中，视频解码器 26D 大体上与图 6 的实例中的视频解码器 26C 一致，但进一步说明不同滤波器功能对整数和分数像素精确度运动向量的应用，例如，在垂直维度和水平维度中。在图 10 的实例中，当一个维度中的运动向量指向整数像素位置且另一维度中的运动向量指向分数像素位置时，视频解码器 26D 通过在预测性区块的水平维度和垂直维度中自适应地应用不同滤波器功能来实施自适应运动补偿。举例来说，实际上，经平滑运动补偿模块 52 所实施的组合式滤波器可对具有整数像素

精确度的运动向量分量应用平滑滤波器，且对具有分数像素精确度的运动向量分量应用例如 2 分接头滤波器的内插滤波器，其可为双线性滤波器。因此，图 10 进一步说明经平滑运动补偿滤波器 52 的操作，例如，如上文关于经平滑运动补偿滤波器 MC'()而描述。

类似于图 6 中所示的视频解码器 26C，图 10 的视频解码器 26D 包括运动补偿模块 30、熵解码模块 32、逆量化模块 34、逆变换模块 36、去块滤波器 38、参考帧存储器 40、运动补偿单元 42 和切换器 54。如上文所述，如果在对 SVC 视频流进行解码的过程中使用解码器 26D，且使用残余预测模式并指示额外滤波，那么可使用适当的上取样（如果基础层具有与增强层的分辨率不同的分辨率），将基础层（或先前层）残余添加到当前层处的经重构残余以及预测以获得经重构的视频。在这些实施例中，根据 H.264/MPEG 4 第 10 部分的 SVC 扩展，视频解码器 26D 可包含切换器 54 的功能性，以提供用于与增强层残余和预测区块求和的基础层残余。

另外，在图 10 的实例中，运动补偿模块 30 包含经平滑运动补偿滤波器 52。在图 10 的实例中，经平滑运动补偿滤波器 52 进一步包含平滑滤波器 56 和 2 分接头滤波器 58，其中 2 分接头滤波器 58 可包括双线性滤波器。平滑滤波器 56 可由 3 分接头滤波器形成。

控制单元 46 基于从经编码的视频位流获得的滤波器模式信号而产生滤波器模式决策。滤波器模式决策可在逐区块基础上改变，以经由运动补偿单元 42 应用规则运动补偿或经由经平滑运动补偿滤波器 52 应用运动补偿加上由平滑滤波器 56 或 2 分接头滤波器 58 表示的额外滤波。明确地说，对于第二滤波模式，当经编码的视频位流中的滤波器模式信号指示应应用额外滤波时，或在一些替代实施方案中，当控制模块 46 从对接收到的视频的分析推断出应应用额外滤波时，控制模块 46 经由经平滑运动补偿滤波器 52 自适应地应用额外滤波器 56、58 中的一者或两者。当选择第二滤波器模式时，在经预测区块的适当维度中，经平滑运动补偿滤波器 52 应用平滑滤波器 56 和 2 分接头滤波器 58，例如，双线性滤波器。

平滑滤波器 56 和 2 分接头滤波器 58 在第二滤波模式下的应用视与经预测区块相关联的运动向量而定。举例来说，如果运动向量指向存储于参考帧存储器 40 中的参考帧的水平维度中的分数像素位置，且选择第二滤波器模式，那么经平滑运动补偿滤波器 52 应用 2 分接头滤波器 58（例如，双线性滤波器）作为预测性区块的水平维度中的水平滤波器。然而，如果运动向量指向所述参考帧的水平维度中的整数像素位置，且选择第二滤波器模式，那么经平滑运动补偿滤波器 52 应用平滑滤波器 56（例如，3 分接头滤波器）作为预测性区块的水平维度中的水平滤波器。

如果运动向量还指向所述参考帧的垂直维度中的分数像素位置，且选择第二滤波器模式，那么经平滑运动补偿滤波器 52 应用 2 分接头滤波器 58（例如，双线性滤波器）作为预测性区块的垂直维度中的垂直滤波器。此外，如果运动向量指向所述参考帧的垂直维度中的整数像素位置，且选择第二滤波器模式，那么经平滑运动补偿滤波器 52 应用平滑滤波器 56 作为预测性区块的垂直维度中的垂直滤波器。因此，经平滑运动补偿滤波器 52 可在水平维度中应用例如双线性滤波器的 2 分接头滤波器 58，且在垂直维度中应用例如低通滤波器的平滑滤波器；在水平维度中应用例如低通滤波器的平滑滤波器 56，且在垂直维度中应用例如双线性滤波器的 2 分接头滤波器；在水平维度和垂直维度两者中应用例如双线性滤波器的 2 分接头滤波器；或在水平维度和垂直维度两者中应用例如 3 分接头低通滤波器的平滑滤波器。

以此方式，在第二滤波器模式下，视频解码器 26D 可基于运动向量是指向分数像素位置还是整数像素位置而在预测性区块的水平维度和垂直维度中自适应地应用不同滤波器。在第一滤波器模式下，运动补偿单元 42 在无额外滤波的情况下应用规则运动补偿。在一些情况下，例如对于分数精确度运动向量分量，第一滤波器模式下的规则运动补偿可包含内插滤波。在第二滤波模式下，因为额外滤波可通过以区块级在不同维度中自适应地使用经平滑运动补偿滤波器 52 来实现且适合于特定情况，所以图 10 的视频解码器 26D 可提供优于常规视频解码器的经改进的编码效率和处理效率。

总之，对于第二滤波模式，如果运动向量的两个分量（垂直和水平）都具有整数精确度，那么经平滑运动补偿滤波器 52 在垂直和水平维度两者中都应用平滑滤波器 56。如果基础运动向量的一个分量具有整数精确度且另一分量具有分数像素精确度，那么对于一个维度中的分数像素分量，经平滑运动补偿滤波器 52 应用 2 分接头滤波器 58，且对于另一维度中的另一整数像素分量，应用平滑滤波器 56。如果运动向量的两个分量都具有分数像素精确度，那么经平滑运动补偿滤波器 52 在两个维度（即，垂直和水平）中都应用 2 分接头滤波器 58。因此，根据水平维度或垂直维度中的相关运动向量分量具有分数像素精确度还是整数像素精确度，水平滤波可包括 2 分接头滤波器 58 或平滑滤波器 56 中的一者，且垂直滤波可包括 2 分接头滤波器或平滑滤波器中的一者。可在应用垂直滤波之前应用水平滤波，或反之亦然。

图 11 是说明图 4 的视频解码器 26A 在以帧间编码帧的区块级执行自适应运动补偿的过程中的示范性操作的流程图。如图 11 中所示，视频解码器 26A（例如）经由信道 16 接收经编码的数字视频（70），且执行运动补偿以形成经预测的区块（72）。第一滤波器模式下的运动补偿可涉及使用与数字视频一起接收到的运动向量在一个或一个以上

参考帧中选择对应的区块，以及内插滤波（如果运动向量指向分数像素位置）。在第二滤波器模式下，在自适应基础上，额外滤波（例如，经由平滑滤波器 44 进行平滑以去除量化噪声或其它假影）可连同规则运动补偿一起应用于经预测的区块。可通过在规则运动补偿滤波器之后应用额外滤波器，或通过应用组合规则运动补偿与例如平滑的额外滤波两者的不同滤波器，来实现所述额外滤波。然而，在图 4 的实例中，通过结合运动补偿单元 42（例如，在级联基础上）应用平滑滤波器 44 来实现所述额外滤波。

如上文所述，运动补偿模块 30 可基于与经编码的数字视频一起提供的滤波器模式信号而自适应地应用第一滤波器模式或第二滤波器模式。在一些情况下，滤波器模式信号可为经编码的信号，例如，如联合草案 7（JD7）中所指定的经平滑_参考（smoothed_reference）旗标。以此方式，视频解码器 26A 可做出滤波器模式决策，如由视频编码器 20 引导。或者，视频解码器 26 可分析经编码的数字视频的特性以确定是否应应用额外滤波模式。

第一滤波器模式可涉及规则运动补偿（例如，使用任何必要的内插滤波器），而第二滤波器模式涉及规则运动补偿加上额外滤波（例如，平滑）。举例来说，可使用 2 分接头滤波器来应用内插，且可通过使用 3 分接头滤波器来应用平滑。如果指示第二滤波器模式（74），那么运动补偿模块 30 将额外滤波器应用于经预测的区块（76）。值得注意的是，可在逐区块基础上做出滤波器模式决策，其中术语“区块”可指代宏区块或较小区块（例如，子区块）。或者，滤波器模式决策可根据情况以帧或程序片级做出，且应用于给定帧或程序片内的所有区块。如果未指示第二滤波器模式（74），那么不应用额外滤波，从而在逐区块自适应运动补偿的情况下，为一些区块省去了处理复杂性。

在规则运动补偿（72）或运动补偿加上额外滤波（76）之后，视频解码器 26A 对经编码的数字视频中所提供的经预测区块与残余数据进行求和（78），且基于总和而形成经解码区块（80）。在视频解码器遵照 H.264/AVC 的 SVC 扩展的情况下，例如类似于图 6 的视频解码器 26C 或图 10 的视频解码器 26D 的视频解码器，视频解码器可进一步包含提供用于求和（例如，如由 S1 指示）的基础层残余的切换器 54 的功能性。在此情况下，将运动补偿应用于 SVC 帧的增强层中的区块。在这些情况下，视频解码器 26C 可对基础层残余与经编码的数字视频中所提供的经预测区块和残余数据进行求和（78），以基于总和而形成经解码区块（80）。在任一情况下，所述总和可由去块滤波器 38 处理以去除块化假影。经解码的区块可用于形成视频帧以驱动显示装置 28，且可被添加到参考帧存储器以形成用于对后续帧进行解码的参考帧。通过在区块级处应用额外滤波，经解码的数字视频可展现出增强的编码效率。然而，通过在自适应基础上而不是全部时间

应用额外滤波，视频解码器 26C 可实现显著的性能增益，而无过多的处理复杂性。

图 12 是说明图 5 的视频解码器 26B 在使用组合式经平滑运动补偿单元执行平滑和运动补偿的过程中的示范性操作的流程图。图 12 中所示的处理可适合应用于 SVC 编码。如图 12 中所示，刚一经由信道 16 接收到数字视频（82），视频解码器 26B（图 5）或视频解码器 26C（图 6）就确定是否指示第二滤波器模式（84）。此外，第二滤波器模式可由包含于经编码的视频位流中的滤波器模式信号指示。可在帧、程序片、宏区块或子区块基础上指示第二滤波器模式。或者，视频解码器 26B 可经配置以基于对数字视频的一个和一个以上特性的分析而确定是否应应用第二滤波器模式。

如果指示第二滤波器模式（84），那么运动补偿模块 30 执行组合式平滑与规则运动补偿（即，经平滑运动补偿）以形成经预测区块（86）。可经由图 5 中的运动补偿模块 30 的经平滑运动补偿滤波器 52（图 5 或图 6）来执行经平滑运动补偿。如果未指示第二滤波器模式（84），那么运动补偿模块 30 在无额外滤波的情况下（例如）经由运动补偿模块 30 的运动补偿单元 42 来执行规则运动补偿以形成经预测区块（88）。视频解码器 26B 或 26C 接着对经预测区块与残余数据进行求和（90），且基于总和而形成解码区块（92）。

此外，在视频解码器遵照 H.264/AVC 的 SVC 扩展的情况下，例如类似于图 6 的视频解码器 26C 或图 10 的视频解码器 26D，视频解码器可进一步包含提供用于求和的基础层残余的切换器 54 的功能性。在此情况下，将运动补偿应用于 SVC 帧的增强层中的区块。在这些情况下，视频解码器可对基础层残余与经编码的数字视频中所提供的经预测区块和残余数据进行求和（90），以基于总和而形成经解码区块（92）。在任一情况下，所述总和可由去块滤波器 38 处理以去除块化假影。经解码区块可用于形成视频帧以驱动显示装置 28，且可被添加到参考帧存储器以形成用于后续帧的解码的参考帧。

图 12 说明在单个滤波器模块中组合平滑与规则运动补偿而不是以级联方式将规则运动补偿和平滑作为单独的滤波操作而应用的组合式经平滑运动补偿单元 52 的使用。以此方式，在图 12 的实例中，通过组合规则运动补偿与平滑，可降低处理复杂性。此处理可在每一帧中的区块上且在与视频序列相关联的多个帧和程序片上继续。此外，可在逐帧、逐程序片、逐宏区块或逐区块基础上确定关于是应用经平滑运动补偿单元 52 还是规则运动补偿单元 42 的滤波器模式决策。

图 13 是说明图 10 的视频解码器 26D 在于垂直维度和水平维度中用不同滤波器来执行自适应运动补偿的过程中的示范性操作的流程图。在图 13 的实例中，视频解码器 26D 应用自适应滤波器模式，类似于图 12。明确地说，在第一滤波器模式下，运动补偿模块

30 可应用规则运动补偿单元 42。在第二滤波器模式下，运动补偿模块 30 可应用经平滑运动补偿滤波器 52，平滑运动补偿滤波器 52 组合规则运动补偿与例如平滑的额外滤波。然而，如图 10 中所示，经平滑运动补偿滤波器 52 的应用可进一步涉及不同滤波器 56、58 在水平维度和垂直维度中的应用。刚一接收到数字视频（94），视频解码器 26 就确定是否指示第二滤波器模式（96）。如果未指示第二滤波器模式，那么运动补偿模块 30（例如）经由运动补偿单元 42（图 10）来应用规则运动补偿（98）。如果指示第二滤波器模式（96），那么运动补偿模块 30 可应用经平滑运动补偿滤波器 52，从而实际上提供规则运动补偿和额外滤波两者。

额外滤波可由经平滑运动补偿单元 52 在相关指向整数像素位置的运动向量的维度中（即，在整数维度中）所应用的平滑滤波器（例如 3 分接头滤波器）提供（100）。另外，在预测区块的相关运动向量指向分数像素位置的维度（即，分数维度）中，经平滑运动补偿单元 52 可应用内插滤波器（例如，2 分接头滤波器，例如双线性滤波器）（102）。因此，当指示第二滤波器模式时，经平滑运动补偿单元 52 可在不同维度中应用不同滤波器。如果未指示第二滤波器模式（96），那么替代地应用规则运动补偿（98）。

在任一情况下，视频解码器对经预测区块与适用的残余数据进行求和（104），且基于总和而形成经解码区块（106）。如先前所论述，在视频解码器遵照 H.264/AVC 的 SVC 扩展的情况下，例如类似于图 10 的视频解码器 26D，视频解码器 26D 可进一步包含提供用于求和的基础层残余的切换器 54 的功能性。在此情况下，将运动补偿应用于 SVC 帧的增强层中的区块。在这些情况下，视频解码器 26D 可对基础层残余与经编码的数字视频中所提供的经预测区块和残余数据进行求和（104），以基于总和而形成经解码区块（106）。在任一情况下，所述总和可由去块滤波器 38 处理以去除块化假影。经解码区块可用于形成视频帧以驱动显示装置 28，且可被添加到参考帧存储器以形成用于后续帧的解码的参考帧。如上文所述，经平滑运动补偿滤波器 52 有效地应用运动补偿和平滑操作两者，因此相对于级联方式下每一操作的独立应用而降低复杂性。另外，平滑运动补偿滤波器 52 经配置以依据适用的运动向量而在水平维度和垂直维度中自适应地应用不同滤波器。

本发明中所描述的任何装置可表示各种类型的装置，例如，无线电话、蜂窝式电话、膝上型计算机、无线多媒体装置、无线通信个人计算机（PC）卡、个人数字助理（PDA）、外部或内部调制解调器、游戏装置或经由无线或有线信道通信的任何装置。此装置可具有各种名称，例如接入终端（AT）、接入单元、订户单元、移动台、移动装置、移动单元、移动电话、移动设备、远程台、远程终端机、远程单元、用户装置、用户装备、手

持型装置或类似名称。在一个方面中，如本发明中所描述的装置可以是无线通信装置手持机或形成无线通信装置手持机的一部分。

本文所描述的技术可在硬件、软件、固件或其任何组合中实施。如果在软件中实施，那么所述技术可至少部分地由计算机可读媒体上的一个或一个以上所存储或所传输的指令或代码来实现。计算机可读媒体可包含计算机存储媒体、通信媒体或两者，且可包含促进计算机程序从一处到另一处的传送的任何媒体。存储媒体可以是可由计算机存取的任何可用媒体。

作为实例而非限制，此计算机可读媒体可包括数据存储媒体，例如 RAM（例如同步动态随机存取存储器（SDRAM））、只读存储器（ROM）、非易失性随机存取存储器（NVRAM）、ROM、电可擦除可编程只读存储器（EEPROM）、EEPROM、快闪存储器、CD-ROM 或其它光盘存储、磁盘存储或其它磁性存储装置，或可用于以指令或数据结构的形式携载或存储所需程序代码且可由计算机存取的任何其它计算机可读数据存储媒体。

而且，任何连接均被适当地称为计算机可读媒体。举例来说，如果使用同轴电缆、光纤电缆、双绞线、数字订户线（DSL）或例如红外线、无线电和微波等无线技术从网站、服务器或其它远程来源传输软件，那么同轴电缆、光纤电缆、双绞线、DSL 或例如红外线、无线电和微波等无线技术包含于媒体的定义中。如本文所使用，磁盘和光盘包含压缩光盘（CD）、激光光盘、光学盘、数字多功能光盘（DVD）、软盘和蓝光光盘（blu-ray disc），其中磁盘通常以磁性方式再现数据，而光盘（例如）用激光以光学方式再现数据。以上各项的组合也应被视为计算机可读媒体。

与计算机程序产品的计算机可读媒体相关联的代码可由计算机执行，例如，由一个或一个以上处理器执行，例如，一个或一个以上数字信号处理器（DSP）、通用微处理器、专用集成电路（ASIC）、现场可编程逻辑阵列（FPGA）或其它等效的集成或离散逻辑电路。在一些方面中，本文所描述的功能性可在经配置用于编码和解码的专用软件模块或硬件模块内提供，或并入组合式视频编码器-解码器（CODEC）中。因此，本发明涵盖一种经配置以实施本发明中所描述的技术的集成电路装置。此些集成电路装置可具有多种应用，包含在无线通信装置手持机内的使用。

已描述了本发明的各个方面。这些和其它方面在所附权利要求的范围内。

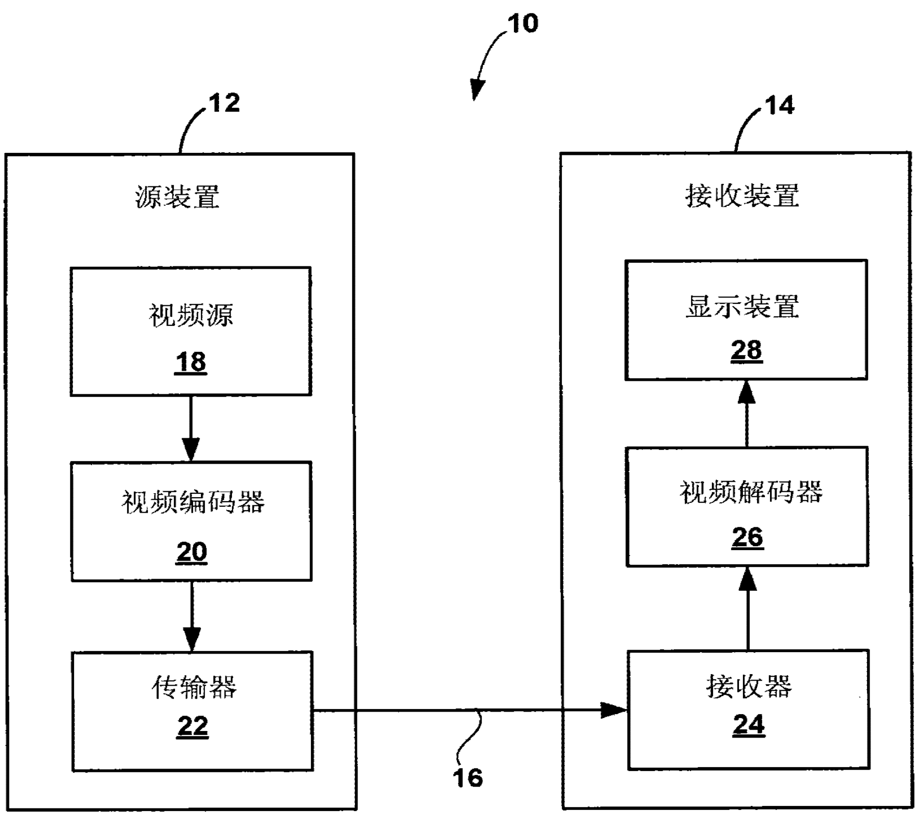

10
12
14
源装置
接收装置
视频源
18
显示装置
28
视频编码器
20
视频解码器
26
传输器
22
接收器
24
16

图1

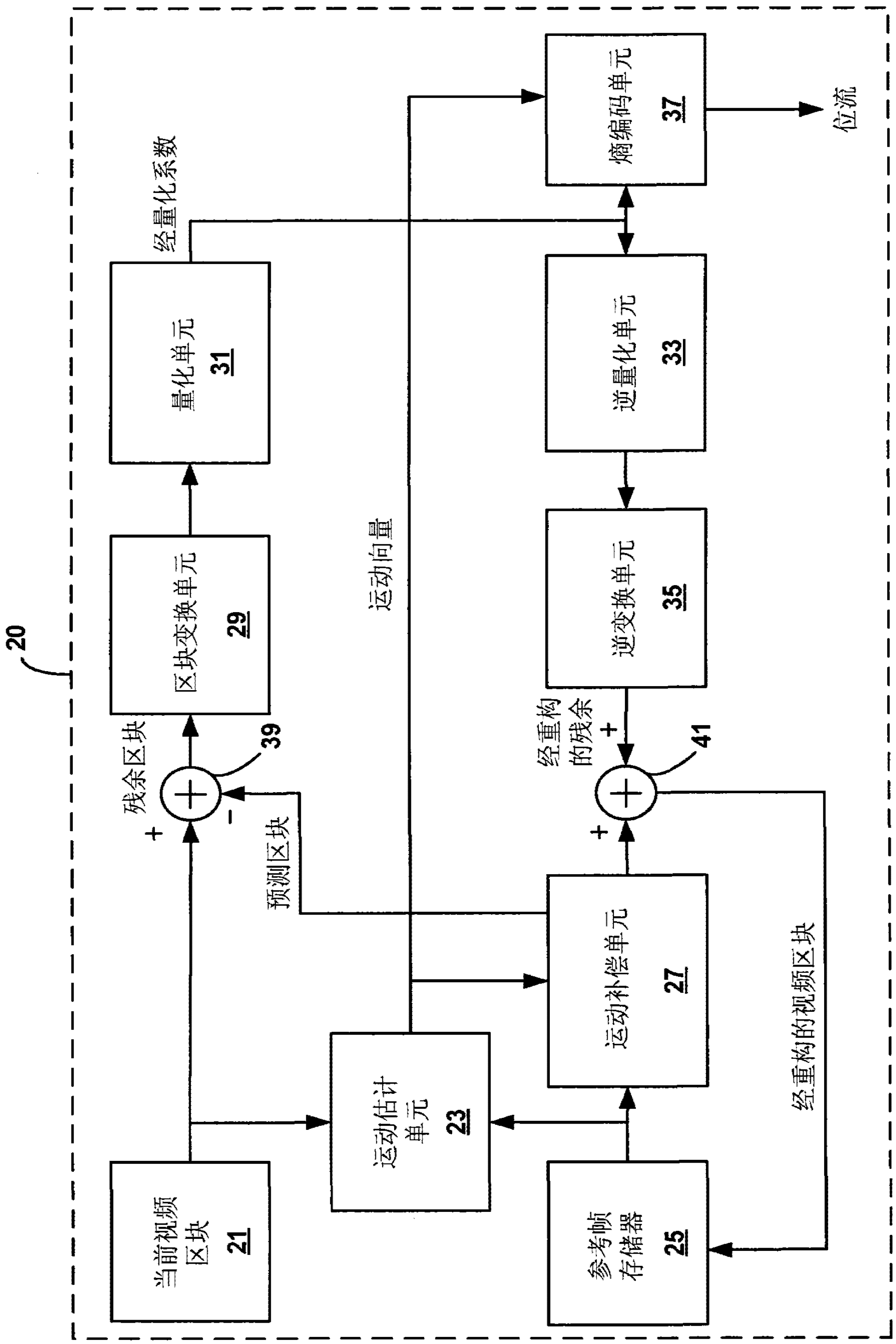

20
当前视频区块
21
运动估计单元
23
参考帧存储器
25
运动补偿单元
27
区块变换单元
29
量化单元
31
逆量化单元
33
逆变换单元
35
熵编码单元
37
残余区块
39
预测区块
经量化系数
运动向量
经重构的残余
41
经重构的视频区块
位流
+
-
+
+

图2

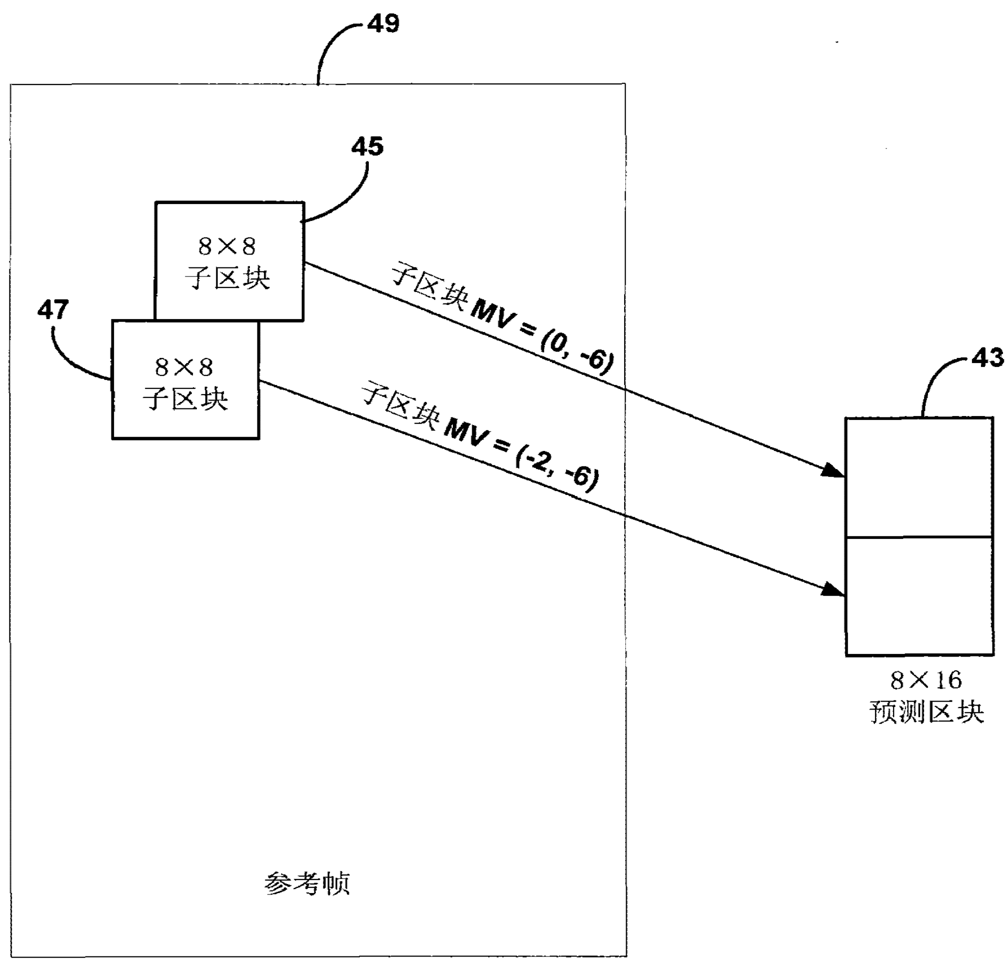


图3

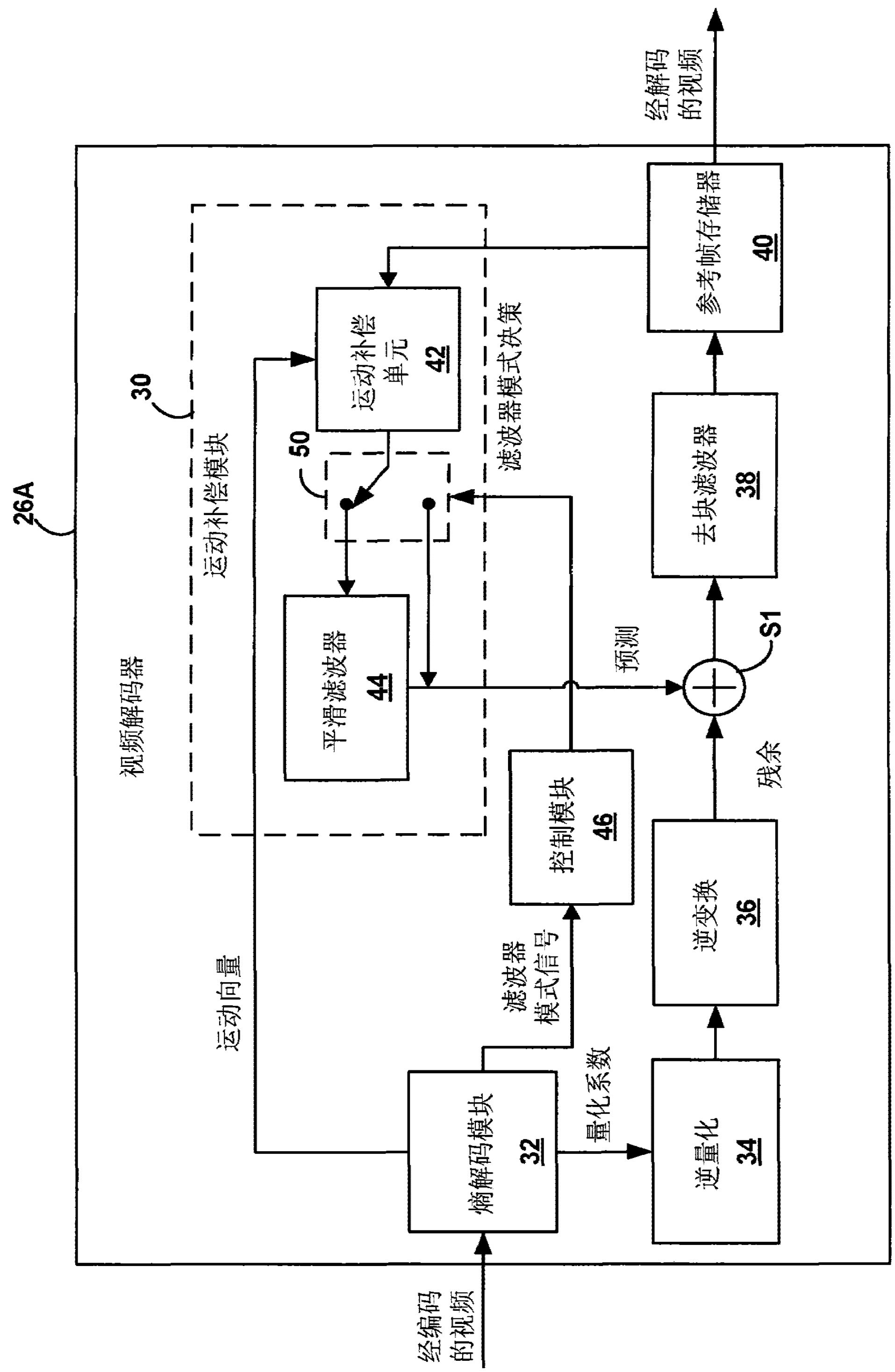

26A
视频解码器
30
运动补偿模块
运动补偿
单元
42
50
平滑滤波器
44
滤波器模式决策
参考帧存储器
40
去块滤波器
38
预测
S1
残余
控制模块
46
逆变换
36
逆量化
34
熵解码模块
32
运动向量
滤波器
模式信号
量化系数
经编码
的视频
经解码
的视频

图4

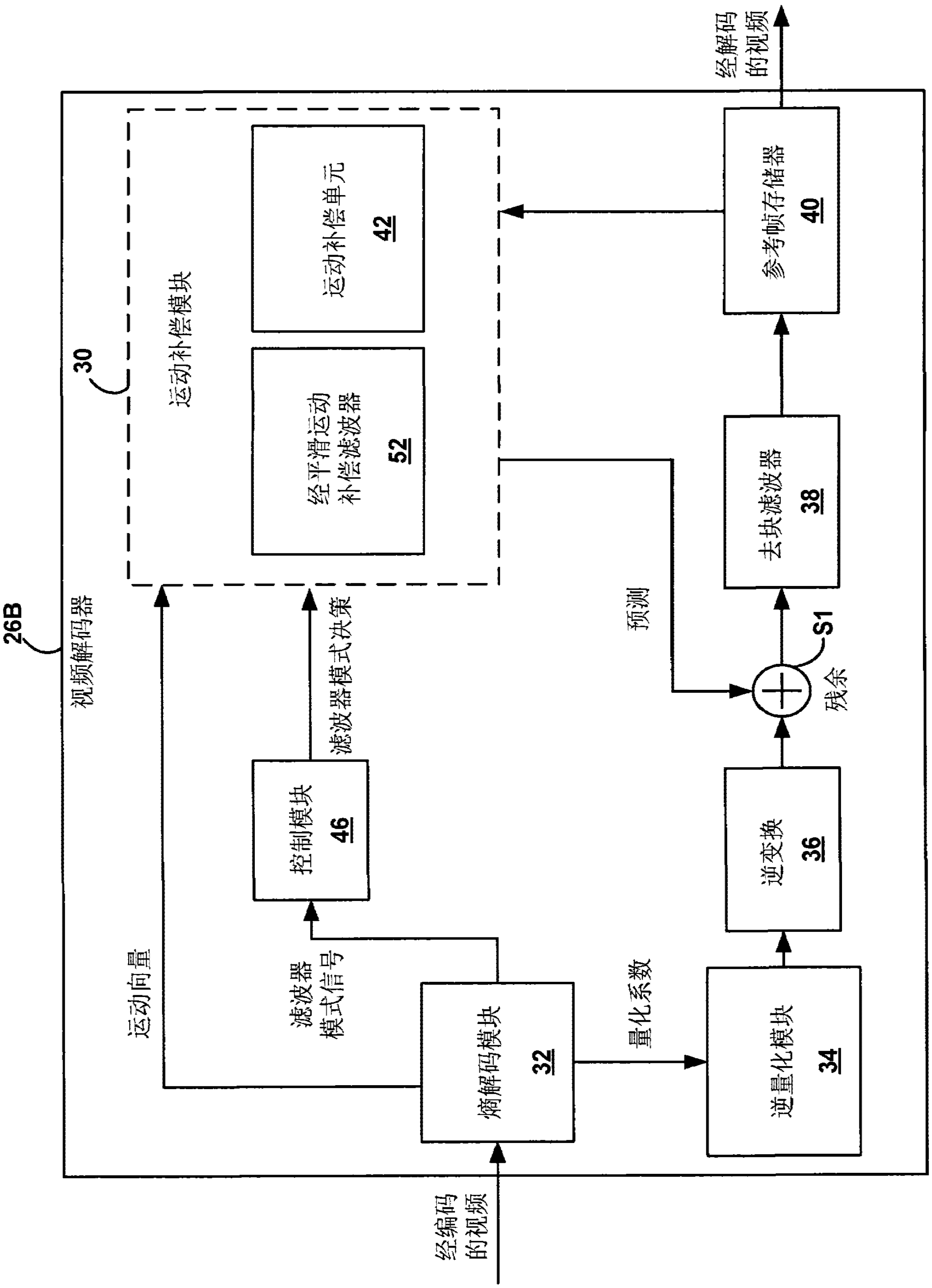

26B
视频解码器
30
运动补偿模块
经平滑运动补偿滤波器
52
运动补偿单元
42
参考帧存储器
40
经解码的视频
去块滤波器
38
预测
S1
残余
逆变换
36
逆量化模块
34
量化系数
熵解码模块
32
经编码的视频
滤波器模式信号
控制模块
46
滤波器模式决策
运动向量

图5

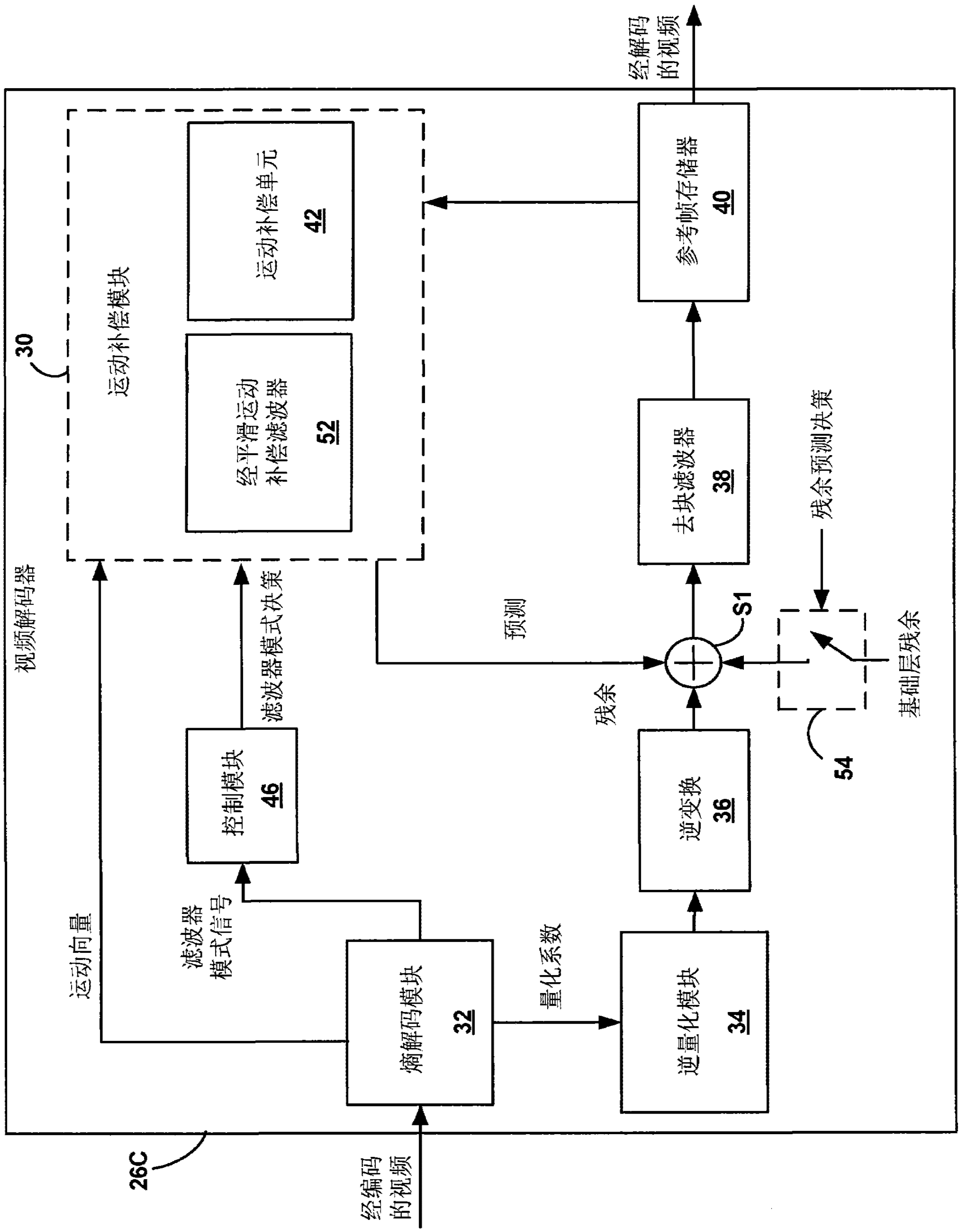

视频解码器
26C
30
运动补偿模块
经平滑运动补偿滤波器
52
运动补偿单元
42
参考帧存储器
40
去块滤波器
38
逆变换
36
逆量化模块
34
熵解码模块
32
控制模块
46
54
S1
经编码的视频
经解码的视频
运动向量
滤波器模式信号
滤波器模式决策
量化系数
残余
预测
残余预测决策
基础层残余

图6

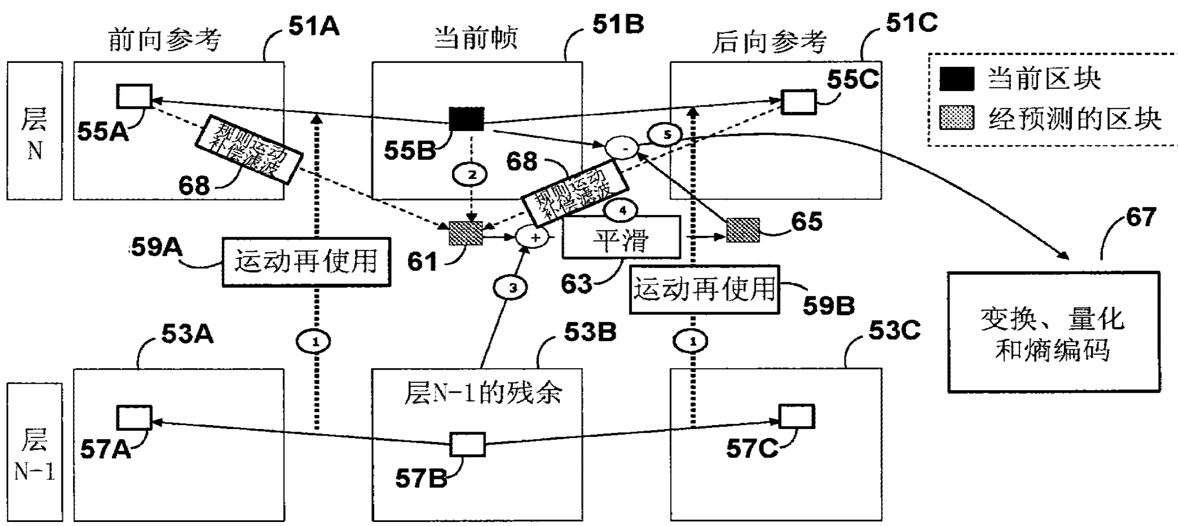

前向参考
51A
当前帧
51B
后向参考
51C
层
N
55A
55B
55C
当前区块
经预测的区块
68
规则运动补偿滤波
68
规则运动补偿滤波
2
4
5
65
67
59A
运动再使用
61
平滑
63
3
运动再使用
59B
变换、量化
和熵编码
53A
53B
53C
1
1
层
N-1
层N-1的残余
57A
57B
57C

图7

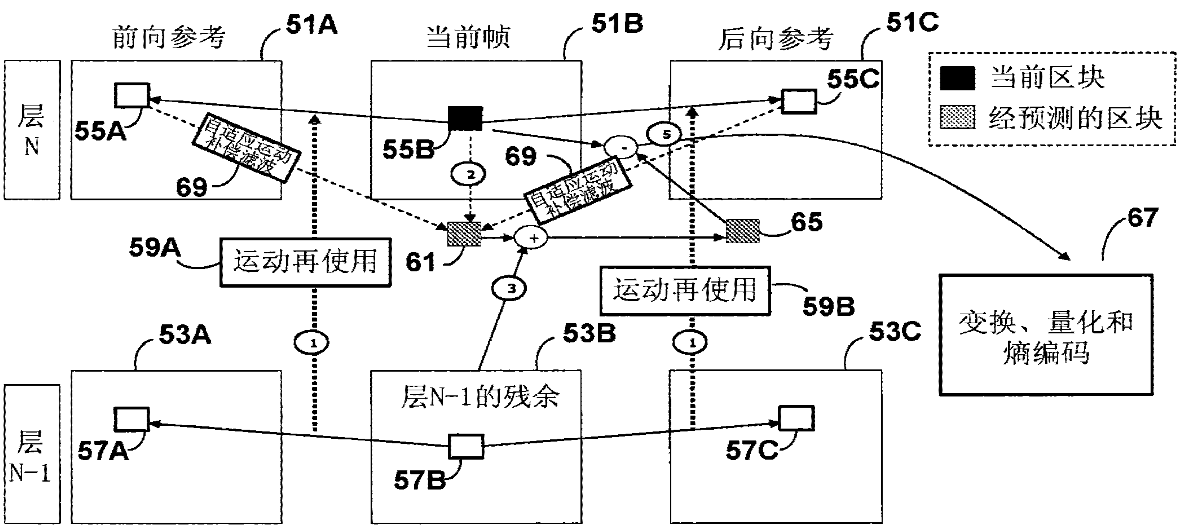

前向参考
51A
当前帧
51B
后向参考
51C
当前区块
经预测的区块
层
N
55A
55B
55C
自适应运动补偿滤波
69
69
65
61
59A
运动再使用
运动再使用
59B
67
变换、量化和熵编码
53A
53B
53C
层N-1的残余
层
N-1
57A
57B
57C

图8

图9

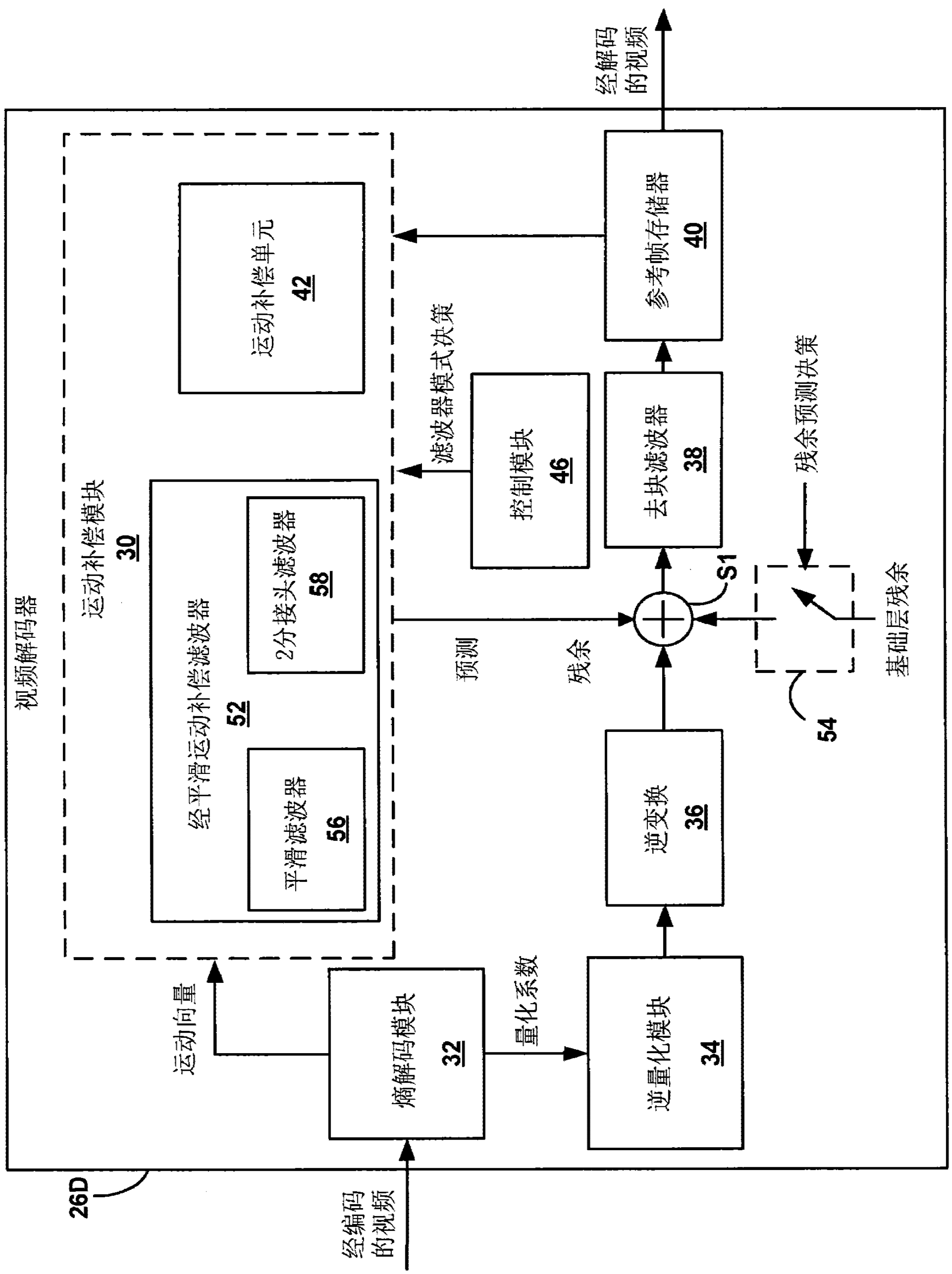

视频解码器
运动补偿模块
30
运动补偿单元
42
经平滑运动补偿滤波器
52
平滑滤波器
56
2分接头滤波器
58
滤波器模式决策
控制模块
46
参考帧存储器
40
经解码的视频
去块滤波器
38
S1
残余预测决策
预测
残余
基础层残余
54
逆变换
36
熵解码模块
32
运动向量
量化系数
逆量化模块
34
26D
经编码的视频

图10

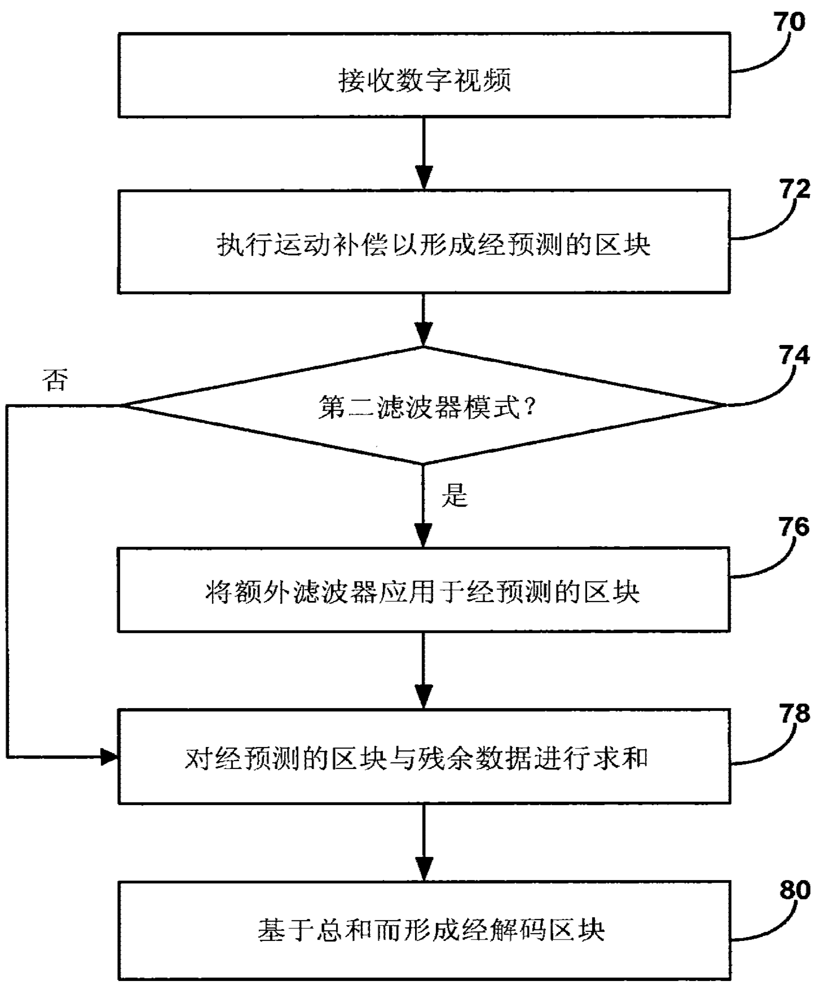
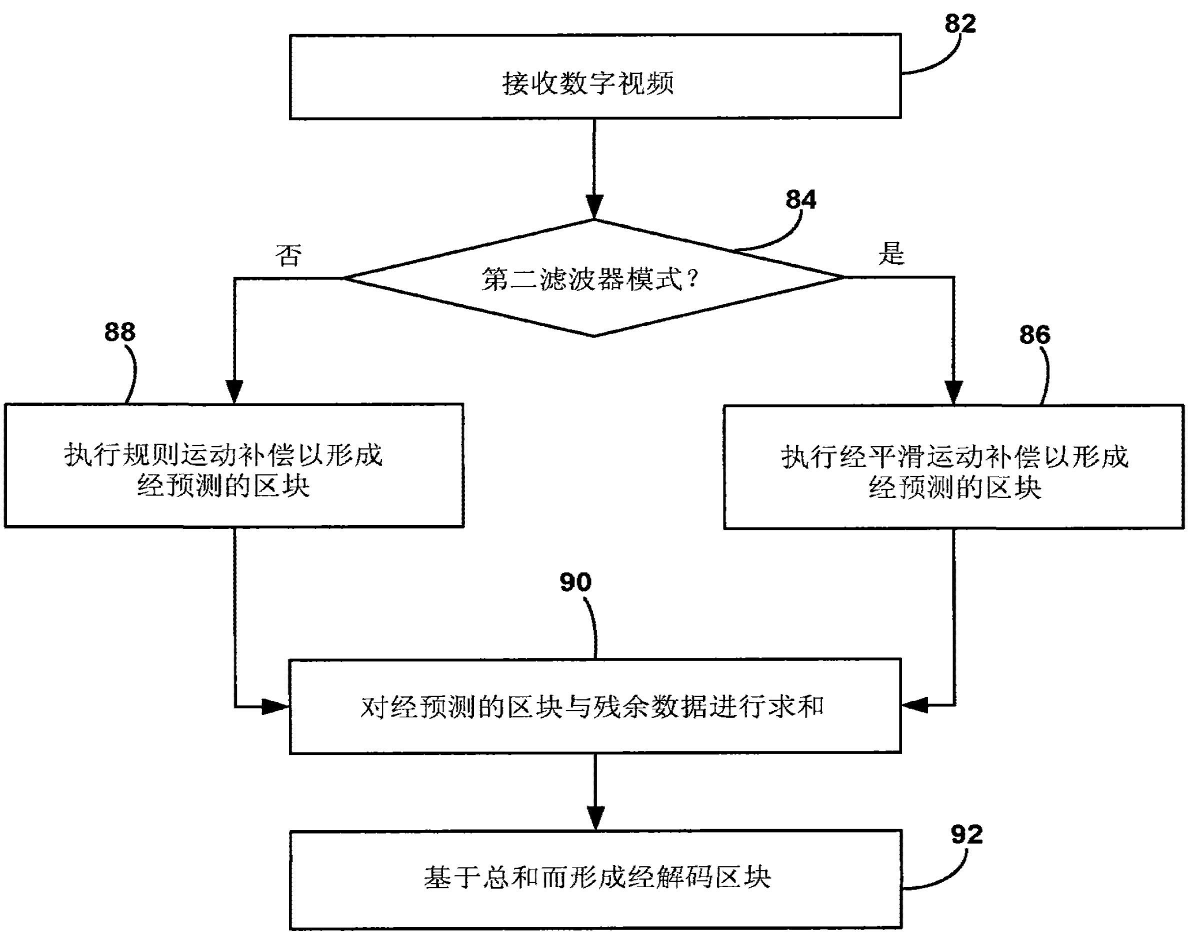

接收数字视频
70
执行运动补偿以形成经预测的区块
72
第二滤波器模式？
74
否
是
将额外滤波器应用于经预测的区块
76
对经预测的区块与残余数据进行求和
78
基于总和而形成经解码区块
80

图11



82
接收数字视频
84
第二滤波器模式？
否
是
88
执行规则运动补偿以形成经预测的区块
86
执行经平滑运动补偿以形成经预测的区块
90
对经预测的区块与残余数据进行求和
92
基于总和而形成经解码区块

图12

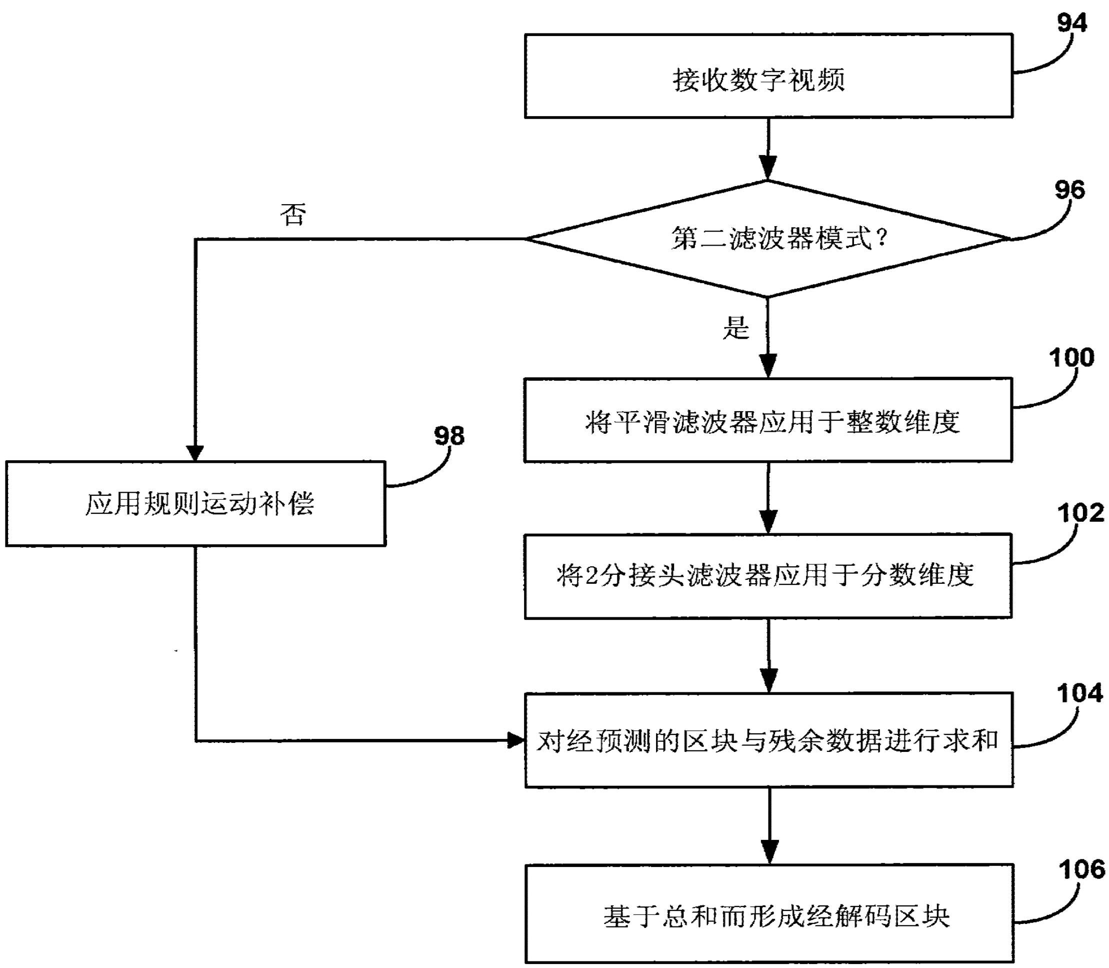

94
接收数字视频
96
第二滤波器模式?
否
是
100
将平滑滤波器应用于整数维度
98
应用规则运动补偿
102
将2分接头滤波器应用于分数维度
104
对经预测的区块与残余数据进行求和
106
基于总和而形成经解码区块

图13

Espacenet

Bibliographic data: CN101816183 (A) — 2010-08-25

Method and apparatus for inter prediction encoding/decoding an image using sub-pixel motion estimation

Inventor(s): TAMMY LEE; WOO-JIN HAN; SUN-MI PARK ± (LEE TAMMY, ; HAN WOO-JIN, ; PARK SUN-MI)

Applicant(s): SAMSUNG ELECTRONICS CO LTD ± (SAMSUNG ELECTRONICS CO., LTD)

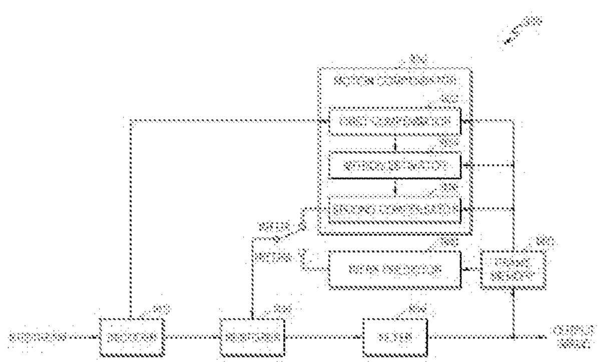
Classification:
- international: *H04N7/32*
- cooperative: H04N19/11 (EP, US); H04N19/137 (KR); H04N19/44 (EP, US); H04N19/51 (EP, KR, US); H04N19/523 (EP, US); H04N19/53 (EP, US); H04N19/533 (EP, US); H04N19/567 (EP, US); H04N19/593 (EP, US); H04N19/82 (EP, US)

Application number: CN200880110254 20080925

Priority number(s): US20070977454P 20071004 ; KR20070129904 20071213 ; WO2008KR05680 20080925

Also published as: CN101816183 (B) EP2198622 (A2) EP2198622 (A4) JP2010541457 (A) JP5385291 (B2) KR101403343 (B1) KR20090034697 (A) US2009092188 (A1) US8503532 (B2) WO2009045021 (A2) WO2009045021 (A3) less

Abstract of CN101816183 (A)



A method of inter prediction encoding of an image, the method including: searching for a first reference block in a reference picture by using a current block, and estimating a first motion vector in a first pel unit in regards to the first reference block; estimating a second motion vector by using pixels included in a pre-encoded area adjacent to the current block, and pixels adjacent to the first reference block, and determining a second reference block based on the second motion vector; and encoding the current block based on the first motion vector and the second reference block.

(19)中华人民共和国国家知识产权局

(12)发明专利申请

(10)申请公布号 CN 101816183 A
(43)申请公布日 2010.08.25

(21)申请号 200880110254.1

(22)申请日 2008.09.25

(30)优先权数据
10-2007-0129904 2007.12.13 KR
60/977,454 2007.10.04 US

(85)PCT申请进入国家阶段日
2010.04.02

(86)PCT申请的申请数据
PCT/KR2008/005680 2008.09.25

(87)PCT申请的公布数据
WO2009/045021 EN 2009.04.09

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(72)发明人 李泰美 韩宇镇 朴先美

(74)专利代理机构 北京铭硕知识产权代理有限公司 11286
代理人 韩明星 马翠平

(51)Int.Cl.
H04N 7/32(2006.01)

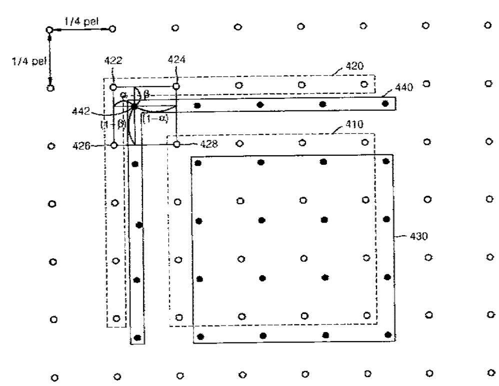
权利要求书 3 页 说明书 10 页 附图 9 页

(54)发明名称

使用子像素运动估计对图像进行帧间预测编码/解码的方法和设备

(57)摘要

一种图像的帧间预测编码的方法，所述方法包括：通过使用当前块来搜索参考图像中的第一参考块，估计第一 pel 单元中的关于第一参考块的第一运动矢量；通过使用与当前块相邻的预编码的区域中包括的像素以及与第一参考块相邻的像素来估计第二运动矢量，基于第二运动矢量确定第二参考块；基于第一运动矢量和第二参考块对当前块编码。



CN 101816183 A

1. 一种对图像进行帧间预测编码的方法，所述方法包括：

通过使用当前块来搜索参考图像中的第一参考块，估计第一 pel 单元中的关于第一参考块的第一运动矢量；

通过使用与当前块相邻的预编码的区域中包括的像素以及与第一参考块相邻的像素来估计第二运动矢量，基于第二运动矢量确定第二参考块；以及

基于第一运动矢量和第二参考块对当前块编码。

2. 如权利要求 1 所述的方法，其中，确定第二运动矢量的步骤包括：

通过执行插值在与第一参考块相邻的像素附近产生子像素；

将相邻于第一参考块的像素和产生的子像素与相邻于当前块的预编码的区域中包括的像素进行比较；以及

基于比较的结果估计第二运动矢量。

3. 如权利要求 2 所述的方法，其中，子像素在第二 pel 单元中，第二运动矢量在第二 pel 单元中。

4. 如权利要求 3 所述的方法，其中，第一 pel 单元是四分之一 pel 单元，第二 pel 单元是八分之一 pel 单元。

5. 如权利要求 4 所述的方法，其中，第二 pel 单元中的子像素是在上、下、左、右、左上、左下、右上和右下方向上距离与第一参考块相邻的像素八分之一 pel 单元的子像素。

6. 如权利要求 3 所述的方法，其中，第一 pel 单元是四分之一 pel 单元，第二 pel 单元是小于八分之一 pel 单元的任意 pel 单元。

7. 如权利要求 1 所述的方法，其中，编码的步骤还包括：

通过将当前块减去第二参考块来产生当前块的残差块；以及

对第一运动矢量和残差块编码。

8. 一种对图像进行帧间预测解码的方法，所述方法包括：

接收包括关于当前块的数据的比特流，从接收的比特流提取第一 pel 单元中的关于第一运动矢量的数据和关于当前块的残差块的数据；

根据第一运动矢量确定第一参考块，通过使用与当前块相邻的预解码的区域中包括的像素以及与第一参考块相邻的像素来确定第二参考块；以及

基于第二参考块和残差块来恢复当前块。

9. 如权利要求 8 所述的方法，其中，产生第二参考块的步骤包括：

通过使用与当前块相邻的预解码的区域中包括的像素以及与第一参考块相邻的像素来估计第二运动矢量；以及

基于第二运动矢量确定第二参考块。

10. 如权利要求 9 所述的方法，其中，估计第二运动矢量的步骤包括：

通过执行插值在与第一参考块相邻的像素附近产生子像素；

将与第一参考块相邻的像素和产生的子像素，以及与当前块相邻的预解码的区域中包括的像素进行比较；以及

基于比较的结果估计第二运动矢量。

11. 如权利要求 10 所述的方法，其中，子像素在第二 pel 单元中，第二运动矢量在第二 pel 单元中。

12. 如权利要求 11 所述的方法，其中，第一 pel 单元是四分之一 pel 单元，第二 pel 单元是八分之一 pel 单元。

13. 如权利要求 12 所述的方法，其中，第二 pel 单元中的子像素是在上、下、左、右、左上、左下、右上和右下方向上距离与第一参考块相邻的像素八分之一 pel 单元的子像素。

14. 如权利要求 11 所述的方法，其中，第一 pel 单元是四分之一 pel 单元，第二 pel 单元是小于八分之一 pel 单元的任意 pel 单元。

15. 如权利要求 8 所述的方法，其中，恢复的步骤包括：通过将当前块的残差块与第二参考块相加来恢复当前块。

16. 一种对图像进行帧间预测编码的设备，所述设备包括：

第一运动估计器，通过使用当前块来搜索参考图像中的第一参考块，估计第一 pel 单元中的关于第一参考块的第一运动矢量；

第二运动估计器，通过使用与当前块相邻的预编码的区域中包括的像素以及与第一参考块相邻的像素来估计第二运动矢量；

运动补偿器，基于第二运动矢量确定第二参考块；和

编码器，基于第一运动矢量和第二参考块对当前块编码。

17. 如权利要求 16 所述的设备，其中，第二运动估计器通过执行插值在与第一参考块相邻的像素附近产生子像素；通过将相邻于第一参考块的像素和产生的子像素与相邻于当前块的预解码的区域中包括的像素进行比较来估计第二运动矢量。

18. 如权利要求 17 所述的设备，其中，子像素在第二 pel 单元中，第二运动矢量在第二 pel 单元中。

19. 如权利要求 18 所述的设备，其中，第一 pel 单元是四分之一 pel 单元，第二 pel 单元是八分之一 pel 单元。

20. 一种对图像进行帧间预测解码的设备，所述设备包括：

解码器，接收包括关于当前块的数据的比特流，从接收的比特流提取第一 pel 单元中的关于第一运动矢量的数据和关于当前块的残差块的数据；

运动补偿器，根据第一运动矢量确定第一参考块，通过使用与当前块相邻的预解码的区域中包括的像素以及与第一参考块相邻的像素来确定第二参考块；以及

恢复器，基于确定的第二参考块和残差块来恢复当前块。

21. 如权利要求 20 所述的设备，其中，运动补偿器包括：

第一补偿器，根据第一运动矢量确定第一参考块；

运动矢量估计器，通过使用与当前块相邻的预解码的区域中包括的像素以及与第一参考块相邻的像素来估计第二运动矢量；以及

第二补偿器，根据第二运动矢量确定将在当前块的帧间预测中使用的第二参考块。

22. 如权利要求 21 所述的设备，其中，运动矢量估计器通过执行插值在与第一参考块相邻的像素附近产生子像素，通过将相邻于第一参考块的像素和产生的子像素与相邻于当前块的预解码的区域中包括的像素进行比较来估计第二运动矢量。

23. 如权利要求 22 所述的设备，其中，子像素在第二 pel 单元中，第二运动矢量在第二 pel 单元中。

24. 如权利要求 23 所述的设备，其中，第一 pel 单元是四分之一 pel 单元，第二 pel 单

元是八分之一 pel 单元。

25. 一种记录有用于使计算机能够实现以下方法的一组指令的计算机可读记录介质：

通过使用当前块来搜索参考图像中的第一参考块，估计第一 pel 单元中的关于第一参考块的第一运动矢量；

通过使用与当前块相邻的预编码的区域中包括的像素以及与第一参考块相邻的像素来估计第二运动矢量，基于第二运动矢量确定第二参考块；以及

基于第一运动矢量和第二参考块对当前块编码。

26. 一种记录有用于使计算机能够实现以下方法的一组指令的计算机可读记录介质：

接收包括关于当前块的数据的比特流，从接收的比特流提取第一 pel 单元中的关于第一运动矢量的数据和关于当前块的残差块的数据；

根据第一运动矢量确定第一参考块，通过使用与当前块相邻的预解码的区域中包括的像素以及与第一参考块相邻的像素来确定第二参考块；以及

基于第二参考块和残差块来恢复当前块。

使用子像素运动估计对图像进行帧间预测编码/解码的方法和设备

技术领域

[0001] 本发明涉及一种对图像进行帧间预测编码/解码的方法和设备，更具体地，涉及一种通过使用高精度子像素执行帧间预测，并基于帧间预测结果对图像进行编码/解码的方法和设备。

背景技术

[0002] 在压缩图像的传统方法（诸如，MPEG-1、MPEG-2 和 MPEG-4H.264/MPEG-4 先进视频编码（AVC））中，图像被划分为宏块，以对图像编码。随后，使用帧间预测或帧内预测对每个宏块进行编码。

[0003] 在通过使用帧间预测对图像进行编码的方法中，通过去除图像间的时间冗余对图像进行编码，这种方法的代表示例是基于运动估计的编码方法，在所述方法中通过使用至少一个参考图像来估计当前图像中包括的块的每个运动。这里，在至少一个参考图像的预定的搜索范围内使用预定的估计函数来搜索与当前块最相似的参考块。

[0004] 对在当前块与参考图像中包括的块之间的绝对差和（SAD）进行计算，具有最小 SAD 的块被确定为当前块的参考块，确定的参考块是当前块的预测块。通过从当前块减去预测块来产生当前块的残差块，通过仅对产生的残差块进行编码而增加图像编码的压缩率。被编码的块的单元可以是各种大小，诸如 16×16、8×16、16×8、8×8 和 4×4 像素。

[0005] 由于仅对残差块进行编码，故预测块越精确，当前块可被压缩的更高效。因此，如果可以找到与当前块最相似的参考块，则可以使用高编码率对当前块进行编码。

[0006] 因此，根据 H.264/AVC，通过对参考图像执行插值来产生像素单元中的小于整数 pel（像素）单元的子像素，随后基于产生的子像素执行高精度运动估计，如将参照图 1 详细描述的。

[0007] 图 1 是用于描述执行插值的传统方法的示图。

[0008] 参照图 1，通过使用 6 阶有限冲激响应（FIR）滤波器执行插值，以产生二分之一 pel 单元中的子像素 a 到 l。查看垂直 1/2 子像素 a 到 f，通过使用 A1、A2、A3、A4、A5 和 A6 执行插值来产生子像素 a，通过使用 B1、B2、B3、B4、B5 和 B6 执行插值来产生子像素 b。以相同的方式产生子像素 c、d、e 和 f。

[0009] 通过例如 $a = (A1-5\times A2+20\times A3+20\times A4-5\times A5+A6)/32$，$b = (B1-5\times B2+20\times B3+20\times B4-5\times B5+B6)/32$ 来计算垂直 1/2 子像素 a 到 f 的像素值。以相同的方式计算垂直 1/2 子像素 c 到 f 的像素值。

[0010] 与垂直 1/2 子像素 a 到 f 相似，通过使用 6 阶 FIR 滤波器执行插值来产生水平 1/2 子像素 g 到 l。通过使用 A1、B1、C1、D1、E1 和 F1 来产生子像素 g，通过使用 A2、B2、C2、D2、E2 和 F2 来产生子像素 h。

[0011] 可以以与垂直 1/2 子像素 a 到 f 的像素值相同的方式来计算水平子像素的像素值。例如，$g = (A1-5\times B1+20\times C1+20\times D1-5\times E1+F1)/32$。

[0012]　通过使用二分之一 pel 单元中的另一子像素对二分之一 pel 单元中的对角线子像素 m 执行插值。换句话说，可通过使用等式 $m = (a-5\times b+20\times c+20\times d-5\times e+f)/32$ 来计算子像素 m 的像素值。

[0013]　当产生二分之一 pel 单元中的子像素时，可通过使用整数 pel 单元中的像素和二分之一 pel 单元中的子像素来产生四分之一 pel 单元中的子像素。通过对两个相邻像素执行线性插值来产生四分之一 pel 单元中的子像素。

[0014]　例如，通过对整数 pel 单元中的像素 C3 和二分之一 pel 单元中的子像素 c 执行线性插值来产生四分之一 pel 单元中的子像素 n。换句话说，通过使用等式 $n = (C3+c)/2$ 来计算子像素 n 的像素值。另外，通过对二分之一 pel 单元中的子像素 c 和二分之一 pel 单元中的子像素 m 执行线性插值来产生四分之一 pel 单元中的子像素 o。因此，通过使用等式 $o = (c+m)/2$ 来计算子像素 o 的像素值。通过使用对角线线性插值对四分之一 pel 单元中的子像素 p 执行插值。通过使用等式 $p = (d+j)/2$ 来计算子像素 p 的像素值。

[0015]　如图 1 所示，当通过对参考图像执行插值来产生二分之一 pel 单元和四分之一 pel 单元中的子像素时，通过将插值的参考图像与当前块进行比较来在四分之一 pel 单元中搜索具有最小 SAD 的块。因此，估计了四分之一 pel 单元中的运动矢量。

[0016]　与对整数 pel 单元中的运动矢量进行编码相比，当对四分之一 pel 单元中的运动矢量进行编码时使用更多的比特。然而，在四分之一 pel 单元中可执行精确的帧间预测，从而可减少用于对残差块进行编码的比特的数量。

[0017]　然而，当通过在小于四分之一 pel 单元（诸如，八分之一 pel 单元）中执行插值来产生子像素时，基于产生的子像素在八分之一 pel 单元中估计运动矢量，在对运动矢量进行编码时使用了过多的比特，从而会降低压缩率。因此，需要一种用于有效地对小 pel 单元中的运动矢量进行编码的方法和设备。

发明内容

[0018]　技术方案

[0019]　本发明提供了一种在最小化用于对运动矢量进行编码的比特的数量的同时，通过估计小 pel 单元中的运动矢量对当前块执行帧间预测编码的方法和设备，以及记录有用于执行所述方法的程序的计算机可读记录介质。

[0020]　有益效果

[0021]　根据本发明，可以减小用于对小 pel 单元中的精确运动矢量进行编码的比特的数量，从而可提高图像编码的压缩率。

[0022]　另外，通过使用精确运动矢量，可准确地执行帧间预测。因此，可减小用于对残差块进行编码的比特的数量，从而可提高图像编码的压缩率。

附图说明

[0023]　通过参照附图对示例性实施例进行的详细描述，本发明的上述和其它特点和优点将会变得更加清楚，其中 ：

[0024]　图 1 是用于描述执行插值的传统方法的示图 ；

[0025]　图 2 是根据本发明示例性实施例的用于对图像进行帧间预测编码的设备的框图 ；

[0026] 图 3 是用于描述根据本发明示例性实施例的确定精确 pel 单元中的参考块的方法的示图 ;

[0027] 图 4 是用于描述根据本发明示例性实施例的运动估计方法的概念性示图 ;

[0028] 图 5 是用于描述根据本发明另一示例性实施例的运动估计方法的概念性示图 ;

[0029] 图 6 是示出根据本发明示例性实施例的用于对图像进行编码的设备的框图 ;

[0030] 图 7 是示出根据本发明示例性实施例的用于对图像进行帧间预测编码的方法的流程图 ;

[0031] 图 8 是根据本发明示例性实施例的用于对图像进行帧间预测解码的设备的框图 ;

[0032] 图 9 是根据本发明示例性实施例的用于对图像进行解码的设备的框图 ;

[0033] 图 10 是示出根据本发明示例性实施例的用于对图像进行帧间预测解码的方法的流程图。

具体实施方式

[0034] 最优模式

[0035] 根据本发明的一方面,提供了一种对图像进行帧间预测编码的方法,所述方法包括 :通过使用当前块来搜索参考图像中的第一参考块,估计第一 pel 单元中的关于第一参考块的第一运动矢量 ;通过使用与当前块相邻的预编码的区域中包括的像素以及与第一参考块相邻的像素来估计第二运动矢量,基于第二运动矢量确定第二参考块 ;基于第一运动矢量和第二参考块对当前块编码。

[0036] 确定第二运动矢量的步骤可包括 :通过执行插值在与第一参考块相邻的像素附近产生子像素 ;将相邻于第一参考块的像素和产生的子像素与相邻于当前块的预编码的区域中包括的像素进行比较 ;基于比较的结果估计第二运动矢量。

[0037] 根据本发明的另一方面,提供了一种对图像进行帧间预测解码的方法,所述方法包括 :接收包括关于当前块的数据的比特流,从接收的比特流提取第一 pel 单元中的关于第一运动矢量的数据和关于当前块的残差块的数据 ;根据第一运动矢量确定第一参考块,通过使用与当前块相邻的预解码的区域中包括的像素以及与第一参考块相邻的像素来确定第二参考块 ;基于第二参考块和残差块来恢复当前块。

[0038] 产生第二参考块的步骤可包括 :通过使用与当前块相邻的预解码的区域中包括的像素以及与第一参考块相邻的像素来估计第二运动矢量 ;基于第二运动矢量确定第二参考块。

[0039] 估计第二运动矢量的步骤可包括 :通过执行插值在与第一参考块相邻的像素附近产生子像素 ;将与第一参考块相邻的像素和产生的子像素,以及与当前块相邻的预解码的区域中包括的像素进行比较 ;基于比较的结果估计第二运动矢量。

[0040] 根据本发明的另一方面,提供了一种对图像进行帧间预测编码的设备,所述设备包括 :第一运动估计器,通过使用当前块来搜索参考图像中的第一参考块,估计第一 pel 单元中的关于第一参考块的第一运动矢量 ;第二运动估计器,通过使用与当前块相邻的预编码的区域中包括的像素以及与第一参考块相邻的像素来估计第二运动矢量 ;运动补偿器,基于第二运动矢量确定第二参考块 ;编码器,基于第一运动矢量和第二参考块对当前块编码。

[0041]　根据本发明的另一方面，提供了一种对图像进行帧间预测解码的设备，所述设备包括：解码器，接收包括关于当前块的数据的比特流，从接收的比特流提取第一 pel 单元中的关于第一运动矢量的数据和关于当前块的残差块的数据；运动补偿器，根据第一运动矢量确定第一参考块，通过使用与当前块相邻的预解码的区域中包括的像素以及与第一参考块相邻的像素来确定第二参考块；恢复器，基于确定的第二参考块和残差块来恢复当前块。

[0042]　根据本发明的另一方面，提供了一种记录有用于执行上述方法的程序的计算机可读记录介质。

[0043]　发明模式

[0044]　以下，将参照示出本发明的示例性实施例的附图更全面地描述本发明。

[0045]　图 2 是根据本发明示例性实施例的用于对图像进行帧间预测编码的设备 200 的框图。

[0046]　参照图 2，设备 200 包括第一运动估计器 210、第二运动估计器 220、运动补偿器 230 和编码器 240。

[0047]　第一运动估计器 210 通过使用当前块搜索参考图像来确定第一参考块，并产生第一 pel 单元中的第一运动矢量。通过搜索第一 pel 单元中的参考图像将具有最小绝对差和 (SAD) 的块确定为第一参考块。这里，第一 pel 单元可以是 H.264/AVC 的运动估计中使用的整数 pel 单元、二分之一 pel 单元或四分之一 pel 单元。当参考图像不是第一 pel 单元中的图像时，对参考图像进行插值，通过搜索插值的参考图像来确定第一参考块。基于整数 pel 单元中的像素通过执行插值来产生二分之一 pel 单元或四分之一 pel 单元中的子像素。第一运动估计器 210 以与传统运动估计方法相同的方式通过将当前块与参考图像的块进行比较来确定具有最小 SAD 的第一参考块。因此，根据确定的第一参考块估计第一 pel 单元中的第一运动矢量。

[0048]　如将参照图 3 进行详细描述的，第二运动估计器 220 通过使用与第一运动估计器 210 确定的第一参考块相邻的像素以及与当前块相邻的预编码的区域中包括的像素来确定第二参考块。

[0049]　图 3 是用于描述根据本发明示例性实施例的确定精确 pel 单元中的参考块的方法的示图。

[0050]　在图 3 中，设备 200 搜索参考图像 310，以对当前图像 320 中包括的当前块 324 进行帧间预测。当前图像 320 被划分为在当前块 324 之前编码的区域 326 和还未编码的区域 328。

[0051]　参照图 3，第一运动估计器 210 将第一 pel 单元中的第一参考块 314 确定为通过使用当前块 324 搜索参考图像 310 的结果，根据确定的第一参考块 314 估计第一运动矢量 330。

[0052]　第二运动估计器 220 通过使用区域 326 中包括的像素 322 和与第一参考块 314 相邻的像素 312 来估计第二运动矢量（未示出）。第二运动矢量是用于 pel 单元中的运动估计的运动矢量，比第一运动矢量 330 更精确。

[0053]　如将参照图 4 和图 5 进行详细描述的，第二运动估计器 220 通过执行插值在与第一参考块 314 相邻的像素 312 附近产生子像素，并通过将像素 312 和产生的子像素与像素 322 进行比较来搜索具有最小 SAD 的像素。

[0054] 图 4 是用于描述根据本发明示例性实施例的运动估计方法的概念性示图。

[0055] 在图 4 中，由第一运动估计器 210 产生作为运动估计的结果的四分之一 pel 单元中的第一运动矢量和第一参考块 410，第二运动估计器 220 估计比四分之一 pel 单元更精确的像素单元中的第二运动矢量。虽然图 4 中第一运动估计器 210 在四分之一 pel 单元中执行运动估计，但是对本领域的普通技术人员公知的是，第一运动估计器 210 可在其它 pel 单元中执行运动估计。

[0056] 假设子像素 440 位于在 x 轴正方向上距离与第一参考块 410 相邻的像素 420 α ×(1/4) 像素、在 y 轴负方向上距离像素 420 β ×(1/4) 像素的位置，其中 α 和 β 是在 0 与 1 之间的预定小数。

[0057] 可如下计算位于 x 轴正方向上距离像素 422 α ×(1/4) 像素、在 y 轴负方向上距离像素 422 β ×(1/4) 像素的位置的子像素 442 的像素值 v0：

[0058] $V0 = v1(1-\alpha)(1-\alpha)+v2(\alpha)(1-\beta)+v3(1-\alpha)(\beta)+v4(\alpha)(\beta)$

[0059] 这里，v1 表示像素 422 的像素值，v2 表示像素 424 的像素值，v3 表示像素 426 的像素值，v4 表示像素 428 的像素值。可以以相同的方式通过执行插值来计算子像素 440 的像素值。通过将执行插值产生的子像素与图 3 的相邻于当前块 324 的预编码的区域中包括的像素 420 进行比较来计算具有最小 SAD 的 α 和 β 。

[0060] 在计算 α 和 β 之后，具有最小 SAD 的 α 和 β 成为用于根据计算的 α 和 β 来估计当前块 324 的第二运动矢量的子像素。在图 4 中，通过产生在 x 轴正方向和 y 轴负方向上的子像素来计算 SAD，但是第二运动估计器 220 可产生在与第一参考块 410 相邻的像素 420 附近所有方向上的子像素，并计算 α 和 β 。例如，第二运动估计器 220 可产生位于 x 轴负方向上距离像素 420 α ×(1/4) 像素、在 y 轴正方向上距离像素 420 β ×(1/4) 像素的位置的子像素，并估计第二运动矢量。

[0061] 第二运动估计器 220 通过将在相邻于第一参考块 410 的像素 420 附近产生的子像素 440 与图 3 的相邻于当前块 324 的预编码的区域中包括的像素 322 进行比较来调节由第一运动估计器 210 估计的第一运动矢量。因此，可以估计在比第一运动矢量的像素单元（即，四分之一 pel 单元）更小的像素单元中的第二运动矢量。

[0062] 由于通过使用与当前块 324 相邻的像素 322 估计小于四分之一 pel 单元的像素单元，故即使在仅用于指定四分之一 pel 单元中的第一运动矢量的信息被编码的情况下，解码器也可恢复第二运动矢量。因此，可以通过使用较少数量的比特对精确运动矢量进行编码。

[0063] 图 5 是用于描述根据本发明另一示例性实施例的运动估计方法的概念性示图。

[0064] 在图 4 的方法的情况下，由于 α 和 β 是在 0 与 1 之间的预定小数，故第二运动估计器 220 必须执行许多操作以计算 α 和 β 。因此，第二运动估计器 220 可通过在与第一参考块 410 相邻的像素 420 附近产生有限数量的子像素并将产生的子像素与相邻于当前块 324 的预编码的区域中包括的像素 322 进行比较来减少执行的操作的数量。图 5 示出通过使用这种有限数量的子像素来估计第二运动矢量的方法。

[0065] 在图 5 中，当第一运动估计器 210 估计四分之一 pel 单元中的第一运动矢量时，第二运动估计器 220 通过使用四分之一 pel 单元中的第一运动矢量来估计八分之一 pel 单元中的第二运动矢量。然而，四分之一 pel 单元和八分之一 pel 单元中的运动矢量仅是示例，

对本领域的普通技术人员公知的是：在本发明中还可使用其它像素单元中的运动矢量。换句话说，由第二运动估计器 220 估计的第二运动矢量的像素单元可以小于八分之一，诸如 1/16pel 单元、1/32pel 单元或 1/64pel 单元。

[0066]　参照图 5，由第一运动估计器 210 将四分之一 pel 单元中的第一参考块 510 确定为运动估计的结果，并且确定与第一参考块 510 相邻的四分之一 pel 单元中的像素 520。第二运动估计器 220 通过执行插值在像素 520 附近的八分之一 pel 单元中产生子像素，并通过将像素 520 与图 3 的相邻于当前块 324 的预编码的区域中包括的像素 322 进行比较来估计第二运动矢量。

[0067]　通过执行插值来产生在上、下、左、右、左上、左下、右上和右下方向上距离与第一参考块 510 相邻的像素 520 八分之一 pel 单元的子像素，通过将与第一参考块 510 相邻的像素 520 和在 8 个方向上产生的子像素与像素 322 进行比较来估计第二运动矢量。比较图 4 和图 5，当在图 4 中 α 和 β 都是 0.5 时，子像素 440 相应于在右下方向上距离像素 520 八分之一 pel 单元的子像素。

[0068]　第二运动估计器 220 必须执行许多运算以计算 α 和 β。然而在根据本发明当前示例性实施例的方法中，第二运动估计器 220 仅通过使用在 8 个方向上距离与第一参考块 510 相邻的像素 520 八分之一 pel 单元的子像素来估计第二运动矢量。由于通过使用与第一参考块 510 相邻的像素 520 和在 8 个方向上距离像素 520 八分之一 pel 单元的子像素来计算 SAD，故可通过执行 9 个 SAD 计算来估计第二运动矢量。

[0069]　参照回图 2，运动补偿器 230 根据第二运动估计器 220 产生的第二运动矢量来确定第二参考块 430。根据在比第一运动矢量的第一 pel 单元更小的像素单元中产生的第二运动矢量来确定将用于对当前块进行帧间预测的第二参考块 430。通过对参考图像进行插值在第一参考块中包括的像素附近产生在比第一 pel 单元更小的像素单元中的子像素，并确定包括产生的子像素的第二参考块。

[0070]　参照图 4，当第二运动估计器 220 通过计算 α 和 β 确定相对于与当前块 324 相邻的像素 322 具有最小 SAD 的子像素 440 时，相应地产生第二运动矢量。运动补偿器 230 确定在比第一 pel 单元更小的像素单元中的第二参考块 430，而不是确定第一参考块 410。

[0071]　根据精确像素单元中的第二运动矢量确定的第二参考块与第一参考块 410 相比相对更相似于当前块 324。因此，在当前块 324 与第二参考块之间的残差值可被高效地压缩。

[0072]　参考回图 2，编码器 240 基于第一运动估计器 210 估计的第一运动矢量和运动补偿器 230 确定的第二参考块对当前块进行编码。

[0073]　通过从当前块减去第二参考块来产生残差块，对产生的残差块和第一运动矢量进行编码。如上所述，可通过使用比用于对第二运动矢量进行编码的比特数量更少的比特数量来对第一运动矢量进行编码，通过使用与当前块相似的第二参考块来产生残差块。因此，可以提高对图像进行编码的压缩率。

[0074]　图 6 是示出根据本发明示例性实施例的用于对图像进行编码的设备 600 的框图。

[0075]　在图 6 中，设备 600 包括图 2 所示的设备 200。因此，设备 600 包括第一运动估计器 610、第二运动估计器 620、运动补偿器 630、编码器 640、帧内预测器 650、恢复器 660、滤波器 670、帧存储器 680，然而，图 2 的第一运动估计器 210、第二运动估计器 220、运动补偿

器 230 和编码器 240 分别对应于图 6 的第一运动估计器 610、第二运动估计器 620、运动补偿器 630 和编码器 640。

[0076] 第一运动估计器 610 通过使用当前块搜索帧存储器 680 中存储的参考图像来估计第一 pel 单元中的第一运动矢量。通过对参考图像进行插值来产生第一 pel 单元中的子像素，通过将当前块与子像素进行比较来确定第一参考块。因此，根据确定的第一参考块估计第一 pel 单元中的第一运动矢量。

[0077] 第二运动估计器 620 通过使用相邻于第一参考块的像素和相邻于当前块的预编码的区域中包括的像素来估计第二运动矢量。

[0078] 通过执行插值在与第一参考块相邻的像素附近产生子像素，通过将相邻于第一参考块的像素和产生的子像素与相邻于当前块的预编码的区域中包括的像素进行比较来搜索具有最小 SAD 的像素。根据确定的子像素来估计比第一 pel 单元更小的像素单元中的第二运动矢量，上面已经参照图 4 和图 5 进行了详细描述。

[0079] 运动补偿器 630 基于第二运动估计器 620 估计的第二运动矢量对当前块进行运动补偿。在与第二运动矢量相同的像素单元中产生第一参考块附近的子像素，将包括该子像素的块确定为将在对当前块进行帧间预测中使用的第二参考块。因此，第二参考块是当前块的预测块。

[0080] 帧内预测器 650 通过执行帧内预测来预测当前块。通过参照帧存储器 680，使用与当前块相邻的预编码的区域中包括的像素执行帧内预测来产生当前块的预测块。

[0081] 编码器 640 基于运动补偿器 630 产生的预测块或帧内预测器 650 产生的预测块来对当前块进行编码。通过考虑率失真代价（R-D 代价）来确定帧间预测和帧内预测中的最优预测方法，通过使用根据确定的最优预测方法产生的预测块来对当前块进行编码。

[0082] 通过从当前块减去预测块来产生残差块，对产生的残差块的像素值进行离散余弦变换。作为离散余弦变换的结果产生的离散余弦系数被量化。接下来，对量化的离散余弦系数进行熵编码以产生比特流。当通过使用帧内预测对当前块进行编码时，运动矢量也被编码并随后被插入到比特流。根据本发明的帧间预测，由第一运动估计器 610 估计的第一运动矢量被编码并被插入到比特流。

[0083] 在从编码器 640 接收到量化的离散余弦系数的情况下，恢复器 660 对接收的离散余弦系数进行反量化。对反量化的离散余弦系数进行离散余弦逆变换，将作为离散余弦逆变换的结果而产生的残差块与作为帧间预测或帧内预测的结果而产生的预测块相加，以恢复当前块。

[0084] 滤波器 670 对在恢复器 660 中恢复的当前块进行去块滤波，将去块滤波的当前块存储在帧存储器 680 中。

[0085] 图 7 是示出根据本发明示例性实施例的用于对图像进行帧间预测编码的方法的流程图。

[0086] 参照图 7，在操作 710，用于对图像进行帧间预测编码的设备通过使用当前块在参考图像的第一 pel 单元中搜索与当前块相应的第一参考块。如果参考图像不在第一 pel 单元中，则对参考图像进行插值以在第一 pel 单元中产生图像，并随后在插值的参考图像中搜索第一参考块。作为结果，估计关于第一参考块的第一 pel 单元中的第一运动矢量。

[0087] 在操作 720，设备通过使用与当前块相邻的预编码的区域中包括的像素和与第一

参考块相邻的像素来估计第二运动矢量。通过执行插值在与第一参考块相邻的像素附近产生比第一 pel 单元更小的像素单元中的子像素，通过将相邻于第一参考块的像素和产生的子像素与相邻于当前块的预编码的区域中包括的像素进行比较来估计第二运动矢量。以上已经参照图 4 和图 5 对估计第二运动矢量的方法进行描述。当估计第二运动矢量时，根据估计的第二运动矢量来确定将在对当前块进行帧间预测中使用的第二参考块。第二参考块在比根据第二运动矢量确定的第一 pel 单元更小的像素单元中，从而当前块可被准确地帧间预测。

[0088] 在操作 730，设备基于在操作 710 中估计的第一运动矢量和在操作 720 中确定的第二参考块对当前块进行编码。通过从当前块减去第二参考块来产生残差块，产生的残差块和第一运动矢量在编码之后被插入到比特流中。

[0089] 通过使用与第一运动矢量相邻的像素和与当前块相邻的预编码的区域中包括的像素来估计第二运动矢量。因此，即使在仅第一运动矢量被编码的情况下，也可恢复第二运动矢量，作为结果，可以使用较少数量的比特对高精确运动矢量进行编码。

[0090] 对产生的残差块进行离散余弦变换，对作为离散余弦变换的结果产生的离散余弦系数进行量化。对量化的离散余弦系数进行熵编码并随后插入到比特流。

[0091] 图 8 是根据本发明示例性实施例的用于对图像进行帧间预测解码的设备 800 的框图。

[0092] 参照图 8，设备 800 包括解码器 810、运动补偿器 820 和恢复器 830，运动补偿器 820 包括第一补偿器 822、运动矢量估计器 824 和第二补偿器 826。

[0093] 解码器 810 接收包括关于当前块的数据的比特流，从接收的比特流提取第一 pel 单元中的关于第一运动矢量的数据和关于残差块的数据。

[0094] 通过从当前块减去在比第一 pel 单元更小的像素单元中的第二参考块来产生残差块。包括在比特流中的关于残差块的数据被熵编码、反量化，并随后被离散余弦逆变换，以恢复残差块。通过对关于第一运动矢量的数据进行熵解码来恢复第一 pel 单元中的第一运动矢量。

[0095] 运动补偿器 820 根据解码器 810 恢复的第一运动矢量确定第一 pel 单元中的第一参考块。随后，通过将相邻于第一参考块的像素与相邻于当前块的预解码的区域中包括的像素进行比较来确定将在对当前块进行帧间预测中使用的第二参考块。第二参考块在比第一 pel 单元更小的像素单元中，并根据基于与第一参考块相邻的像素和与当前块相邻的预解码的区域中包括的像素产生的第二运动矢量来确定第二参考块。

[0096] 第一补偿器 822 根据解码器 810 中解码的第一运动矢量来确定第一参考块。通过根据第一 pel 单元执行运动补偿来确定第一参考块。因此，如果参考图像不在第一 pel 单元中，则对参考图像进行插值，以在第一 pel 单元中产生参考图像，并对插值的参考图像执行运动补偿。

[0097] 运动矢量估计器 824 通过使用与当前块相邻的预解码的区域中包括的像素以及与第一参考块相邻的像素来估计第二运动矢量。

[0098] 在与第一参考块相邻的像素附近产生在比第一 pel 单元更小的像素单元中的子像素。可以如图 4 所述产生位于 x 轴正方向上距离像素 420 α ×(1/4) 像素、在 y 轴负方向上距离像素 420 β ×(1/4) 像素的位置的子像素 440，或可以如图 5 所述产生位于与像素

520 的距离为第二 pel 单元(即,八分之一像素单元)的位置的像素。

[0099] 当产生子像素时,通过将相邻于第一参考块的像素和产生的子像素与相邻于当前块的预解码的区域中包括的像素进行比较来产生在比第一 pel 单元更小的像素单元中的第二运动矢量。

[0100] 第二补偿器 826 基于运动矢量估计器 824 估计的第二运动矢量对当前块进行运动补偿。根据第二运动矢量的像素单元对参考图像进行插值,根据第二运动矢量来确定将在对当前块进行帧间预测中使用的第二参考块。确定的第二参考块是当前块的预测块。

[0101] 恢复器 830 基于第二补偿器 826 的结果来恢复当前块。由第二补偿器 826 产生当前块的预测块,通过将产生的预测块与解码器 810 解码的残差块相加来恢复当前块。

[0102] 图 9 是根据本发明示例性实施例的用于对图像进行解码的设备 900 的框图。

[0103] 参照图 9,设备 900 包括解码器 910、运动补偿器 920、恢复器 930、帧内预测器 940、滤波器 950 和帧存储器 960。运动补偿器 920 包括第一补偿器 922、运动估计器 924 和第二补偿器 926。图 8 的解码器 810、运动补偿器 820 和恢复器 830 分别与图 9 的解码器 910、运动补偿器 920 和恢复器 930 对应。

[0104] 解码器 910 接收包括关于当前块的数据的比特流,从接收的比特流提取关于当前块的编码模式的数据和关于残差块的数据。如果使用帧间预测对当前块进行编码,则第一 pel 单元中的关于第一运动矢量的数据也被提取。

[0105] 运动补偿器 920 在帧存储器 960 中存储的参考图像中搜索与当前块相应的第一 pel 单元中的第一参考块。如果参考图像不在第一 pel 单元中,则对参考图像进行插值以在第一 pel 单元中产生图像,并在插值的参考图像中搜索第一参考块。

[0106] 第一补偿器 922 根据解码器 910 解码的第一 pel 单元中的第一运动矢量来确定第一参考块。根据第一运动矢量通过执行运动补偿来确定第一参考块。

[0107] 运动估计器 924 通过使用第一补偿器 922 确定的与第一参考块相邻的像素和与当前块相邻的预编码的区域中包括的像素来估计将在对当前块进行帧间预测中使用的第二运动矢量。

[0108] 在与第一参考块相邻的像素附近产生在比第一 pel 单元更小的像素单元中的子像素。通过将相邻于第一参考块的像素和产生的子像素与相邻于当前块的预解码的区域中包括的像素进行比较来估计第二运动矢量。

[0109] 第二补偿器 926 基于由运动估计器 924 估计的第二运动矢量来确定将在对当前块进行帧间预测中使用的第二参考块。通过在与第二运动矢量相同的像素单元中对参考图像进行插值并在插值的参考图像中搜索第二运动矢量来确定第二参考块。因此,确定的第二参考块是当前块的预测块。

[0110] 帧内预测器 940 通过使用与当前块相邻的预解码的区域中包括的像素执行帧内预测来产生当前块的预测块。

[0111] 恢复器 930 基于运动补偿器 920 或帧内预测器 940 产生的预测块来恢复当前块。通过将解码器 910 产生的残差块与预测块相加来恢复当前块。由滤波器对恢复的当前块进行去块滤波,并随后存储在帧存储器 960 中,以用于对另一块或另一图像的预测。

[0112] 图 10 是示出根据本发明示例性实施例的用于对图像进行帧间预测解码的方法的流程图。

[0113] 参照图 10，在操作 1010，用于对图像进行帧间预测编码的设备接收包括关于当前块的数据的比特流，从接收的比特流提取关于第一 pel 单元中的第一运动矢量的数据和关于残差块的数据。对关于第一运动矢量的数据进行解码以恢复第一运动矢量，对关于残差块的数据进行熵解码、反量化，并随后进行离散余弦逆变换，以恢复残差块。

[0114] 在操作 1020，设备通过使用第一 pel 单元中的第一运动矢量来确定第一 pel 单元中的第一参考块。也就是说，根据第一运动矢量通过搜索参考图像来确定第一参考块。这里，如果参考图像不在第一 pel 单元中，则对参考图像进行插值，并随后通过搜索插值的参考图像来确定第一参考块。

[0115] 当确定第一参考块时，通过使用与第一参考块相邻的像素和与当前块相邻的预解码的区域中包括的像素来确定第二参考块。

[0116] 通过执行插值来产生与第一参考块相邻的像素附近的子像素，通过将相邻于第一参考块的像素和产生的子像素与相邻于当前块的预解码的区域中包括的像素进行比较来估计第二运动矢量。

[0117] 当估计了第二运动矢量时，根据第二运动矢量来确定第二参考块。在与第二运动矢量相同的像素单元中对参考图像进行插值，从插值的参考图像确定第二参考块。确定的第二参考块是当前块的预测块。

[0118] 在操作 1030，设备基于在操作 1020 确定的第二参考块来恢复当前块。也就是说，通过将第二参考块与在操作 1010 中产生的残差块相加来恢复当前块。

[0119] 本发明也可被实施为计算机可读记录介质上的计算机可读代码。计算机可读记录介质是存储其后可被计算机系统读取的数据的任何数据存储装置。计算机可读记录介质的示例包括：只读存储器（ROM）、随机访问存储器（RAM）、CD-ROM、磁带、软盘、光数据存储装置和载波（诸如，通过互联网的数据传输）。计算机可读记录介质还可分布于联网的计算机系统，从而以分布方式存储和执行计算机可读代码。

[0120] 虽然已经参照本发明的示例性实施例具体示出和描述了本发明，但是本领域的普通技术人员应该理解，在不脱离由权利要求限定的本发明的精神和范围的情况下，可以进行形式和细节上的各种改变。

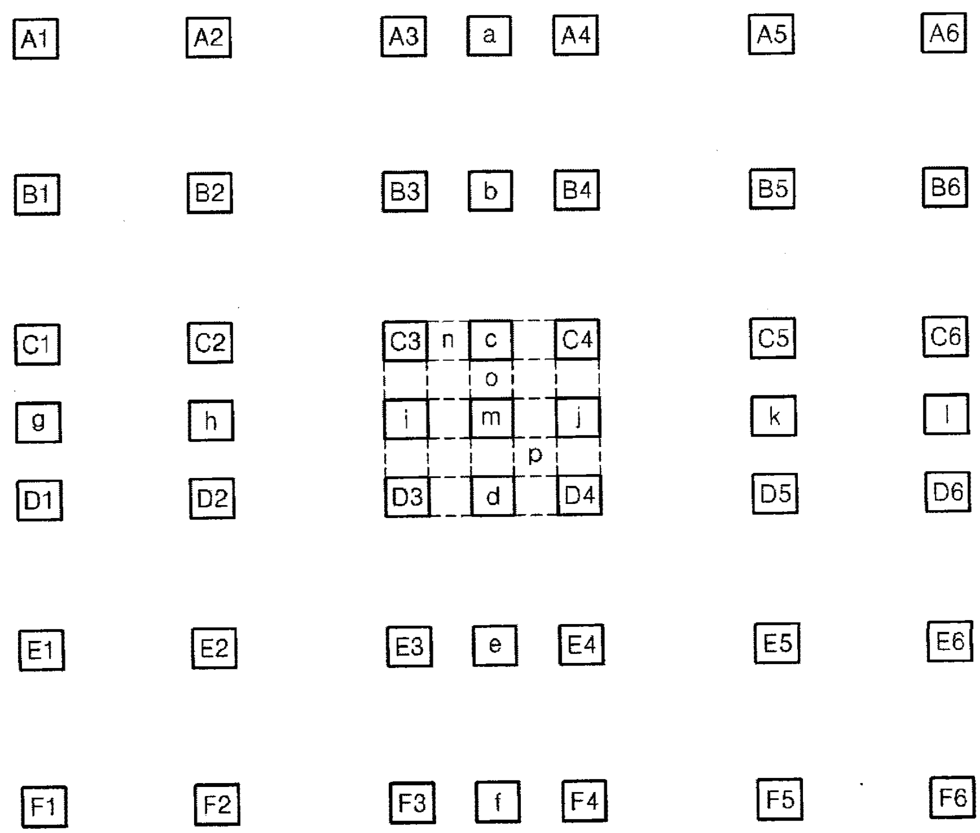

A1
A2
A3
a
A4
A5
A6
B1
B2
B3
b
B4
B5
B6
C1
C2
C3
n
c
C4
C5
C6
o
g
h
i
m
j
k
l
p
D1
D2
D3
d
D4
D5
D6
E1
E2
E3
e
E4
E5
E6
F1
F2
F3
f
F4
F5
F6

图 1

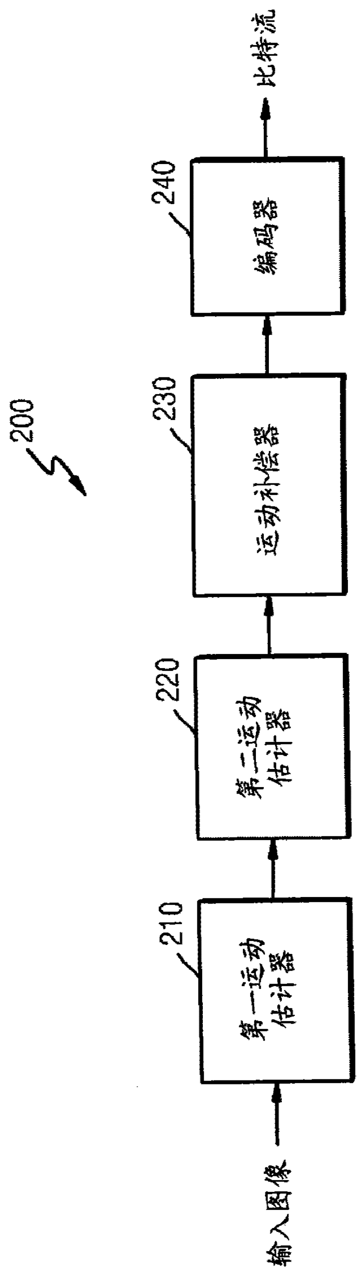


图 2

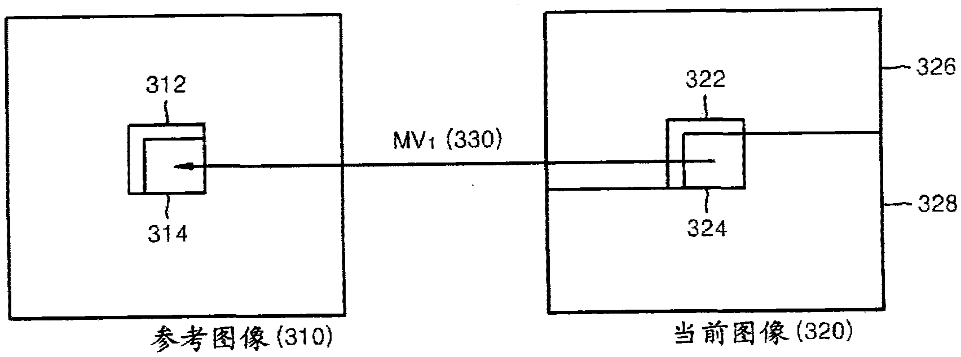

312
314
322
324
326
328
MV1 (330)
参考图像(310)
当前图像(320)

图 3

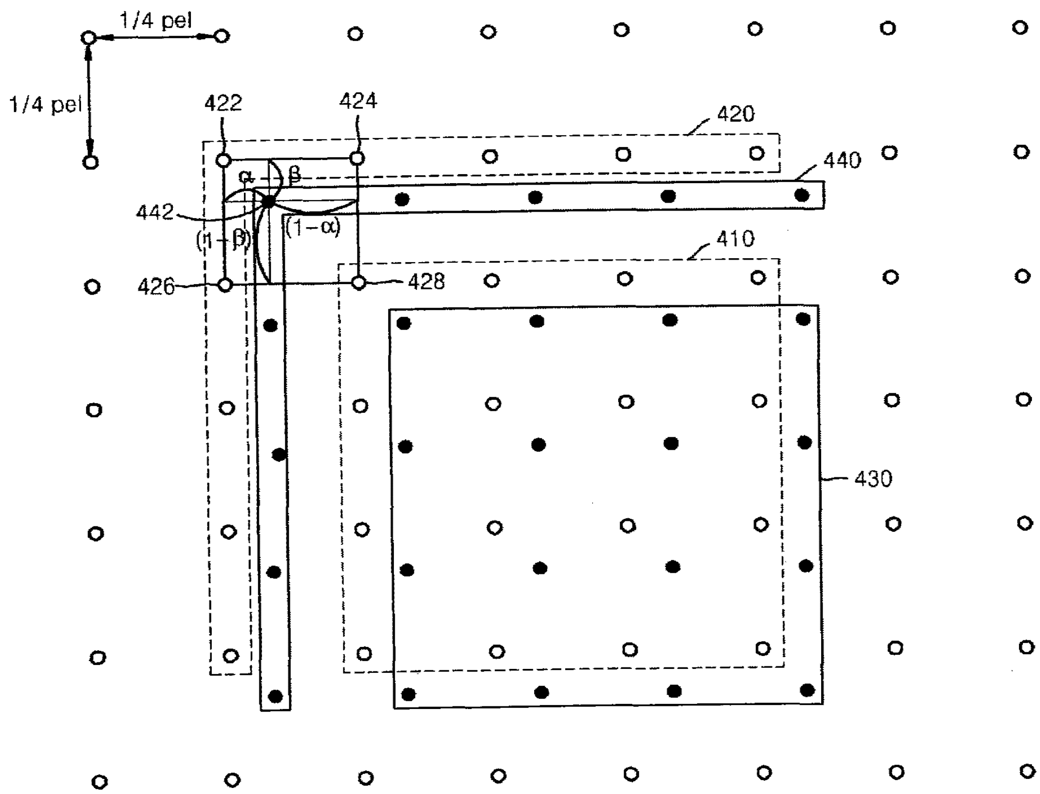

1/4 pel
1/4 pel
422
424
420
440
442
α
β
(1-β)
(1-α)
410
426
428
430

图 4

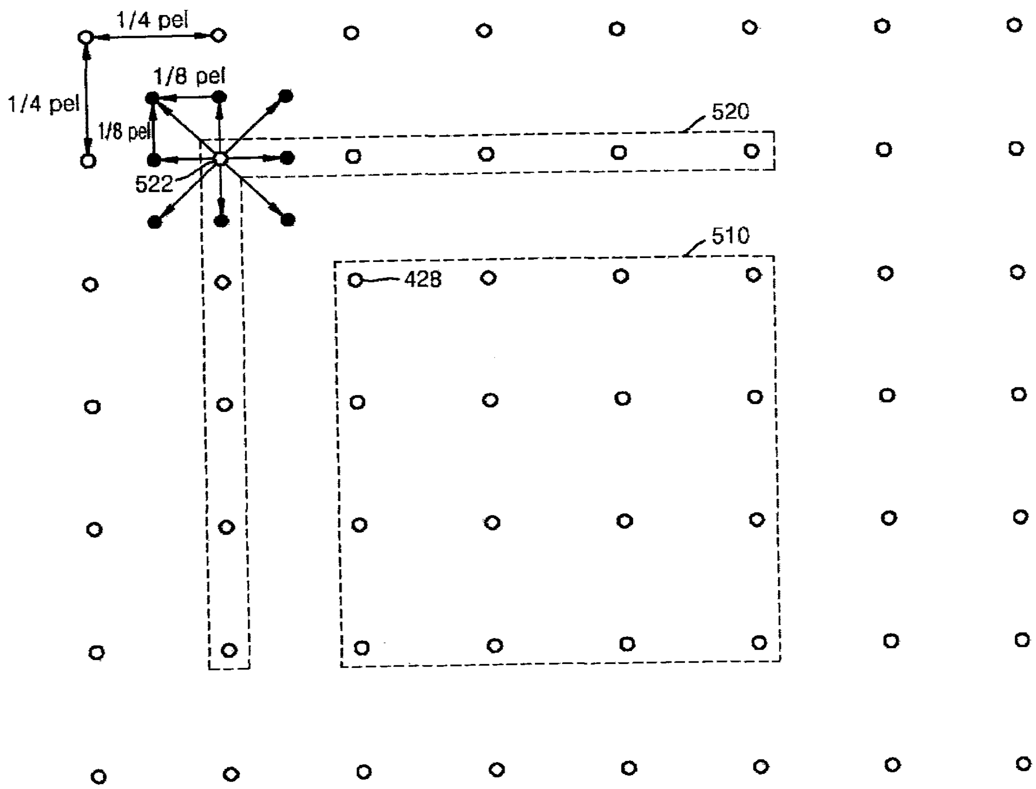
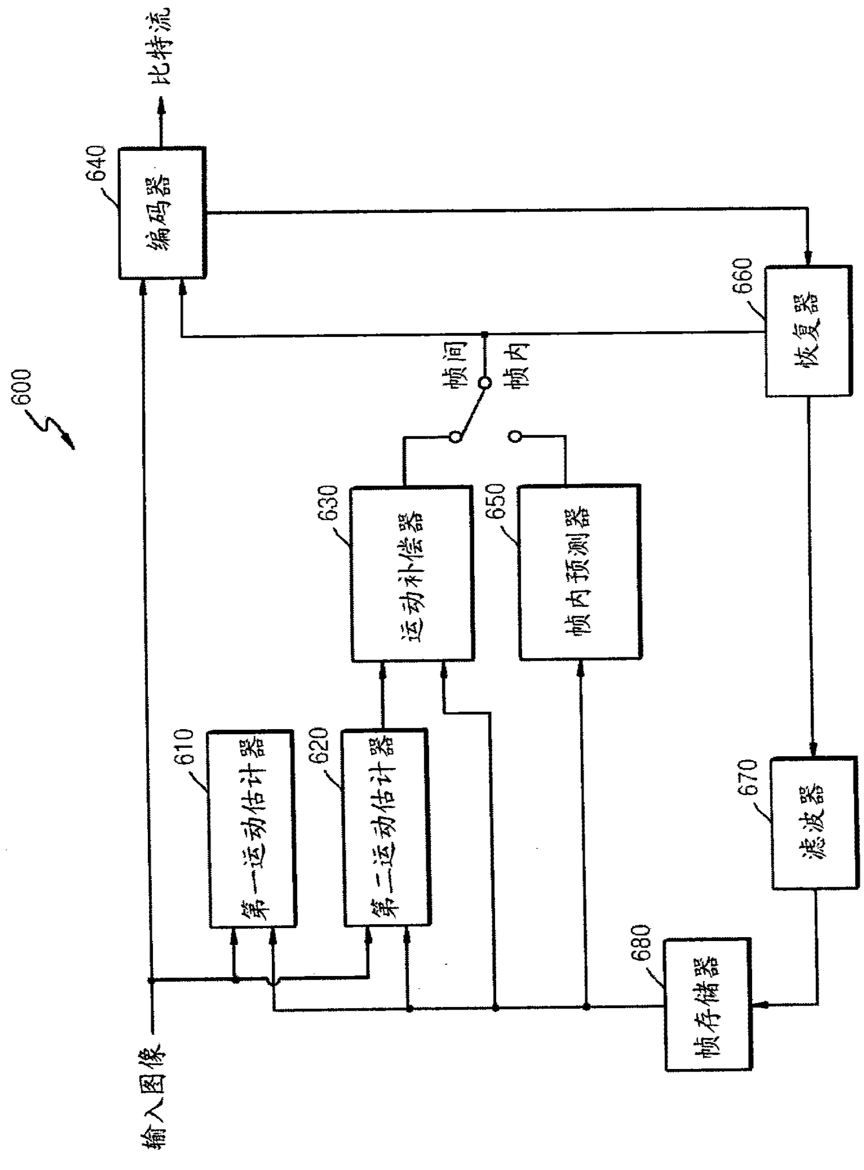


图 5



比特流
640
编码器
600
660
恢复器
帧间
帧内
630
运动补偿器
650
帧内预测器
610
第一运动估计器
620
第二运动估计器
670
滤波器
680
帧存储器
输入图像

图 6

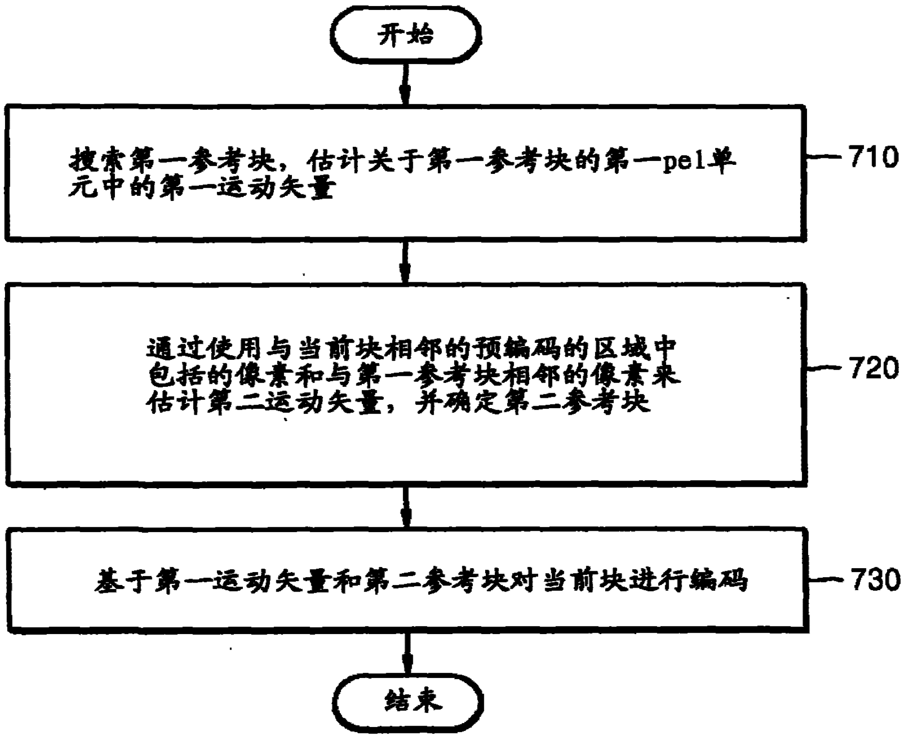

开始
搜索第一参考块，估计关于第一参考块的第一pel单元中的第一运动矢量
710
通过使用与当前块相邻的预编码的区域中包括的像素和与第一参考块相邻的像素来估计第二运动矢量，并确定第二参考块
720
基于第一运动矢量和第二参考块对当前块进行编码
730
结束

图 7

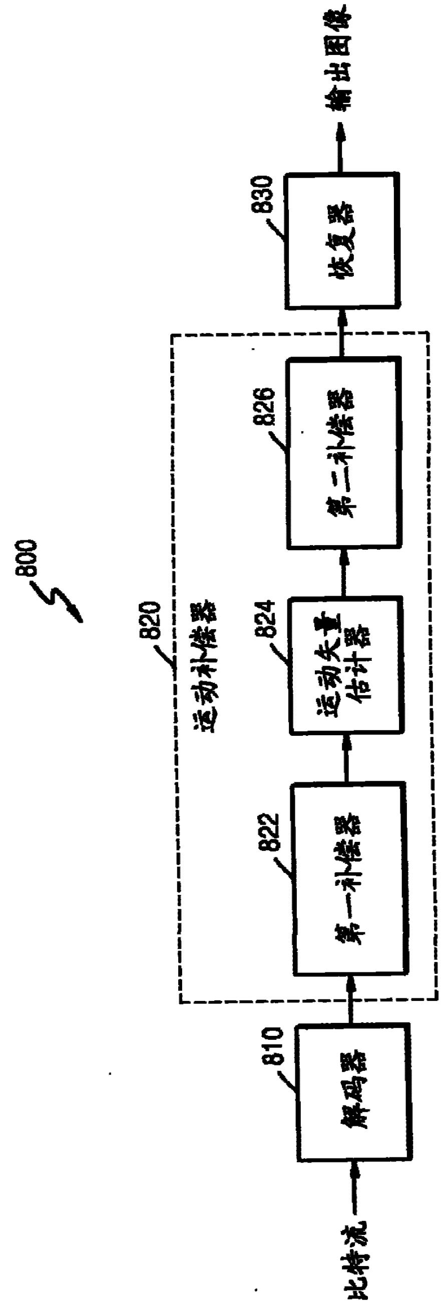

800
比特流
810
解码器
820
运动补偿器
822
第一补偿器
824
运动矢量估计器
826
第二补偿器
830
恢复器
输出图像

图 8

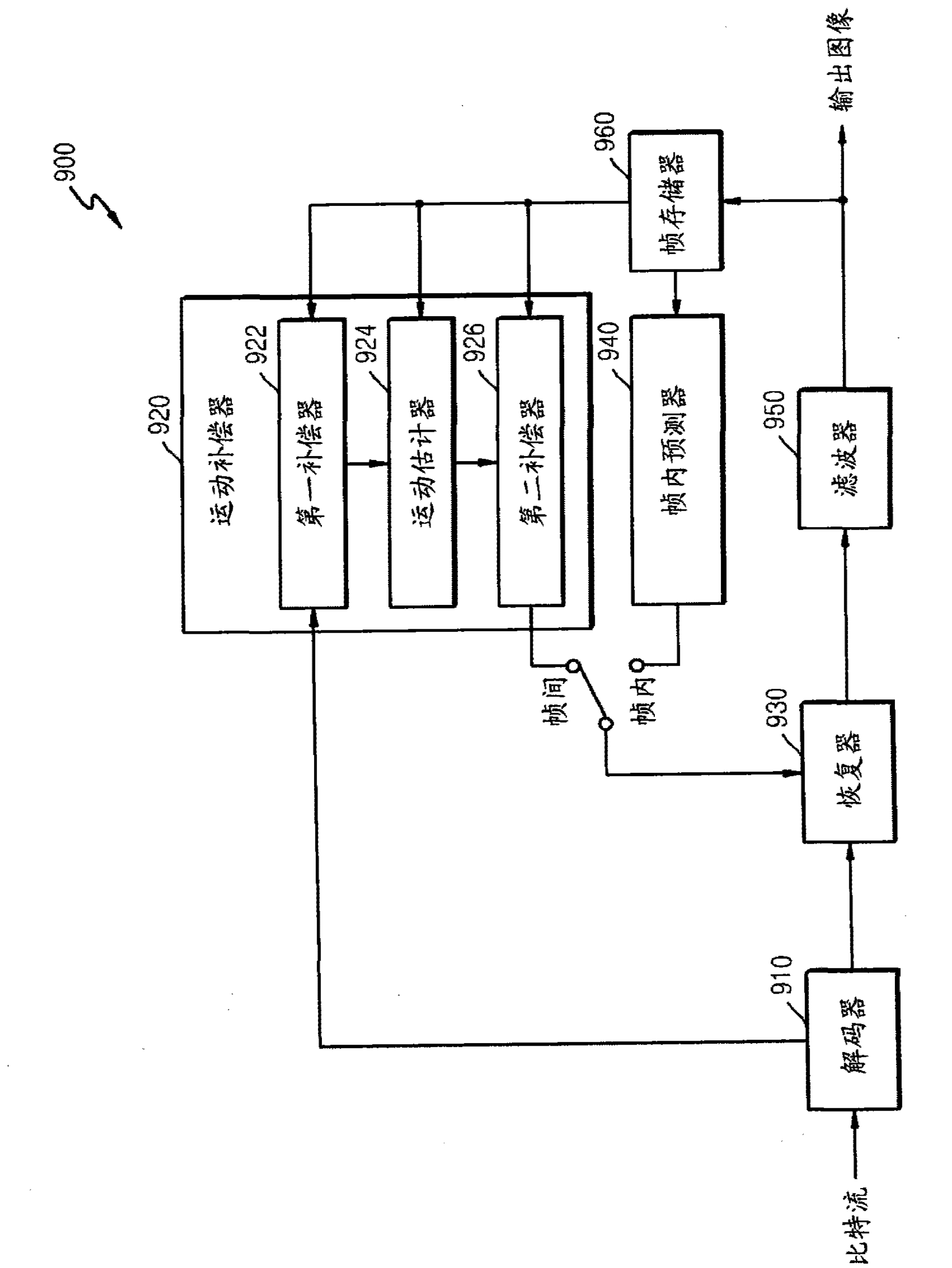

900
920
运动补偿器
922
第一补偿器
924
运动估计器
926
第二补偿器
940
帧内预测器
960
帧存储器
输出图像
950
滤波器
930
恢复器
帧间
帧内
910
解码器
比特流

图 9

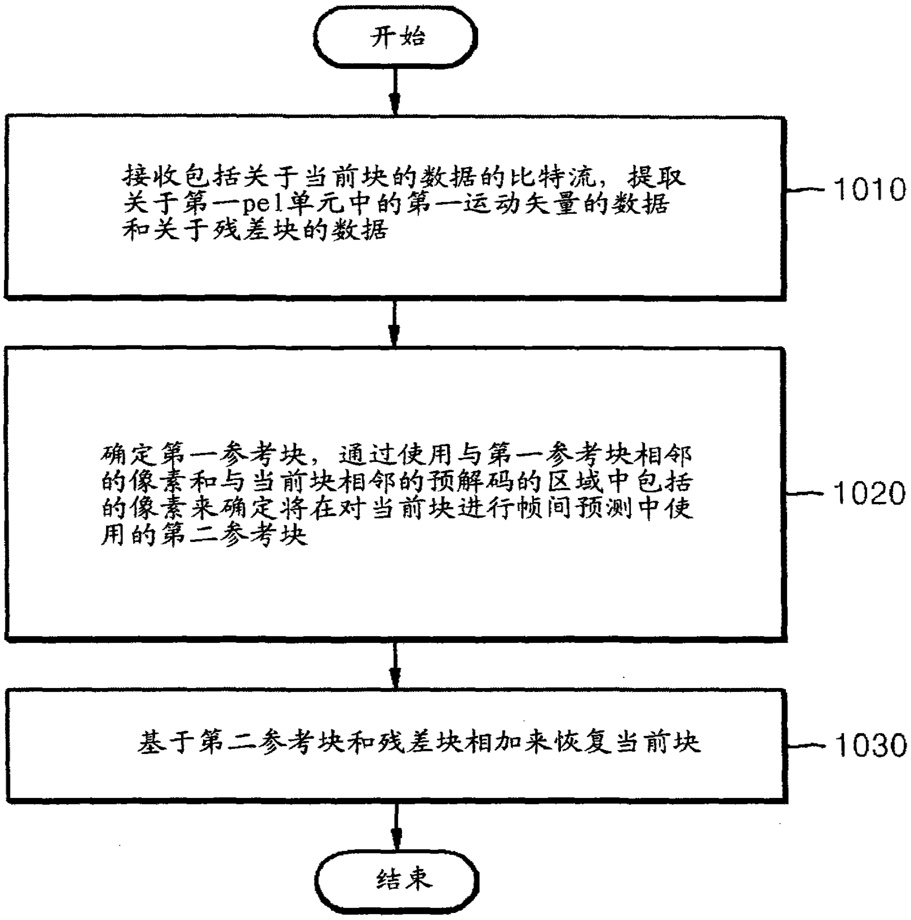

开始
接收包括关于当前块的数据的比特流，提取关于第一pel单元中的第一运动矢量的数据和关于残差块的数据
1010
确定第一参考块，通过使用与第一参考块相邻的像素和与当前块相邻的预解码的区域中包括的像素来确定将在对当前块进行帧间预测中使用的第二参考块
1020
基于第二参考块和残差块相加来恢复当前块
1030
结束

图 10

Espacenet

Bibliographic data: RU2004103743 (A) — 2005-06-10

METHOD AND DEVICE FOR GENERATION OF SCALED ENCODED VIDEO-SIGNAL USING A NON-SCALED ENCODED VIDEO SIGNAL

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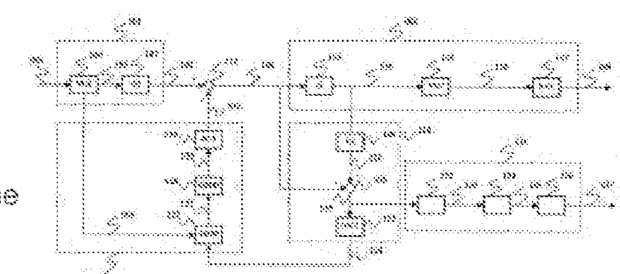
Classification:
- **international:** ***G06T9/00; H03M7/30; H03M7/40; H04N1/00; H04N7/26; H04N7/30;*** (IPC1-7): H04N1/00
- **cooperative:** **G11B20/10 (KR); H04N19/34 (EP, US); H04N19/37 (EP, US); H04N19/40 (EP, US)**

Application number: RU20040103743 20020705

Priority number(s): EP20010401850 20010710

Also published as: BR0205725 (A) CN1251512 (C) CN1526240 (A) EP1407615 (A1) JP2004521583 (A) KR20030029961 (A) RU2313190 (C2) US2004208247 (A1) WO03007619 (A1) less

Abstract of RU2313190 (C2)



FIELD: video signals. ^ SUBSTANCE: method for modifying data in input encoded video signal for generation of output scaled video signal, composed of main video signal and a set of at least one quality increase video signal, where method contains at least one error decoding stage for generation of decoded data signal using input encoded video signal, first stage of repeated encoding for generation of main video signal using intermediate data signal, received by addition of signal with movement compensation and decoded data signal, reconstruction stage for generating main video signal encoding error, movement compensation stage for generation of signal with compensation of movement based on encoding error, second stage of repeated encoding for generation of quality increase video signal on basis of encoding error. Encoding error of main video signal is repeatedly encoded with higher degree of detail in comparison to error which is used for generation of main video

signal. ^ EFFECT: ensured adaptation of bit-rate of encoded video signal being transferred to traffic capacity of communication network. ^ 6 cl, 3 dwg

РОССИЙСКАЯ ФЕДЕРАЦИЯ

ФЕДЕРАЛЬНАЯ СЛУЖБА
ПО ИНТЕЛЛЕКТУАЛЬНОЙ СОБСТВЕННОСТИ,
ПАТЕНТАМ И ТОВАРНЫМ ЗНАКАМ

(19) **RU** (11) **2008 138 706** (13) **A**

(51) МПК
H04N 7/32 (2006.01)
G06T 5/00 (2006.01)
H04N 11/02 (2006.01)

(12) ЗАЯВКА НА ИЗОБРЕТЕНИЕ

(21), (22) Заявка: **2008138706/09, 30.03.2007**

(30) Конвенционный приоритет:
30.03.2006 JP 2006-095597
19.10.2006 JP PCT/JP2006/320876

(43) Дата публикации заявки: **10.04.2010** Бюл. № **10**

(85) Дата перевода заявки PCT на национальную фазу: **29.09.2008**

(86) Заявка PCT:
JP 2007/057197 (30.03.2007)

(87) Публикация PCT:
WO 2007/114368 (11.10.2007)

Адрес для переписки:
129090, Москва, ул.Б.Спасская, 25, стр.3, ООО "Юридическая фирма Городисский и Партнеры", пат.пов. А.В.Мицу, рег.№ 364

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(54) УСТРОЙСТВО И СПОСОБ КОДИРОВАНИЯ ИЗОБРАЖЕНИЙ И УСТРОЙСТВО И СПОСОБ ДЕКОДИРОВАНИЯ ИЗОБРАЖЕНИЙ

(57) Формула изобретения

1. Устройство кодирования изображения, содержащее:

преобразователь глубины пикселя в битах для преобразования глубины в битах каждого пикселя входного изображения, сформированного из множества пикселей, каждый из которых имеет глубину N бит, до глубины (N+M) бит, которая больше глубины N бит на M бит;

генератор предсказываемого изображения для создания предсказываемого изображения глубиной (N+M) бит по входному изображению глубиной (N+M) бит исходя из опорного изображения глубиной (N+M) бит;

вычитатель для получения дифференциального сигнала между входным изображением глубиной (N+M) бит и предсказываемым изображением глубиной (N+M) бит;

кодер для кодирования дифференциального сигнала и вывода информации о кодированном изображении;

декодер для вывода декодированного разностного изображения на основе информации о кодировании изображения;

сумматор для добавления предсказываемого изображения глубиной (N+M) бит к декодированному разностному изображению глубиной (N+M) бит и вывода декодированного изображения глубиной (N+M) бит;

память, запоминающая опорное изображение, для запоминания декодированного изображения в качестве опорного изображения.

2. Устройство кодирования изображения по п.1, содержащее также мультиплексор для мультиплексирования информации о преобразовании в битах, представляющей количество бит, на которое происходит изменение в результате преобразования, с информацией о кодировании изображения.

3. Устройство кодирования изображения по п.1, содержащее также

первый преобразователь глубины пикселя в битах, обеспеченный на предыдущей ступени памяти, запоминающей опорное изображение, для преобразования каждого пикселя декодированного изображения глубиной (N+M) бит до глубины (N+M-L) бит (L - целое число, удовлетворяющее неравенству $L \leq M$), и

второй преобразователь глубины пикселя в битах, обеспеченный на задней ступени памяти, запоминающей опорное изображение, для преобразования каждого пикселя опорного изображения глубиной (N+M-L) бит до глубины (N+M) бит,

память, запоминающую опорное изображение, которая запоминает декодированное изображение глубиной (N+M-L) бит в качестве опорного изображения.

4. Устройство кодирования изображений по п.1, в котором первый преобразователь глубины пикселя в битах включает в себя средство для вычисления репрезентативного значения исходя из максимального и минимального значений глубины пикселя, содержащихся в изображении единицы кодирования декодированного изображения глубиной (N+M) бит для каждой единицы кодирования, средство для вычисления величины смещения Q ($0 \leq Q \leq L$), с помощью которого значение полученное путем смещения вправо разности между значением каждого пикселя изображения единицы кодирования и указанным репрезентативным значением попадает в динамический диапазон глубины в (N+M-L) бит, и средство для преобразования декодированного изображения глубиной (N+M) бит в декодированное изображение глубиной (N+M-L) бит путем преобразования значения каждого пикселя в изображении единицы кодирования в значение с глубиной (N+M-L) бит посредством сдвига вправо разности между значением каждого пикселя и указанного репрезентативного значения, и

память, запоминающая опорное изображение, запоминает декодированное изображение глубиной (N+M-L) бит в качестве опорного изображения и запоминает указанную величину Q и репрезентативное значение для изображения каждой произвольной единицы кодирования, а

второй преобразователь глубины пикселя в битах считывает опорное изображение, величину смещения Q и репрезентативное значение из памяти, запоминающей опорное изображение, для каждой единицы кодирования и добавляет значение пикселя, полученное путем смещения вправо на Q бит значения пикселя глубиной (N+M-L) бит для каждого пикселя опорного изображения, к репрезентативному значению для преобразования указанного значения пикселя в значение пикселя глубиной (N+M) бит.

5. Устройство кодирования изображения, содержащее:

генератор предсказываемого изображения для создания предсказываемого изображения глубиной (N+M) бит по входному изображению глубиной N бит исходя из опорного изображения глубиной (N+M) бит;

преобразователь, уменьшающий глубину пикселя в битах, для уменьшения каждого пикселя предсказываемого изображения глубиной (N+M) бит до глубины N бит;

вычитатель для получения дифференциального сигнала между входным изображением глубиной N бит и предсказываемым изображением глубиной N бит;

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кодер для кодирования дифференциального сигнала и вывода информации о кодировании изображения;

декодер для вывода декодированного разностного изображения на основе информации о кодировании изображения;

сумматор для добавления предсказываемого изображения, преобразованного до глубины N бит, к декодированному разностному изображению для вывода декодированного изображения глубиной N бит;

преобразователь глубины пикселя в битах для преобразования значения каждого пикселя декодированного изображения глубиной N бит до глубины (N+M) бит, превышающей указанную глубину на M; и

память, запоминающую опорное изображение, для запоминания декодированного изображения глубиной (N+M) бит в качестве опорного изображения.

6. Устройство кодирования изображения, содержащее:

генератор предсказываемого изображения для создания предсказываемого изображения глубиной (N+M) бит по входному изображению глубиной N бит исходя из опорного изображения глубиной (N+M) бит;

преобразователь глубины пикселя в битах для уменьшения каждого пикселя предсказываемого изображения глубиной (N+M) бит до глубины в N бит;

вычитатель для получения дифференциального сигнала между входным изображением глубиной N бит и предсказываемым изображением глубиной N бит;

кодер для кодирования дифференциального сигнала и вывода информации о кодировании изображения;

декодер для вывода декодированного разностного изображения на основе информации о кодировании изображения;

сумматор для добавления предсказываемого изображения к декодированному дифференциальному изображению для вывода декодированного изображения глубиной N бит;

память, запоминающую опорный сигнал, для запоминания декодированного изображения глубиной N бит в качестве опорного изображения;

преобразователь глубины пикселя в битах для преобразования каждого пикселя опорного изображения глубиной N бит, запомненного в памяти, запоминающей опорное изображение, до глубины (N+M) бит, превышающую указанную глубину на M бит.

7. Устройство кодирования изображения по п.1, в котором информация о кодировании изображения включает в себя данные, указывающие количество бит M, на которое должно быть выполнено увеличение, в качестве информации о преобразовании глубины в битах для каждой произвольной единицы кодирования.

8. Устройство кодирования изображения по п.3, в котором информация о кодировании изображения включает в себя данные, указывающие глубину (N+M-L) в битах опорного изображения, хранящегося в памяти, запоминающей опорное изображение, в качестве информации о преобразовании в битах для каждой произвольной единицы кодирования.

9. Устройство кодирования изображения по п.1, в котором информация о кодировании изображения включает в себя данные, указывающие глубину N в битах при выводе декодированного изображения в качестве информации о преобразовании глубины в битах для каждой произвольной единицы кодирования.

10. Устройство кодирования изображения по п.1, в котором преобразователь глубины пикселя в битах преобразует значение каждого пикселя входного изображения в значение, отличное по глубине в битах, а затем преобразует каждую компоненту входного изображения в другое цветовое пространство.

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11. Устройство кодирования изображения по п.1, в котором преобразователь глубины пикселя в битах преобразует значение каждого пикселя изображения глубиной N бит до глубины (N+M) бит, превышающей ее на M бит, а затем преобразует каждую компоненту изображения в другое цветовое пространство.

12. Устройство кодирования изображения по п.10 или 11, в котором информация о кодировании изображения включает в себя данные, указывающие количество бит M, на которое подлежит увеличить глубину, и данные, указывающие цветовое пространство при выводе декодированного изображения в качестве информации о преобразовании в битах для каждой произвольной единицы кодирования.

13. Устройство кодирования изображения по п.10 или 11, в котором информация о кодировании изображения включает в себя данные, указывающие глубину N в битах при выводе декодированного изображения, и цветовое пространство при выводе декодированного изображения в качестве информации о преобразовании в битах для каждой произвольной единицы кодирования.

14. Устройство кодирования изображения по п.1, в котором генератор предсказываемого изображения создает предсказываемое изображение на основе информации адаптивного интерполяционного фильтра, а информация о кодировании изображения включает в себя информацию адаптивного интерполяционного фильтра.

15. Устройство кодирования изображения по п.1, содержащее также фильтр, обеспеченный на предыдущей ступени памяти опорного изображения, чтобы подвергнуть декодированное изображение фильтрации на основе информации о фильтрации, причем информация о кодировании изображения включает в себя информацию о фильтрации.

16. Устройство кодирования изображения по п.1, в котором преобразователь глубины пикселя в битах также включает в себя фильтр, чтобы подвергнуть входное изображение фильтрации на основе информации о фильтрации после преобразования каждого пикселя входного изображения, каждый пиксель которого имеет глубину N бит, до глубины (N+M) бит, превышающей ее на M бит.

17. Устройство кодирования изображения по п.1, в котором преобразователь глубины пикселя в битах снабжен фильтром, чтобы подвергнуть входное изображение фильтрации на основе информации о фильтрации после преобразования каждого пикселя входного изображения глубиной N бит в пиксель глубиной (N+M) бит, превышающей ее на M бит, причем информация о кодировании изображения включает в себя информацию о фильтрации.

18. Устройство кодирования изображения по п.15, в котором преобразователь глубины пикселя в битах снабжен блоком вставки информации о водяном знаке, сконфигурированном для добавления к входному изображению информации о водяном знаке размером в слово, не превышающее M бит, после преобразования каждого пикселя входного изображения глубиной N бит в пиксель глубиной (N+M) бит, превышающей ее на M бит.

19. Устройство кодирования изображения по п.1, в котором информация о кодировании изображения включает в себя флаг, указывающий, увеличивать ли глубину в битах каждого пикселя сигнала изображения на M бит, в качестве информации о преобразовании в битах для каждой произвольной единицы кодирования.

20. Устройство кодирования изображения по п.1, в котором информация о кодировании изображения включает в себя флаг, указывающий, увеличивать ли глубину в битах каждого пикселя сигнала изображения на M бит, в качестве информации о преобразовании в битах для каждой произвольной единицы кодирования, и дополнительно включает в себя данные, указывающие количество бит

M, на которое подлежит увеличить глубину.

21. Устройство декодирования изображения, содержащее:

демультиплексор для приема информации об изображении, мультиплексированной с информацией о преобразовании глубины в битах и информацией о кодировании изображения, и демультиплексирования информации о преобразовании в битах и информации о кодировании изображения;

декодер изображения для декодирования информации о кодировании изображения для вывода декодированного изображения; и

преобразователь глубины пикселя в битах для преобразования значения каждого пикселя декодированного изображения до другой глубины в битах на основе информации о преобразовании глубины в битах.

22. Устройство декодирования изображения, содержащее:

декодер для декодирования введенной информации о кодированном изображении в декодированное разностное изображение глубиной (N+M) бит;

генератор предсказываемого изображения для создания предсказываемого изображения глубиной (N+M) бит из опорного изображения глубиной (N+M) бит с использованием информации о кодированном изображении;

сумматор для добавления декодированного разностного изображения к предсказываемому изображению для получения декодированного изображения глубиной (N+M) бит;

память, запоминающую опорное изображение, для запоминания декодированного изображения глубиной (N+M) бит в качестве опорного изображения; и

преобразователь глубины пикселя в битах для преобразования каждого пикселя декодированного изображения глубиной (N+M) бит до глубины N бит для вывода декодированного изображения глубиной N бит.

23. Устройство декодирования изображения, содержащее:

декодер для приема информации о кодированном изображении и вывода декодированного разностного изображения глубиной (N+M) бит;

преобразователь с увеличением глубины пикселя в битах для преобразования каждого пикселя опорного изображения глубиной (N+M-L) бит в пиксель глубиной (N+M) бит для вывода декодированного изображения глубиной (N+M) бит;

генератор предсказываемого изображения для создания предсказываемого изображения глубиной (N+M) бит из опорного изображения глубиной (N+M) бит с использованием информации о кодированном изображении;

сумматор для добавления декодированного разностного изображения к предсказываемому изображению для получения декодированного изображения глубиной (N+M) бит;

блок уменьшения глубины пикселя в битах, сконфигурированный для преобразования каждого пикселя декодированного изображения глубиной (N+M) бит в пиксель глубиной (N+M-L) бит для вывода декодированного изображения глубиной (N+M-L) бит и преобразования каждого пикселя декодированного изображения глубиной (N+M) бит в пиксель глубиной N бит для вывода декодированного изображения глубиной N бит; и

память, запоминающую опорное изображение, для запоминания декодированного изображения глубиной (N+M-L) бит в качестве опорного изображения.

24. Устройство декодирования изображения, содержащее:

декодер для приема информации о кодированном изображении и вывода декодированного разностного изображения глубиной N бит;

генератор предсказываемого изображения для создания предсказываемого изображения глубиной (N+M) бит из опорного изображения глубиной (N+M) бит с

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использованием информации о кодированном изображении;

преобразователь глубины пикселя в битах для преобразования каждого пикселя опорного изображения глубиной (N+M) бит в пиксель глубиной N бит для вывода предсказываемого изображения глубиной N бит;

сумматор для добавления декодированного разностного изображения к предсказываемому изображению с целью получения декодированного изображения глубиной N бит;

преобразователь с уменьшением глубины пикселя в битах, для преобразования каждого пикселя декодированного изображения глубиной N бит в пиксель глубиной (N+M) бит для вывода декодированного изображения глубиной (N+M) бит; и

память, запоминающую опорное изображение, для запоминания декодированного изображения глубиной (N+M) бит в качестве опорного изображения.

25. Устройство декодирования изображения по п.24, в котором преобразователь глубины пикселя в битах имеет первый преобразователь глубины пикселя в битах, включающий в себя средство для вычисления репрезентативного значения исходя из максимального значения и минимального значения пикселя, содержащихся в изображении единицы кодирования в опорном изображении, для каждой единицы декодирования, средство для вычисления величины смещения Q ($0 \leq Q \leq L$), с помощью которой значение, полученное путем смещения вправо на Q бит разности между значением каждого пикселя в изображении единицы кодирования и репрезентативным значением, попадает в динамический диапазон глубиной (N+M-L) бит, и средство для преобразования каждого значения пикселя в изображении единицы кодирования в значение глубиной (N+M-L) путем смещения разности между значением каждого пикселя и репрезентативным значением вправо на Q бит;

память, запоминающая опорное изображение, запоминает декодированное изображение глубиной (N+M-L) бит в качестве опорного изображения, а также запоминает величину смещения и репрезентативное значение для каждой единицы кодирования; и

преобразователь глубины пикселя в битах включает в себя второй преобразователь глубины пикселя в битах, содержащий средство для считывания опорного изображения, величины смещения Q и репрезентативного значения из памяти, запоминающей опорное изображение, для каждой единицы декодирования, и преобразующий значение пикселя глубиной (N+M-L) бит каждого пикселя опорного изображения в значение пикселя глубиной (N+M) бит путем смещения значения пикселя вправо на Q бит и добавления его к репрезентативному значению.

26. Устройство декодирования изображения, содержащее:

декодер для приема информации о кодированном изображении и вывода декодированного разностного изображения глубиной N бит;

преобразователь глубины пикселя в битах для преобразования каждого пикселя опорного изображения глубиной N бит в пиксель глубиной (N+M) бит для вывода опорного изображения глубиной (N+M) бит;

генератор предсказываемого изображения для создания предсказываемого изображения глубиной (N+M) бит из опорного изображения глубиной (N+M) бит с использованием информации о кодированном изображении;

преобразователь глубины пикселя в битах для преобразования каждого пикселя предсказываемого изображения глубиной (N+M) бит в пиксель глубиной N бит для вывода предсказываемого изображения глубиной N бит;

сумматор для добавления декодированного разностного изображения к предсказываемому изображению для получения декодированного изображения глубиной N бит; и

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память, запоминающую опорное изображение, для запоминания декодированного изображения глубиной N бит в качестве опорного изображения.

27. Устройство декодирования изображения по 21, в котором информация о кодированном изображении включает в себя информацию о преобразовании глубины в битах, указывающую количество бит M, на которое выполняется преобразование, в качестве информации о преобразовании для каждой произвольной единицы кодирования, и

преобразователь увеличивает или уменьшает каждый пиксель изображения с глубиной в битах на основе информации о преобразовании глубины в битах.

28. Устройство декодирования изображения по п.23, в котором информация о кодированном изображении включает в себя данные, указывающие глубину (N+M-L) в битах памяти, запоминающей опорное изображение, в качестве информации о преобразовании в битах для каждой произвольной единицы кодирования, а преобразователь с увеличением глубины пикселя в битах и преобразователь с уменьшением глубины пикселя в битах выполняют преобразование с увеличением и преобразование с уменьшением на основе информации о преобразовании в битах и запоминание в качестве опорного изображения глубиной (N+M-L) бит в памяти, запоминающей опорное изображение.

29. Устройство декодирования изображения по п.21, в котором информация о кодированном изображении включает в себя информацию о преобразовании глубины в битах, указывающую глубину в N бит при выводе декодированного изображения в качестве информации о преобразовании глубины в битах для каждой произвольной единицы кодирования, и которое преобразует глубину в битах декодированного изображения до той же глубины в битах, что глубина N бит, при выводе декодированного изображения.

30. Устройство декодирования изображения по п.21, в котором преобразователь глубины изображения в битах преобразует каждую компоненту декодированного изображения в другое цветовое пространство, а затем преобразует каждый пиксель каждой компоненты декодированного изображения до другой глубины в битах.

31. Устройство декодирования изображения по п.21, в котором преобразователь с уменьшением глубины пикселя в битах преобразует каждую компоненту изображения глубиной (N+M) бит в другое цветовое пространство, а затем преобразует каждый пиксель каждой компоненты изображения в пиксель глубиной N бит.

32. Устройство декодирования изображения по п.30 или 31, в котором информация о кодированном изображении включает в себя информацию о преобразовании глубины в битах, указывающую количество бит M, на которое подлежит увеличить глубину, и данные, указывающие цветовое пространство, при выводе декодированного изображения в качестве информации о преобразовании глубины в битах для каждой произвольной единицы кодирования, а преобразователь выполняет цветовое преобразование декодированного изображения в данные, указывающие цветовое пространство, при выводе декодированного изображения, на основе информации о преобразовании глубины в битах, а затем увеличивает или уменьшает глубину в битах каждого пикселя преобразованного по цвету декодированного изображения.

33. Устройство декодирования изображения по п.30 или 31, в котором информация о кодированном изображении включает в себя информацию о преобразовании глубины в битах, указывающую глубину N бит входного изображения при выводе декодированного изображения, и данные, указывающие цветовое пространство при выводе декодированного изображения, в качестве информации о преобразовании глубины в битах для каждой произвольной единицы кодирования, и которое

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выполняет цветовое преобразование декодированного изображения в данные, указывающие цветовое пространство, при выводе декодированного изображения, а затем преобразует преобразованное по цвету декодированное изображение в пиксель, имеющий то же глубину, что и глубина N бит при выводе декодированного изображения.

34. Устройство декодирования изображения по п.21, в котором информация о кодированном изображении включает в себя информацию об адаптивной интерполяционной фильтрации, а генератор предсказываемого изображения создает предсказываемое изображение на основе информации об адаптивной интерполяционной фильтрации.

35. Устройство декодирования изображения по п.21, в котором информация о кодированном изображении включает в себя информацию о фильтрации и который подвергает декодированное изображение фильтрации на основе информации о фильтрации.

36. Устройство декодирования изображения по п.21, в котором преобразователь глубины пикселя в битах также содержит фильтр для выполнения фильтрации в кодированном изображении и преобразует каждый пиксель декодированного изображения глубиной (N+M) бит в пиксель глубиной N бит после того, как фильтр выполнил фильтрацию в декодированном изображении.

37. Устройство декодирования изображения по п.21, в котором информация о кодированном изображении включает в себя информацию о фильтрации, а преобразователь глубины пикселя в битах дополнительно содержит фильтр, чтобы подвергнуть декодированное изображение фильтрации на основе информации о фильтрации и преобразовать каждый пиксель декодированного изображения глубиной (N+M) бит в пиксель глубиной N бит после того, как фильтр выполнит фильтрацию в декодированном изображении.

38. Устройство декодирования изображения по п.22, содержащее также детектор водяного знака для обнаружения информации о водяном знаке, вставленной в декодированное изображение на задней ступени сумматора.

39. Устройство декодирования изображения по п.21, в котором информация о кодировании изображения включает в себя флаг, указывающий, преобразовывать ли глубину в битах декодированного изображения на M бит, в качестве информации о преобразовании глубины в битах для каждой произвольной единицы, причем преобразователь не выполняет преобразование, когда этот вышеупомянутый флаг находится в состоянии FALSE, и преобразователь выполняет увеличение или уменьшение глубины в битах каждого пикселя изображения на основе информации о преобразовании в битах, когда упомянутый флаг находится в состоянии TRUE.

40. Устройство декодирования изображения по п.21, в котором информация о кодировании изображении включает в себя флаг, указывающий, увеличивать ли глубину в битах декодированного изображения на M бит, и данные, указывающие количество бит M, на которое подлежит увеличить глубину, в качестве информации о преобразовании глубины в битах для каждой произвольной единицы, причем преобразователь не выполняет преобразование, когда вышеупомянутый флаг находится в состоянии FALSE, и преобразователь выполняет уменьшение глубины в битах каждого пикселя изображения на основе информации о преобразовании в битах, когда упомянутый флаг находится в состоянии TRUE.

41. Способ кодирования изображения, содержащий:

шаг преобразования глубины в битах каждого пикселя входного изображения для создания преобразованного входного изображения с другой длиной в битах;

шаг вывода информации о преобразовании в битах, указывающий количество бит,

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изменяемых преобразованием;

шаг кодирования преобразованного входного изображения для вывода информации о кодированном изображении; и

шаг мультиплексирования информации о преобразовании в битах и информации о колированном изображении.

42. Способ кодирования изображения, содержащий:

шаг преобразования глубины в битах каждого пикселя входного изображения, состоящего из множества пикселей, имеющих глубину N бит, соответственно до глубины (N+M) бит, превышающей ее на M бит;

шаг создания предсказываемого изображения глубиной (N+M) бит по отношению к входному изображению глубиной (N+M) бит из опорного изображения глубиной (N+M) бит;

шаг получения дифференциального сигнала между входным изображением глубиной (N+M) бит и предсказываемым изображением глубиной (N+M) бит;

шаг кодирования дифференциального сигнала для вывода информации о кодированном изображении;

шаг создания декодированного разностного изображения на основе информации о кодировании изображения;

шаг добавления предсказываемого изображения глубиной (N+M) бит к декодированному разностному изображению для вывода декодированного изображения глубиной (N+M) бит; и

шаг запоминания декодированного изображения глубиной (N+M) бит в качестве опорного изображения в памяти, запоминающей опорное изображение.

43. Способ декодирования изображения, содержащий:

шаг демультиплексирования информации о входном изображении, с которой мультиплексированы информация о преобразовании глубины в битах и информация о кодированном изображении, в информацию о преобразовании в битах и информацию о кодированном изображении;

шаг декодирования информации о кодированном изображении для создания декодированного изображения; и

шаг преобразования каждого пикселя декодированного изображения в пиксель с другой глубиной в битах на основе информации о преобразовании глубины в битах.

44. Способ декодирования изображения, содержащий:

шаг декодирования введенной информации о кодированном изображении в декодированное разностное изображение глубиной (N+M) бит;

шаг создания предсказываемого изображения глубиной (N+M) бит из опорного изображения глубиной (N+M) бит с использованием введенной информации о кодированном изображении;

шаг добавления декодированного разностного изображения к предсказываемому изображению для создания декодированного изображения глубиной (N+M) бит;

шаг запоминания декодированного изображения глубиной (N+M) бит в качестве опорного изображения; и

шаг преобразования значения каждого пикселя декодированного изображения глубиной (N+M) бит до глубины N бит для создания декодированного изображения глубиной N бит.

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Espacenet

Bibliographic data: WO2010001832 (A1) — 2010-01-07

DYNAMIC IMAGE PREDICTION/ENCODING DEVICE AND DYNAMIC IMAGE PREDICTION/DECODING DEVICE

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Classification:
- **international:** ***H04N7/32***
- **cooperative:** **H04N19/117 (EP, US); H04N19/159 (EP, US); H04N19/176 (EP, US)**

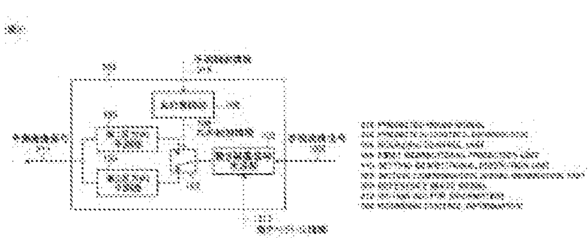
Application number: WO2009JP61738 20090626 Global Dossier

Priority number(s): JP20080171326 20080630

Also published as: AU2009264603 (A1) CA2729615 (A1) JPWO2010001832 (A1) US2011090966 (A1)

Abstract of WO2010001832 (A1)

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.



(12) 特許協力条約に基づいて公開された国際出願

(19) 世界知的所有権機関
国際事務局

(43) 国際公開日
2010 年 1 月 7 日(07.01.2010)

PCT

(10) 国際公開番号
WO 2010/001832 A1

(51) 国際特許分類:
H04N 7/32 (2006.01)

(21) 国際出願番号: PCT/JP2009/061738

(22) 国際出願日: 2009 年 6 月 26 日(26.06.2009)

(25) 国際出願の言語: 日本語

(26) 国際公開の言語: 日本語

(30) 優先権データ:
特願 2008-171326 2008 年 6 月 30 日(30.06.2008) JP

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(81) 指定国 (表示のない限り、全ての種類の国内保護が可能): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

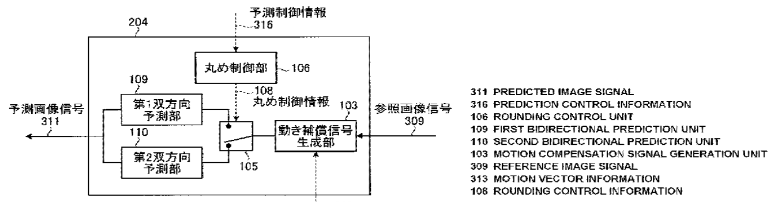
(84) 指定国 (表示のない限り、全ての種類の広域保護が可能): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), ユーラシア (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), ヨーロッパ (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

添付公開書類:
— 国際調査報告（条約第 21 条(3)）

(54) **Title**: DYNAMIC IMAGE PREDICTION/ENCODING DEVICE AND DYNAMIC IMAGE PREDICTION/DECODING DEVICE

(54) 発明の名称: 動画像予測符号化装置および動画像予測復号化装置

[図3]



(57) **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.

(57) 要約: 符号化対象画像に対応する復号画像が他の符号化対象画像の参照画像となる場合とならない場合とで、予測画像を生成する際の丸め処理を切り替える。

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明 細 書

発明の名称 ： 動画像予測符号化装置および動画像予測復号化装置

技術分野

[0001] 本発明は、動画像予測符号化及び動画像予測復号化に関する。

背景技術

[0002] H.264/AVCでは、二つの参照画像を使って予測値作成する双方向予測が可能ないわゆるBスライスも、他のスライスの予測のための参照画像として用いることが許されている。Bスライスからの参照構造を階層的に構成する階層双方向予測構造によって、高い符号化効率を実現することができることが知られている（非特許文献１）。

[0003] 双方向予測された画像を参照した場合、双方向予測のための平均値を計算する予測式の丸め方法が固定的なため、丸め誤差が伝搬し予測効率が低下していた。

[0004] また、動画像符号化技術において、丸め誤差が伝搬する問題については、動き補償補間フィルタにおいて既に知られており、その対策方法も提案されている（特許文献１）。

先行技術文献

特許文献

[0005] 特許文献1：特許第２９９８７４１号公報

非特許文献

[0006] 非特許文献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.

発明の概要

発明が解決しようとする課題

[0007] 従来の双方向予測では、予測式から得られる値を常に同じ方法で丸めていた。そのため、双方向予測された画像を参照画像として用いると丸め誤差が

伝搬する。その結果、予測効率が低下する。H.264/AVC以前の予測符号化方式では、双方向予測された画像が参照画像として用いられることがなかったので、問題になることはなかった。

[0008] 本発明は上記課題を解決するためになされた。双方向予測され、かつ、他の画像から参照される画像については、双方向予測の予測式から得られる値の丸め方法を可変制御する。本発明の目的は、丸め誤差の伝搬を抑制して予測効率を改善することが可能な、動画像予測符号化および復号化の装置を提供することである。

課題を解決するための手段

[0009] 上記目的を達成するために、本発明の動画像予測符号化装置は、参照画像と動きベクトル情報とを用いて動き補償画像を生成する動き補償部と、複数の動き補償画像を用いて符号化対象画像の予測画像を生成する双方向予測部と、前記符号化対象画像と前記予測画像との予測誤差を符号化する符号化部と、を備え、前記双方向予測部は、前記符号化対象画像に対応する復号画像が他の符号化対象画像の参照画像となる場合に、前記予測画像を生成する際の丸め処理を複数の方法で切り替えることを特徴とする。

[0010] また、本発明の一側面の動画像予測復号化装置は、入力された符号化データから復号化対象画像の動きベクトル情報と予測誤差情報とを抽出する復号化部と、参照画像と動きベクトル情報とを用いて動き補償画像を生成する動き補償部と、複数の動き補償画像を用いて復号化対象画像の予測画像を生成する双方向予測部と、前記予測画像と前記予測誤差を加算して前記復号化対象画像を再生する再生部と、を備え、前記双方向予測部は、前記復号化対象画像に対応する前記復号化対象画像が他の復号化対象画像の参照画像となる場合に、前記予測画像を生成する際の丸め処理を複数の方法で切り替える、ことを特徴とする。

発明の効果

[0011] 丸め誤差の伝搬が抑制されるので符号化効率が改善される。

図面の簡単な説明

[0012] [図1]動画像予測符号化装置のブロック図。

[図2]予測生成部のブロック図。

[図3]双方向予測生成部のブロック図。

[図4]丸め制御信号のシンタクスを示す図。

[図5]動画像予測復号化装置のブロック図。

[図6]フレームメモリのブロック図。

発明を実施するための形態

[0013] （第１の実施形態）

図１は第１の実施形態の動画像予測符号化装置３００のブロック図である。動画像予測符号化装置３００は、減算器３０２、変換／量子化部３０３、逆量子化／逆変換部３０４、エントロピー符号化部３０５、加算器３０６、フレームメモリ３０８、予測画像生成部３１０、動きベクトル探索部３１２、および、符号化制御部３１４を備える。動画像予測符号化装置３００は、入力動画像信号３０１から、符号化データ３１５を生成する。

[0014] 動画像予測符号化装置３００には、入力動画像信号３０１が入力される。入力動画像信号３０１の各フレームは複数の符号化対象ブロックに分けられている。予測画像生成部３１０は符号化対象ブロックの予測画像信号３１１を生成する。減算器３０２は符号化対象ブロックの予測画像信号３１１と符号化対象ブロックの入力動画像信号３０１との差分を求めて符号化対象ブロックの予測誤差信号を生成する。

[0015] 変換／量子化部３０３は予測誤差信号を直交変換して直交変換係数を求めるとともに、直交変換係数を量子化して量子化直交変換係数情報を求める。直交変換としては、例えば離散コサイン変換を用いることができる。量子化直交変換係数情報は、エントロピー符号化部３０５と逆量子化／逆変換部３０４に入力される。

[0016] 逆量子化／逆変換部３０４は量子化直交変換係数情報に対して、変換／量子化部３０３の処理と逆の処理を行う。すなわち、逆量子化／逆変換部３０４は量子化直交変換係数情報を逆量子化および逆直交変換の処理を行って予

測誤差信号を再生する。加算器３０６は再生された予測誤差信号と予測画像信号３１１とを加算して復号画像信号３０７を生成する。復号画像信号３０７はフレームメモリ３０８に入力される。

[0017] フレームメモリ３０８は、復号画像信号３０７にフィルタ処理を行う。フレームメモリ３０８は、予測制御情報３１６に基づいて、フィルタ処理された復号画像信号３０７を記憶するかを判定する。フレームメモリ３０８が記憶する復号画像信号３０７は、予測画像生成部３１０に入力する参照画像信号３０９とするためのものである。

[0018] 参照画像信号３０９は、予測画像生成部３１０と動きベクトル探索部３１２に入力される。動きベクトル探索部３１２は、入力動画像信号３０１と参照画像信号３０９とを用いて、動きベクトル情報３１３を生成する。動きベクトル情報３１３は、予測画像生成部３１０とエントロピー符号化部３０５とに入力される。予測画像生成部３１０は、参照画像信号３０９と予測制御情報３１６と動きベクトル情報３１３とを用いて、予測画像信号３１１を生成する。

[0019] 符号化制御部３１４は、変換／量子化部３０３、予測画像生成部３１０、および、フレームメモリ３０８の制御を行う。符号化制御部３１４によって生成された予測制御情報３１６は、予測画像生成部３１０とフレームメモリ３０８とエントロピー符号化部３０５とに入力される。エントロピー符号化部３０５は、変換／量子化部３０３からの量子化直交変換係数情報、符号化制御部３１４からの予測制御情報３１６、動きベクトル探索部３１２からの動きベクトル情報３１３を含む符号化情報をエントロピー符号化するとともに、予め決められたシンタクスに従って符号化データ３１５を生成する。

[0020] 図２は予測画像生成部３１０のブロック図である。予測画像生成部３１０は、スイッチ２０３と双方向予測部２０４と単方向予測部２０５とイントラ予測部２０６とを備える。予測画像生成部３１０は、予測制御情報３１６と動きベクトル情報３１３とに従って、参照画像信号３０９から予測画像信号３１１を生成する。

[0021] スイッチ２０３は、双方向予測部２０４と単方向予測部２０５とイントラ予測部２０６とを切り替える。参照画像信号３０９は、双方向予測部２０４と単方向予測部２０５とイントラ予測部２０６とのうち、スイッチ２０３によって選択されたものに入力される。

[0022] 双方向予測部２０４と単方向予測部２０５とイントラ予測部２０６とはそれぞれ参照画像信号３０９から予測画像信号３１１を生成する。双方向予測部２０４は、複数の参照フレームの参照画像信号３０９と複数の動きベクトル情報３１３とを用いた双方向予測を行うことにより予測画像信号３１１を生成する。なお、双方向予測部２０４は複数の動きベクトルに従って同じ参照フレームの異なる領域を参照しても構わない。

[0023] 単方向予測部２０５は、単一の参照フレームからの参照画像信号３０９と動きベクトル情報３１３とを用いて予測画像信号３１１を生成する。イントラ予測部２０６は、画面内の参照画像信号３０９を用いて予測画像信号３１１を生成する。

[0024] 図３は双方向予測部２０４のブロック図である。双方向予測部２０４は、動き補償信号生成部１０３とスイッチ１０５と丸め制御部１０６と第１双方向予測部１０９と第２双方向予測部１１０とを備える。双方向予測部２０４は参照画像信号３０９と予測制御情報３１６と動きベクトル情報３１３とを用いて、予測画像信号３１１を生成する。

[0025] 動き補償信号生成部１０３は、動きベクトル情報３１３と参照画像信号３０９とを用いて動き補償信号を生成する。スイッチ１０５は、丸め制御情報１０８に従って、第１双方向予測部１０９と第２双方向予測部１１０とを切り替える。丸め制御情報１０８は、演算方式としての丸め処理を示す情報であり、第１双方向予測部１０９および第２双方向予測部１１０のいずれか一方を指定する情報である。動き補償信号は、第１双方向予測部１０９と第２双方向予測部１１０とのうち切り替えられた方へ入力される。第１双方向予測部１０９または第２双方向予測部１１０によって、動き補償信号から予測画像信号３１１が生成される。

[0026] 動き補償信号生成部１０３は、フレームメモリ３０８からの参照画像信号３０９と動きベクトル探索部３１２からの動きベクトル情報３１３とを用いて、二つの動き補償画像信号MC_{L0}とMC_{L1}を作成する。

[0027] 丸め制御部１０６は、これから生成される予測画像信号との間で予測残差信号を求められる入力画像信号に対応する復号画像信号が参照画像信号としてフレームメモリ３０８に記憶されるか否かを判定する。つまり、これから生成される予測画像信号と入力画像信号との間で求められた予測残差信号を、直交変換、量子化、逆量子化、逆直交変換および動き補償して得られる復号画像信号が、参照画像信号としてフレームメモリ３０８に記憶されるか否かを、丸め制御部１０６は判定する。この判定は予測制御情報３１６に基づいて行われる。例えば、H.264/AVCのStored B-pictureは参照画像として用いられることが許容されている。Stored B-pictureは参照画像信号としてフレームメモリ３０８に記憶される。しかも、参照画像信号として用いられる可能性があることは予測制御情報３１６に基づいて判別できる。このように、予測制御情報３１６は、参照画像信号として用いられる画像か否かを示す情報である。

[0028] 丸め制御部１０６は、復号画像信号を他の符号化対象画像の参照画像信号として用いることが許可されている場合には第１双方向予測部１０９を選択し、復号画像信号を他の符号化対象画像の参照画像信号として用いることが許容されていない場合には第２双方向予測部１１０を選択する。

[0029] 第１双方向予測部１０９および第２双方向予測部１１０は動き補償画像信号MC_{L0}およびMC_{L1}から予測画像信号３１１を生成する。なお、第１双方向予測部１０９および第２双方向予測部１１０は整数演算を行うものとする。

[0030] 第１双方向予測部１０９および第２双方向予測部１１０は、それぞれ式（１）および式（２）に従った演算を行って予測画像を求める。第１双方向予測部１０９は式（１）に従って予測画像信号を生成し、第２双方向予測部１１０は式（２）に従って予測画像信号を生成する。

$$Pred = (MC_{L0} + MC_{L1}) >> 1 \quad \cdots \quad 式（１）$$

$Pred = (MC_{L0} + MC_{L1} + 1) >> 1$ ・・・ 式（２）

式（１）および式（２）は両方とも、動き補償信号生成部１０３で生成された動き補償画像信号MC_{L0}とMC_{L1}から、予測画像信号Predを生成する演算処理を表す数式である。なお、式（１）、式（２）における“＞＞”は算術右シフト処理を意味する。

[0031] 通常、参照される双方向予測が用いられる階層双方向予測構造などにおいては、参照されるBスライスと参照されないBスライスの数が同じになるため、予測制御情報３１６に基づいて第１双方向予測部１０９と第２双方向予測部１１０を選択しても、丸め誤差を打ち消しあうことになる。

[0032] 本実施形態では、第１双方向予測部１０９が式（１）を用い、第２双方向予測部１１０に式（２）を用いる場合を示した。参照画像として用いられることが許容されている場合と許容されていない場合とで丸め処理を変えることによって、丸め誤差の伝搬を抑制することができる。その結果として予測効率が改善されるので符号化効率が向上する。

[0033] なお、丸め制御部１０６は、丸め処理を変えることで丸め誤差の伝搬を抑制できるので、例えば、第１双方向予測部１０９が式（２）を用い、第２双方向予測部１１０が式（１）を用いても構わない。

[0034] （第２の実施形態）

第１の実施形態と異なる点を中心に、第２の実施形態を説明する。第１の実施形態では、丸め制御部１０６は、予測制御情報３１６に基づいて丸め処理を示す丸め制御情報１０８を決定する。本実施形態では、丸め制御情報１０８を、ある符号化単位、例えばフレーム単位やスライス単位で明示的に符号化する。

[0035] 図４は、丸め制御情報１０８を明示的にエントロピー符号化で符号化する場合のシンタクスの例を示す。予測制御情報３１６は、ある符号化単位、例えばフレーム単位やスライス単位での復号画像信号を予測画像生成のために他の符号化対象画像の参照画像信号として用いることが許容されているか否かを示す情報である。もし当該符号化単位が、参照画像信号として用いられ

ることが許容されている場合には、丸め制御情報を符号化して送り、許容されていない場合は、丸め制御情報の符号化および送信は行わない。

[0036] （第３の実施形態）

第１の実施形態および第２の実施形態と異なる点を中心に第３の実施形態を説明する。本実施形態の第１双方向予測部１０９は式（３）を用い、第２双方向予測部１１０は式（４）を用いる。式（３）は最近接偶数への丸め（round to the nearest even; RN）の演算を示し、式（４）は最近接奇数への丸め演算を示す。

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

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

[0037] 式（３）では、MC_{L0}とMC_{L1}との和の下位２ビットの値に応じて丸め処理が変わる。下位２ビットの値が３である場合には１を加算してから２で除算する処理が行われ、それ以外の場合にはそのまま２で除算する処理が行われる。式（３）は整数演算の場合の最近接偶数への丸め演算に相当する。

[0038] 式（４）では、MC_{L0}とMC_{L1}との和の下位２ビットの値に応じて丸め処理が変わる。下位２ビットの値が１である場合には１を加算してから２で除算する処理が行われ、それ以外の場合にはそのまま２で除算する処理が行われる。式（４）は整数演算の場合の最近接奇数への丸め演算に相当する。

[0039] なお、第１双方向予測部１０９が式（４）を用い、第２双方向予測部１１０が式（３）を用いても構わない。

[0040] （第４の実施形態）

第１〜第３の実施形態と異なる点を中心に第４の実施形態を説明する。本実施形態の第１双方向予測部１０９は式（５）を用いる。本実施形態では擬似乱数を発生させ、オフセット値Ｒを用いた確率丸めの処理を行う。

$$Pred = (MC_{L0} + MC_{L1} + R) >> 1 \quad \cdot\cdot\cdot \quad 式（５）$$

[0041] 本実施形態では動画像予測符号化装置３００と後述する動画像予測復号化

装置とで同一の種を持つ擬似乱数を用いる。また、本実施形態では０と１とが３：１の割合で発生する擬似乱数が用いられる。

[0042] なお、０と１の発生の割合がほぼ３：１ならば、必ずしも乱数である必要はない。例えば、周期的や規則的な数列の生成方法でも構わない。また、符号化データの他の情報、例えば、フレーム数を表す情報の下位２ビットの値などを用いても構わない。

[0043] （第５の実施形態）

第１～第４の実施形態と異なる点を中心に第５の実施形態を説明する。本実施形態の第１双方向予測部１０９は式（６）を用いる。

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

式（６）では、MC_{L0}とMC_{L1}との和の下位１ビットの値に応じて丸め処理が変わる。下位１ビットの値が１である場合には擬似乱数のオフセット値Ｒを加算してから２で除算する処理が行われ、それ以外の場合にはそのまま２で除算する処理が行われる。すなわち、式（６）では、MC_{L0}とMC_{L1}との和が奇数である場合にのみ確率丸めの処理が行われる。

[0044] このとき、動画像予測符号化装置３００と後述する動画像予測復号化装置とで、同一の種を持つ０と１の割合が１：１に発生する値の擬似乱数を発生させてオフセット値Ｒとして用いる。擬似乱数に関しては、０と１の発生の割合がほぼ１：１ならば、乱数である必要はなく、周期的や規則的な数列の生成方法でもよい。また、符号化データの他の情報、例えば、フレーム数を表す情報の最下位ビットの値などを用いてもよい。

[0045] （第６の実施形態）

第１～第５の実施形態と異なる点を中心に第６の実施形態を説明する。本実施形態の第１双方向予測部１０９は式（７）を用い、第２双方向予測部１１０は式（８）を用いる。

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

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

式（７）および式（８）において、W_0、W_1は重み係数、O_0、O_1はオフセット係数である。

[0046]　式（７）および式（８）は、重み付き双方向予測の処理である。式（７）の第１項では2^Lを加算してから2^{L+1}で除算する処理が行われる。式（７）では1/2以上の端数が切り上げられ、1/2未満の端数が切り捨てられる。１０進数の場合の四捨五入に相当する丸め処理が行われる。式（８）の第１項では$(2^L - 1)$を加算してから2^{L+1}で除算する処理が行われる。式（８）では1/2より大きい端数が切り上げられ、1/2以下の端数が切り捨てられる。１０進数の場合の五捨六入に相当する丸め処理が行われる。H.264/AVCの重み付き双方向予測では、常に四捨五入による丸め処理が用いられる。本実施形態では式（７）と式（８）とが切り替わるので、丸め誤差が伝搬しにくくなる。

[0047]　なお、式（３）および式（４）のような最近接偶数や最近接奇数への丸め処理や、式（５）および式（６）のような確率的な丸め処理と、本実施形態の予測式とを組み合わせても構わない。

[0048]　また、第１双方向予測部１０９が式（８）を用い、第２双方向予測部１１０が式（７）を用いても構わない。

[0049]　（第７の実施形態）

図５は第１～第６の実施形態の動画像予測符号化装置３００に対応する動画像予測復号化装置４００のブロック図である。動画像予測復号化装置４００は、エントロピー復号化部４０２、逆量子化／逆変換部４０３、加算器４０４、フレームメモリ４０６、予測画像生成部４０９を備える。動画像予測復号化装置４００は、符号化データ４０１から再生動画像信号４０７を生成する。

[0050]　エントロピー復号化部４０２は、予め決められたシンタクスに従って符号化データ４０１のエントロピー復号化処理を行う。エントロピー復号化部４０２は、量子化直交変換係数情報と予測制御情報４１１と動きベクトル情報

４１２とを求める。復号化された量子化直交変換係数情報は逆量子化／逆変換部４０３に入力される。復号化された予測制御情報４１１および動きベクトル情報４１２は予測画像生成部４０９に入力される。さらに、復号化対象画像が他の復号化対象画像の参照画像として用いられることが許可されている場合には、符号化データ４０１には、丸め制御情報が含まれており、エントロピー復号化部４０２は、この場合には、符号化データ４０１の復号化によりこの丸め制御情報も抽出する。

[0051] 逆量子化／逆変換部４０３は、逆量子化、逆直交変換処理を行って予測誤差信号を再生する。加算器４０４は、予測誤差信号と予測画像信号４１０とを加算して、復号画像信号４０５を生成する。

[0052] 復号画像信号４０５はフレームメモリ４０６に入力される。フレームメモリ４０６は復号画像信号４０５にフィルタ処理を行って再生動画像信号４０７として出力する。フレームメモリ４０６は、フィルタ処理された復号画像信号４０５を記憶するかを、予測制御情報４１１に基づいて判定する。記憶された復号画像信号４０５は、参照画像信号４０８として予測画像生成部４０９に入力される。

[0053] 予測画像生成部４０９は、参照画像信号４０８と予測制御情報４１１と動きベクトル情報４１２とを用いて、予測画像信号４１０を生成する。なお、予測画像生成部４０９の構成は、図２および図３を参照しつつ説明した動画像予測符号化装置３００の予測画像生成部３１０の構成と同様である。すなわち、予測画像生成部４０９は、予測画像生成部３１０と同様に、式（１）または式（２）のいずれかの演算により予測画像を求める。さらに、符号化データ４０１から丸め制御情報が得られた場合には、予測画像生成部４０９は、丸め制御情報をさらに用いて予測画像信号４１０を生成する。

[0054] 図６はフレームメモリ４０６のブロック図である。なお、図１のフレームメモリ３０８の構成は、図６に示すフレームメモリ４０６の構成と同様である。フレームメモリ４０６は、ループフィルタ５０３と、スイッチ５０４と、参照画像バッファ５０６を備える。フレームメモリ４０６は、予測制御情

報４１１と復号画像信号４０５とを用いて、参照画像信号４０８と再生動画像信号４０７とを生成する。ループフィルタ５０３は、復号画像信号４０５にデブロックフィルタや画像復元フィルタを適用する。

[0055] スイッチ５０４は、予測制御情報４１１に基づいて、ループフィルタ５０３が適用された後の復号画像信号を参照画像バッファ５０６に記憶するか否かを切り替える。復号画像信号が参照画像信号として用いられることが許可されている場合には復号画像信号を参照画像バッファ５０６に入力し、復号画像信号が参照画像信号として用いられることが許可されていない場合には復号画像信号を参照画像バッファ５０６には入力しない。

[0056] フレームメモリ４０６が動画像予測復号化装置側にある場合、ループフィルタ５０３が適用された後の復号画像信号は参照画像バッファ５０６に入力される場合にも入力されない場合にも、再生動画像信号４０７として出力される。

[0057] （第８の実施形態）

第１～第７の実施形態と異なる点を中心に第８の実施形態を説明する。本実施形態の丸め制御部１０６は、入力画像信号に対応する復号画像信号が参照画像信号として用いられる場合には第１双方向予測部１０９と第２双方向予測部１１０とを切り替える。本実施形態の丸め制御部１０６は、入力画像信号に対応する復号画像信号が参照画像信号として用いられない場合には第２双方向予測部１１０を選択する。つまり、入力画像信号に対応する復号画像信号が参照画像信号として用いられる場合には、丸め処理を複数の方法で切り替えながら双方向予測を行う。丸め処理の切り替えは、例えば、ラウンドロビン方式でも構わないし、ランダムでも構わない。

[0058] 動画像予測符号化装置は選択された丸め処理を示す丸め制御情報を明示的にエントロピー符号化する。動画像予測復号化装置は符号化データから抽出された丸め制御情報に従って丸め処理を切り替える。

[0059] なお、丸め制御情報は暗黙的に符号化されても構わない。符号化データの他の情報、例えば、フレーム数を表す情報の最下位ビットの値に基づいて切

り替えても構わない。

[0060] この動画像予測符号化装置あるいは動画像予測復号化装置は、例えば、汎用のコンピュータ装置を基本ハードウェアとして用いることでも実現することが可能である。すなわち、動画像予測符号化装置あるいは動画像予測復号化装置は、上記のコンピュータ装置に搭載されたプロセッサにプログラムを実行させることにより実現することができる。このとき、動画像予測符号化装置あるいは動画像予測復号化装置は、上記のプログラムをコンピュータ装置にあらかじめインストールすることで実現してもよいし、ＣＤ－ＲＯＭなどの記憶媒体に記憶して、あるいはネットワークを介して上記のプログラムを配布して、このプログラムをコンピュータ装置に適宜インストールすることで実現してもよい。また、動画像予測符号化装置あるいは動画像予測復号化装置は、上記のコンピュータ装置に内蔵あるいは外付けされたメモリ、ハードディスクもしくは、光ディスクなどの記憶媒体などを適宜利用して実現することができる。

[0061] なお、本発明は上記実施形態そのままに限定されるものではなく、実施段階ではその要旨を逸脱しない範囲で構成要素を変形して具体化できる。また、上記実施形態に開示されている複数の構成要素の適宜な組み合わせにより、種々の発明を形成できる。例えば、実施形態に示される全構成要素から幾つかの構成要素を削除してもよい。さらに、異なる実施形態にわたる構成要素を適宜組み合わせてもよい。

符号の説明

[0062] １０３　動き補償信号生成部

１０５　スイッチ

１０６　丸め制御部

１０９　第１双方向予測部

１１０　第２双方向予測部

２０３　スイッチ

２０４　双方向予測部

２０５　単方向予測部

２０６　イントラ予測部

３００　動画像予測符号化装置

３０２　減算器

３０３　変換／量子化部

３０４　逆量子化／逆変換部

３０５　エントロピー符号化部

３０６　加算器

３０８　フレームメモリ

３１０　予測画像生成部

３１２　動きベクトル探索部

３１４　符号化制御部

４００　動画像予測復号化装置

４０２　エントロピー復号化部

４０３　逆量子化／逆変換部

４０４　加算器

４０６　フレームメモリ

４０９　予測画像生成部

請求の範囲

[請求項1] 既に双方向予測符号化された画像についての復号画像を含む参照画像と動きベクトル情報とを用いて符号化対象画像の予測画像を生成する双方向予測部と、

前記符号化対象画像と前記予測画像との予測誤差を符号化する符号化部と、

を備え、

前記双方向予測部は、丸め処理方法が異なる複数の演算方式を切り替えながら前記予測画像を生成する、

ことを特徴とする動画像符号化装置。

[請求項2] 前記符号化部は前記演算方式を示す制御情報を符号化することを特徴とする請求項１に記載の動画像符号化装置。

[請求項3] 前記符号化部は、

（Ａ）前記符号化対象画像に対応する復号画像を他の符号化対象画像の参照画像として用いることが許容されている場合には前記制御情報を符号化し、

（Ｂ）前記復号画像を他の符号化対象画像の参照画像として用いることが許容されていない場合には前記制御情報を符号化しない、

ことを特徴とする請求項２に記載の動画像符号化装置。

[請求項4] 前記双方向予測部は、

（１）二つの信号の和を２で除算する第１演算方式と、

（２）二つの信号の和に１を加えてから２で除算する第２演算方式と、

を切り替えることを特徴とする請求項３に記載の動画像符号化装置。

[請求項5] 前記双方向予測部は、

（ａ）前記復号画像を他の符号化対象画像の参照画像として用いることが許容されている場合には前記第１演算方式を用い、

（ｂ）前記復号画像を他の符号化対象画像の参照画像として用い

ることが許容されていない場合には前記第２演算方式を用いる、
ことを特徴とする請求項４に記載の動画像符号化装置。

[請求項6] 前記双方向予測部は、
（ａ）前記復号画像を他の符号化対象画像の参照画像として用いることが許容されていない場合には前記第１演算方式を用い、
（ｂ）前記復号画像を他の符号化対象画像の参照画像として用いることが許容されている場合には前記第２演算方式を用いる、
ことを特徴とする請求項４に記載の動画像符号化装置。

[請求項7] 入力された符号化データから復号対象画像の動きベクトル情報と復号対象画像の予測誤差情報とを抽出する復号化部と、
既に双方向予測復号化された画像を含む参照画像と複数の動きベクトル情報とを用いて復号対象画像の予測画像を生成する双方向予測部と、
前記予測画像と前記予測誤差とを加算して前記復号対象画像の復号画像を求める再生部と、
を備え、
前記双方向予測部は、丸め処理方法が異なる複数の演算方式を切り替えながら前記予測画像を生成する、
ことを特徴とする動画像復号化装置。

[請求項8] 前記復号化部は前記符号化データから前記演算方式を示す制御情報を抽出し、
前記双方向予測部は前記制御情報に従って演算方式を切り替える、
ことを特徴とする請求項７に記載の動画像復号化装置。

[請求項9] 前記復号化部は、前記復号画像を他の復号対象画像の参照画像として用いることが許容されている場合には前記制御情報を抽出し、
前記双方向予測部は、前記制御情報に従って前記複数の演算方式を切り替えることを特徴とする請求項８に記載の動画像復号化装置。

[請求項10] 前記双方向予測部は、

（１）二つの信号の和を２で除算する第１演算方式と、

（２）二つの信号の和に１を加算してから２で除算する第２演算方式と、

を切り替えることを特徴とする請求項９に記載の動画像復号化装置。

[請求項11] 前記双方向予測部は、

（ａ）前記復号画像を他の復号対象画像の参照画像として用いることが許容されている場合には前記第１演算方式を用い、

（ｂ）前記復号画像を他の復号対象画像の参照画像として用いることが許容されていない場合には前記第２演算方式を用いる、

ことを特徴とする請求項１０に記載の動画像復号化装置。

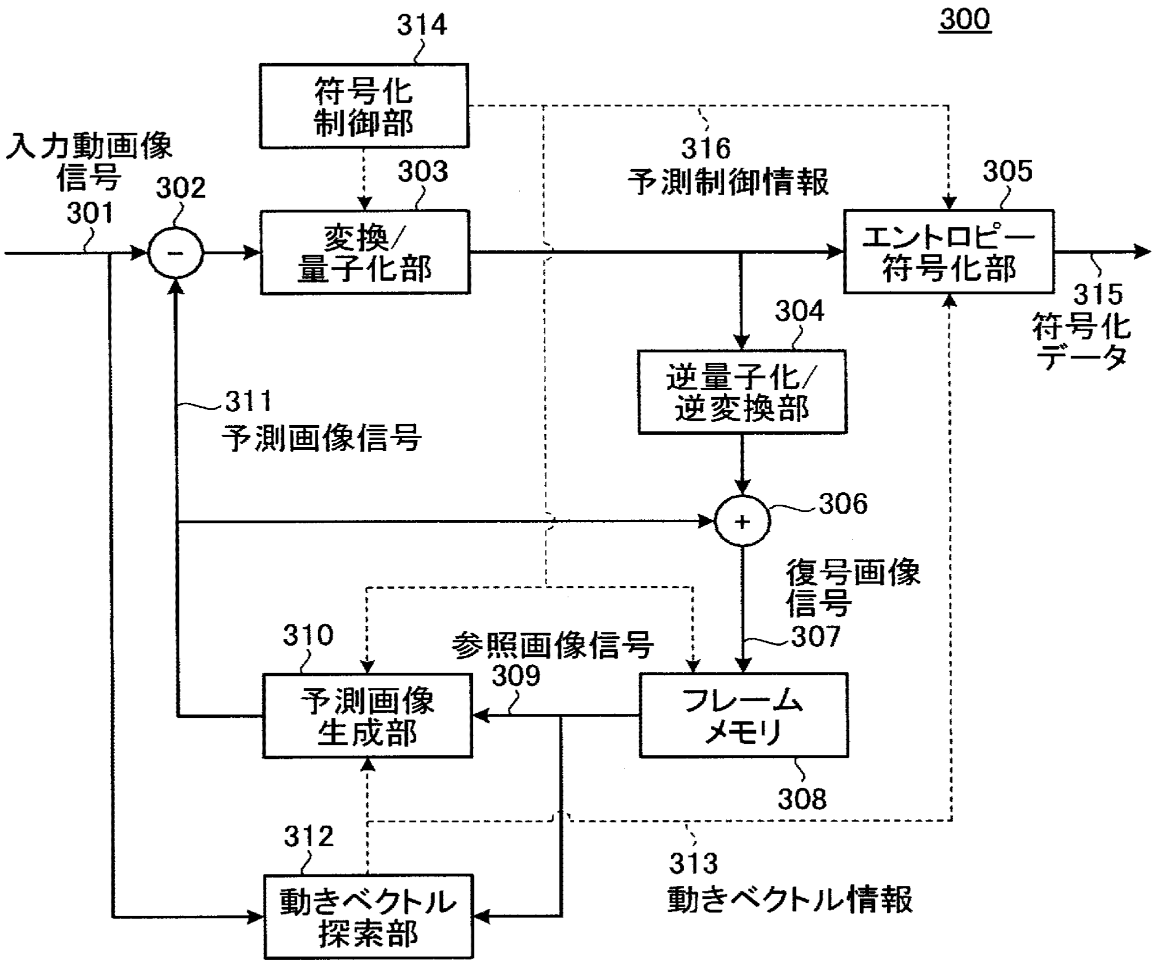
[請求項12] 前記双方向予測部は、

（ａ）前記復号画像を他の復号対象画像の参照画像として用いることが許容されていない場合には前記第１演算方式を用い、

（ｂ）前記復号画像を他の復号対象画像の参照画像として用いることが許容されている場合には前記第２演算方式を用いる、

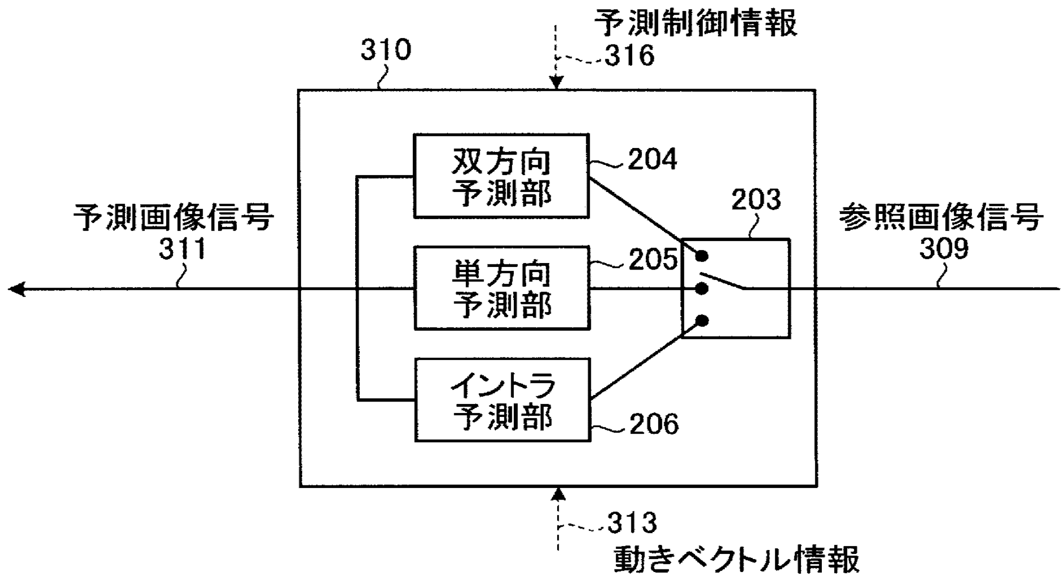
ことを特徴とする請求項１０に記載の動画像復号化装置。

[図1]

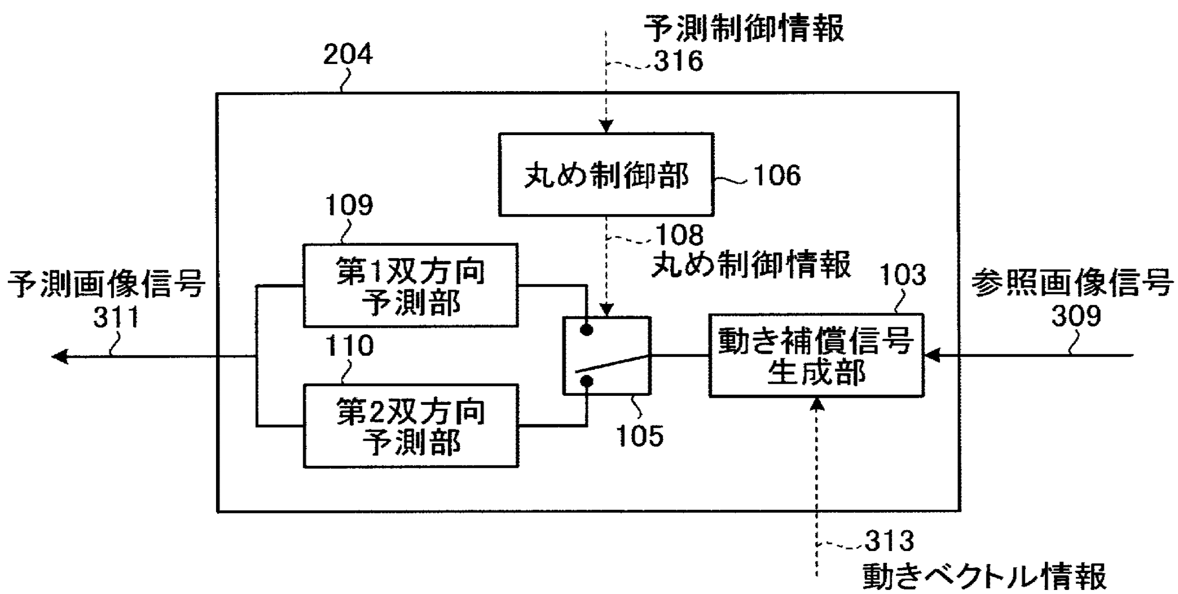


300
314
符号化
制御部
入力動画像
信号
301
302
303
変換/
量子化部
316
予測制御情報
305
エントロピー
符号化部
315
符号化
データ
304
逆量子化/
逆変換部
311
予測画像信号
306
復号画像
信号
307
310
予測画像
生成部
参照画像信号
309
フレーム
メモリ
308
312
動きベクトル
探索部
313
動きベクトル情報

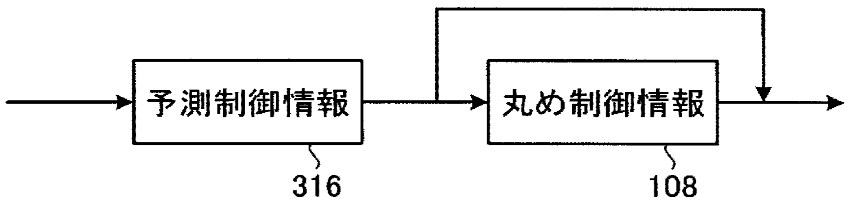
[図2]


予測制御情報
316
310
双方向
予測部
204
203
予測画像信号
311
参照画像信号
309
単方向
予測部
205
イントラ
予測部
206
313
動きベクトル情報

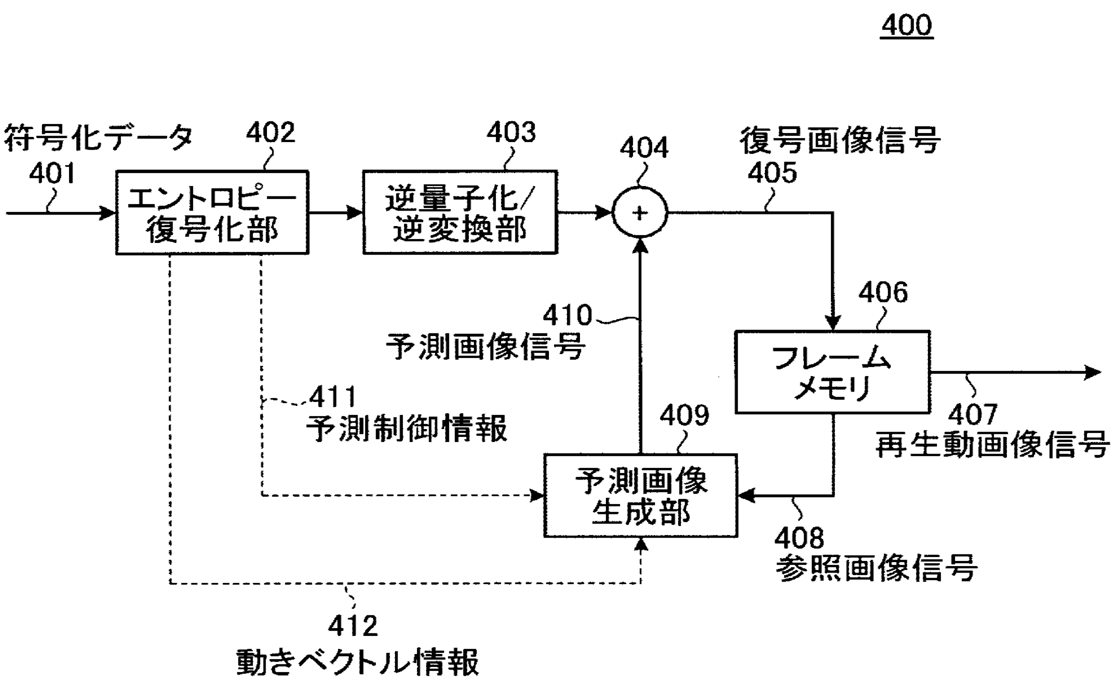
[図3]


予測制御情報
316
204
丸め制御部
106
109
108
丸め制御情報
103
予測画像信号
311
第1双方向
予測部
参照画像信号
309
110
動き補償信号
生成部
第2双方向
予測部
105
313
動きベクトル情報

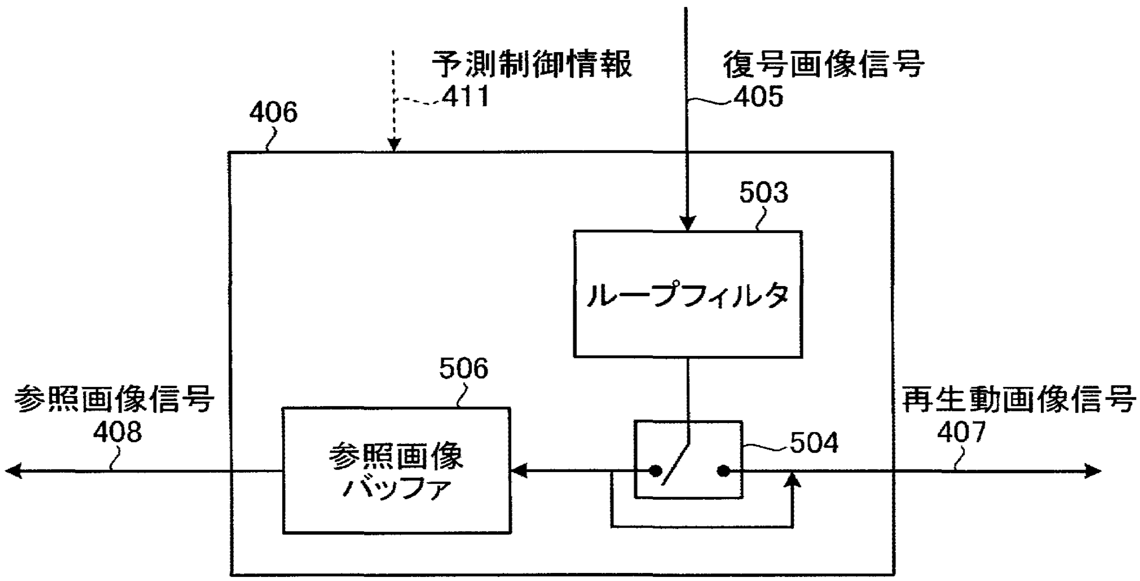
[図4]


予測制御情報
316
丸め制御情報
108

[図5]


400
符号化データ
401
402
エントロピー復号化部
403
逆量子化/逆変換部
404
+
復号画像信号
405
406
フレームメモリ
407
再生動画像信号
410
予測画像信号
411
予測制御情報
409
予測画像生成部
408
参照画像信号
412
動きベクトル情報

［図6］


予測制御情報
411
復号画像信号
405
406
503
ループフィルタ
506
参照画像信号
408
参照画像
バッファ
504
再生動画像信号
407

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/061738

A. CLASSIFICATION OF SUBJECT MATTER
H04N7/32(2006.01)i

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)
H04N7/32

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2009
Kokai Jitsuyo Shinan Koho	1971-2009	Toroku Jitsuyo Shinan Koho	1994-2009

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 11-069362 A (Hitachi, Ltd.), 09 March, 1999 (09.03.99), Column 17, line 2 to column 20, line 13 & CA 2240118 A1 & EP 1056294 A1 & CN 1283044 A & US 6295376 B1 & KR 10-0393125 B1	1-12
Y	WO 2005/094086 A1 (THOMSON LICENSING S.A.), 06 October, 2005 (06.10.05), Column 3, lines 7 to 15 & JP 2007-525908 A & US 2008/0225946 A1 & EP 1719347 A & CN 1922889 A	1-12

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

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search 05 August, 2009 (05.08.09)	Date of mailing of the international search report 18 August, 2009 (18.08.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

国際調査報告	国際出願番号　ＰＣＴ／ＪＰ２００９／０６１７３８

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.　H04N7/32(2006.01)i

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.　H04N7/32

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２００９年
日本国実用新案登録公報	１９９６－２００９年
日本国登録実用新案公報	１９９４－２００９年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

Ｃ．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求項の番号
Y	JP 11-069362 A（株式会社日立製作所）1999.03.09，第 17 欄第 2 行-第 20 欄第 13 行 & CA 2240118 A1 & EP 1056294 A1 & CN 1283044 A & US 6295376 B1 & KR 10-0393125 B1	1-12
Y	WO 2005/094086 A1（THOMSON LICENSING S.A.）2005.10.06，第 3 欄第 7 行-第 15 行 & JP 2007-525908 A & US 2008/0225946 A1 & EP 1719347 A & CN 1922889 A	1-12

☐　Ｃ欄の続きにも文献が列挙されている。　　☐　パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー
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「Ｅ」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
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「Ｏ」口頭による開示、使用、展示等に言及する文献
「Ｐ」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「Ｔ」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「Ｘ」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
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「＆」同一パテントファミリー文献

国際調査を完了した日	国際調査報告の発送日
０５．０８．２００９	１８．０８．２００９

国際調査機関の名称及びあて先	特許庁審査官（権限のある職員）
日本国特許庁（ＩＳＡ／ＪＰ） 郵便番号１００－８９１５ 東京都千代田区霞が関三丁目４番３号	５Ｃ　３１４４ 金田　孝之 電話番号　０３－３５８１－１１０１　内線　３５４１

様式ＰＣＴ／ＩＳＡ／２１０（第２ページ）（２００７年４月）

Electronic Patent Application Fee Transmittal

Application Number:	17328750
Filing Date:	24-May-2021
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Filer:	Guy Randall Gosnell/Kristen Mims
Attorney Docket Number:	042933/560470

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($)
Miscellaneous:				
RCE- 1ST REQUEST	1801	1	1360	1360
	Total in USD ($)			**1360**

Electronic Acknowledgement Receipt	
EFS ID:	48092781
Application Number:	17328750
International Application Number:	
Confirmation Number:	8335
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Customer Number:	10949
Filer:	Guy Randall Gosnell/Kristen Mims
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/560470
Receipt Date:	02-JUN-2023
Filing Date:	24-MAY-2021
Time Stamp:	11:34:25
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$1360
RAM confirmation Number	E202362B35127189
Deposit Account	
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	Request for Continued Examination (RCE)	560470_RCE.pdf	1693299 ae1a2ee7104c25c844566617bb4ddf26d06 7f2d9	no	3
Warnings:					
Information:					
2		560470_IDS.pdf	281130 99a1c8634492c5a655ccb448fe6d5c16f015 af18	yes	3

Multipart Description/PDF files in .zip description

Document Description	Start	End
Transmittal Letter	1	1
Information Disclosure Statement (IDS) Form (SB08)	2	3

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
Warnings:					
Information:					
3	Foreign Reference	560470_CN101523922A.pdf	2475044 507ac491aec515ffe795d977704bc4d37eb7 77ab	no	46
Warnings:					
Information:					
4	Foreign Reference	560470_CN101816183A.pdf	1229836 fb4b828e8dfb6b55cefb195e5de8de08941 63849	no	24
Warnings:					
Information:					
5	Foreign Reference	560470_RU2004103743A.pdf	121178 241cfa4248e3d07650d9b9791f041339951 8b098	no	2
Warnings:					
Information:					

6	Foreign Reference	560470_RU2008138706A.pdf	738312 24b1dfd3f67624ca393226349a3d33c7ef9cb552	no	9
Warnings:					
Information:					
7	Non Patent Literature	560470_CNNOA.pdf	140525 139ba1025b7f67c8282b553f8cece524179a775a	no	4
Warnings:					
Information:					
8	Non Patent Literature	560470_RUNOA.pdf	603108 ed1c3481168f5c5b75d4ff609b9e19bf674244ef	no	12
Warnings:					
Information:					
9	Non Patent Literature	560470_EPMinutes.pdf	2885700 f9c8989b3dfa62682a84707d00149d6fdd1f2d06	no	27
Warnings:					
Information:					
10	Non Patent Literature	560470_VNNOA.pdf	945898 a22bd67cb25c02e0abdb50addb1722cc3b58f64d	no	2
Warnings:					
Information:					
11	Non Patent Literature	560470_CNOA.pdf	622796 933c1b6289826ad7945ef808985df3f24335b4d5	no	10
Warnings:					
Information:					
12	Non Patent Literature	560470_JCTVCC183_.pdf	284302 f552b779ce6af80ecbe81cc156783a62b0e37214	no	4
Warnings:					
Information:					

13	Foreign Reference	560470_WO2010001832A1.pdf	1004718 94a93ff34ffdd019f9a27f76f0022d7fd98f85c1	no	25
Warnings:					
Information:					
14	Fee Worksheet (SB06)	fee-info.pdf	37755 01b6d88dfb4779f0d1f68dd199b8de9c4a632609	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	13063601		

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.

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 06/22/2023
Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street
Suite 300
Charlotte, NC 28203-6818

EXAMINER	
LE, PETER D	
ART UNIT	PAPER NUMBER
2488	

DATE MAILED: 06/22/2023

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/328,750	05/24/2021	Kemal Ugur	042933/560470	8335

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	$1200	$0.00	$0.00	$1200	09/22/2023

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 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted 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. 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: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PTOL-85 (Rev. 02/11)

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (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 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. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

10949 7590 06/22/2023

Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street
Suite 300
Charlotte, NC 28203-6818

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/328,750	05/24/2021	Kemal Ugur	042933/560470	8335

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	$1200	$0.00	$0.00	$1200	09/22/2023

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/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or 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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). 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. Fees submitted: ❑Issue Fee ❑Publication Fee (if required)

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via Patent Center or EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. __________

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. ______________________________

PTOL-85 Part B (08-18) Approved for use through 01/31/2020 OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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.
17/328,750	05/24/2021	Kemal Ugur	042933/560470	8335

10949 7590 06/22/2023

Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street
Suite 300
Charlotte, NC 28203-6818

EXAMINER	
LE, PETER D	
ART UNIT	**PAPER NUMBER**
2488	

DATE MAILED: 06/22/2023

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 30 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.

Notice of Allowability	Application No. 17/328,750	Applicant(s) Ugur et al.	
	Examiner PETER D LE	Art Unit 2488	AIA (FITF) 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 RCE filed on 06/02/2023.
☐ 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 1-36 . 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 06/02/2023.
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/
Primary Examiner, Art Unit 2488

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions

The response filed on 06/02/2023 has been entered and made of record.

Claims 1-36 are pending.

Terminal Disclaimer

The terminal disclaimer filed on 05/08/2023 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of U.S Patent Application No. 15/876495 (which is now U.S Patent 10523960) and U.S Patent Application No. 16/729974 (which is now U.S Patent 11,019,354) has been reviewed and is accepted. The terminal disclaimer has been recorded.

REASON FOR ALLOWANCE

[1] The invention is related to a method/apparatus for decoding and encoding a block of pixels. The claims comprise claim limitations set forth similar to the claim limitations of the parent cases which are now U.S Patents 10,523,960 and 11,019,354.

[1] 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."

[2] **Claims 1-36** 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: 10AM-6:30PM.

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/

Primary Examiner, Art Unit 2488

Index of Claims	Application/Control No. 17/328,750	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

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	11/02/2022	05/14/2023	06/08/2023						
	1	✓	=	=						
	2	✓	=	=						
	3	✓	=	=						
	4	✓	=	=						
	5	✓	=	=						
	6	✓	=	=						
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	9	✓	=	=						
	10	✓	=	=						
	11	✓	=	=						
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	26	✓	=	=						
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	29	✓	=	=						
	30	✓	=	=						
	31	✓	=	=						
	32	✓	=	=						
	33	✓	=	=						
	34	✓	=	=						
	35	✓	=	=						
	36	✓	=	=						

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/328,750	Ugur et al.
	Examiner	**Art Unit**
	PETER D LE	2488

CPC - Searched*		
Symbol	**Date**	**Examiner**
Update Search; Ref. Cases: 13344893; 15250124; 15490469; 15876495; 16729974	11/02/2022	PL
Update Search	05/14/2023	PL
Update Search	06/08/2023	PL

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
See Search History	11/02/2022	PL
See Search History	05/14/2023	PL
See Search History	06/08/2023	PL

Search Notes	Application/Control No. 17/328,750	Applicant(s)/Patent Under Reexamination Ugur et al.
	Examiner PETER D LE	Art Unit 2488

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	Limit To Text Search	11/02/2022	PL
	Limit To Text Search	05/14/2023	PL

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/328,750	Ugur et al.
	Examiner	**Art Unit**
	PETER D LE	2488

CPC						
Symbol					**Type**	**Version**
H04N	/	19	/	50	F	2014-11-01
H04N	/	19	/	42	I	2014-11-01
H04N	/	19	/	523	I	2014-11-01
H04N	/	19	/	577	I	2014-11-01
H04N	/	19	/	105	I	2014-11-01
H04N	/	19	/	176	A	2014-11-01
H04N	/	19	/	182	A	2014-11-01
H04N	/	19	/	184	A	2014-11-01

CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE (Assistant Examiner) (Date)	**Total Claims Allowed:** 36	
/PETER D LE/ 08 June 2023 Primary Examiner, Art Unit 2488 (Primary Examiner) (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 10

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/328,750	Ugur et al.
	Examiner	Art Unit
	PETER D LE	2488

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04N	/	19	/	50

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE (Assistant Examiner) (Date)		Total Claims Allowed: 36	
/PETER D LE/ Primary Examiner, Art Unit 2488 (Primary Examiner)	08 June 2023 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 10

U.S. Patent and Trademark Office

Part of Paper No.: 20230608

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/328,750	Ugur et al.
	Examiner	**Art Unit**
	PETER D LE	2488

☑ Claims renumbered in the same order as presented by applicant ☐ CPA ☑ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10		19		28								
	2		11		20		29								
	3		12		21		30								
	4		13		22		31								
	5		14		23		32								
	6		15		24		33								
	7		16		25		34								
	8		17		26		35								
	9		18		27		36								

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 36	
/PETER D LE/ Primary Examiner, Art Unit 2488 (Primary Examiner)	08 June 2023 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 10

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L2	1	13/344893.app.	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:24 PM
L3	6190	(H04N19/42 OR H04N19/523 OR H04N19/577).CPC.	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:26 PM
L4	38055	(bit NEAR2 pixel)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:48 PM
L5	4413	(bit NEAR2 pixel) WITH (resolution)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:49 PM
L6	4897	(bit NEAR2 pixel) WITH (resolution precision)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 09:49 PM
L7	7265	((bit NEAR2 pixel) (bit NEAR2 depth)) WITH (resolution precision)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:35 PM
L8	160	(((bit NEAR2 pixel) (bit NEAR2 depth) (number NEAR2 bits)) WITH (resolution precision) WITH (predict$3))	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:37 PM
L9	8	("6512523"|"20100002770"|"20100086027"|"20090087111"|"6539058"|"20090257503"|"20080089417"|"20100086027"|"20130142262").PN.	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:48 PM
L10	1	L9 and L7	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 10:59 PM
L11	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	ON	2015/07/15 11:31 PM
L12	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	ON	2015/07/15 11:32 PM
L13	1	13/344893.app. AND (predict$3 WITH precision)	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 11:51 PM
L14	90	(((bit NEAR2 pixel) (bit NEAR2 depth) (number	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/15 11:56 PM

		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)					
L15	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	ON	2015/07/16 12:44 AM
L16	716	L15 not L14	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 12:44 AM
L17	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	ON	2015/07/16 12:46 AM
L18	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	ON	2015/07/16 01:42 AM
L19	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	ON	2015/07/16 01:43 AM
L20	5180	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision))	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 01:53 AM
L21	219	(((bit NEAR2 pixel) (bit NEAR2 depth) (bit	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 01:54 AM

		NEAR2 length)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME (predict$3)					
L22	580	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) SAME precision	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 01:54 AM
L23	539	(((bit NEAR2 pixel) (bit NEAR2 depth)) NEAR3 (determin$3 calculat$3 conver$5 precision)) WITH precision	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/16 01:55 AM
L24	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	ON	2015/07/16 02:02 AM
L25	1	"20100086027".pn.	(US-PGPUB; USPAT)	OR	ON	ON	2015/07/20 06:36 PM
L26	1	13/344893.app. and (precision)	(US-PGPUB; USPAT)	OR	ON	ON	2016/01/20 01:45 PM
L27	1	13/344893.app. and (precision WITH (predict$3 bi$2predict$3))	(US-PGPUB; USPAT)	OR	ON	ON	2016/01/20 01:55 PM
L28	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	ON	2016/01/20 03:39 PM
L29	231	(round$3 WITH (bit$2depth precision) WITH bit WITH (add$5 combin$5))	(US-PGPUB; USPAT)	OR	ON	ON	2016/04/14 11:43 AM
L34	21	("20020171737"|"20040028286"|"20040179738"|"20040212703"|"20060038826"|"20060164699"|"20080025630"|"20080266413"|"20080278607"|"20090021611"|"20110050969"|"20120075506"|"20120099001"|"4	(US-PGPUB; USPAT)	OR	ON	ON	2016/05/27 12:13 PM

		972260"|"5157732"|"5598482"|"5887084"|"5943170"|"6122314"|"6211515"|"7362911").PN.					
L35	5	("20100111182"|"20090257503"|"20100086027"|"6512523"|"6539058").PN.	(US-PGPUB; USPAT)	OR	ON	ON	2016/05/27 12:18 PM
L36	9	("6512523"|"20100002770"|"20100086027"|"20100111182"|"20090087111"|"6539058"|"20090257503"|"20080089417"|"20100086027"|"20130142262").PN.	(US-PGPUB; USPAT)	OR	ON	ON	2016/05/27 12:20 PM
L37	26	((encod$5 decod$5 cod$5) SAME (reference) SAME (fraction$5 pel interpolat$5) SAME (add$5 sum$5 combin$5) SAME (shift$5 WITH right))	(US-PGPUB; USPAT)	OR	ON	ON	2016/12/03 01:12 AM
L38	0	15/250124.app.	(US-PGPUB; USPAT)	OR	ON	ON	2016/12/03 01:14 AM
L41	1	15/490469.app.	(US-PGPUB; USPAT)	OR	ON	ON	2017/08/28 12:05 PM
L42	5	"13344893" "15250124"	(US-PGPUB; USPAT)	OR	ON	ON	2017/08/28 04:29 PM
L43	84	(predict$5 WITH interpolat$5 WITH (combin$8 add$5) WITH (shift$5 divi$8))	(US-PGPUB; USPAT)	OR	ON	ON	2017/09/04 06:37 PM
L46	7	"13344893" "15250124" "15490469" "15876495"	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 01:43 PM
L47	24	(deblock$5 de$2block$5) WITH (edge boundary) WITH (intra$2predict$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:04 PM
L48	252	(deblock$5 de$2block$5) WITH (edge boundary) WITH (intra$2predict$5 intra$2block intra$2frame intra$2picture intra)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:05 PM
L49	490	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:13 PM
L50	443	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double) WITH	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:14 PM

		(filter$5)					
L51	601	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double second) WITH (filter$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:14 PM
L52	520	(deblock$5 de$2block$5) WITH (edge boundary) WITH (two double second) WITH (filter$5) WITH (block$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 06:14 PM
L53	114	(deblock$5 de$2block$5) WITH (first NEAR2 (filter$5)) WITH (second NEAR2 (filter$3)) WITH (block$5)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:07 PM
L54	3	((deblock$5 de$2block$5) WITH (edge boundary across) WITH (filter$5) WITH (block$5)) SAME ((deblock$5 de$2block$5) WITH (edge NEAR2 (orientation$5 angle angular$5)) WITH (filter$5) WITH (block$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:19 PM
L55	24	((deblock$5 de$2block$5) WITH (edge boundary across) WITH (filter$5) WITH (block$5)) SAME ((deblock$5 de$2block$5) WITH (edge NEAR2 (orientation$5 angle angular$5 direction$5)) WITH (filter$5) WITH (block$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:20 PM
L56	1	14/336913.app.	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 07:48 PM
L57	550	((deblock$5 de$2block$5) WITH (orientation$5 direction$5 angle angular$3) WITH (filter$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:02 PM
L58	234	((deblock$5 de$2block$5) WITH (orientation$5 direction$5 angle angular$3) WITH	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:02 PM

		(filter$5) WITH (block))					
L59	8	((deblock$5 de$2block$5) WITH (orientation$5 angle angular$3) WITH (filter$5) WITH (block))	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:10 PM
L60	4	"20050117653"	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:12 PM
L61	0	(deblock$5 de$2block$5) WITH (orientation$3 direction$3 angle angular) WITH (filter$3) WITH (cascad$3)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:34 PM
L62	67	(deblock$5 de$2block$5) WITH (orientation$3 direction$3 angle angular) WITH (filter$3) WITH (post)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:34 PM
L63	13	(deblock$5 de$2block$5) WITH (orientation$3 direction$3 angle angular) WITH (filter$3) WITH ("35" "45" "135")	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:38 PM
L64	942	(deblock$5 de$2block$5) WITH (horizontal WITH vertical)	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:49 PM
L65	214	(deblock$5 de$2block$5) WITH (horizontal WITH vertical) WITH (filter$3) WITH (edge boundary) WITH block	(US-PGPUB; USPAT)	OR	OFF	OFF	2018/07/25 08:49 PM
L67	7	"15876495" "13344893" "15250124" "15490469"	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 12:44 PM
L68	9	("20080089417"|"20090000871"|"20090257503"|"20100002770"|"20100086027"|"20100111182"|"20130142262"|"6512523"|"6539058").PN.	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 02:05 PM
L69	8	L68 and (precision)	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 02:07 PM
L70	1	L68 and (precision WITH reference WITH pixel)	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/02/20 02:08 PM
L72	1	"15876495"	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/03/04 01:57 AM
L75	362	(reference SAME predict$5 SAME precision SAME (shift$5	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/08/19 11:58 AM

		divi$8) SAME (decod$5 encod$5 cod$5))					
L76	101	(reference SAME predict$5 SAME precision SAME (shift$5 divi$8) SAME (pixel) SAME (decod$5 encod$5 cod$5))	(US-PGPUB; USPAT)	OR	OFF	OFF	2019/08/19 12:00 PM
L79	1	16/729974.app.	(US-PGPUB; USPAT)	OR	ON	ON	2020/06/07 03:05 AM
L80	9	13/344893.app. 15/250124.app. 15/490469.app. 15/876495.app. 16/729974.app.	(US-PGPUB; USPAT)	OR	ON	ON	2021/01/06 01:42 AM
L81	0	(first WITH second WITH predict$3 WITH precission WITH decreas$5 WITH combined).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2021/01/06 02:00 AM
L82	3	(first WITH second WITH predict$3 WITH precision WITH decreas$5 WITH combined).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2021/01/06 02:01 AM
L83	5	17/328750.app. 16/729974.app. 15/876495.app.	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/01 03:08 AM
L84	10	(block SAME pixels SAME reference SAME precision SAME shift$3 SAME bit).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/11/02 11:57 PM
L85	11	13/344893.app. 15/250124.app. 15/490469.app. 15/876495.app. 16/729974.app. 17/328750.app.	(US-PGPUB; USPAT)	OR	ON	ON	2023/05/14 04:41 PM
L86	27	(reference SAME block SAME motion SAME vector SAME (precision resolution) SAME (combin$5 add$5) SAME (predict$5) SAME (residual difference)).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2023/05/14 05:05 PM
L87	38	("20030202607" OR "20050105620" OR "20050207496" OR "20080089417" OR "20090087111" OR "20090232215" OR "20090257499" OR "20090257503" OR	(US-PGPUB; USPAT)	OR	ON	ON	2023/06/08 12:41 AM

		"20100002770" OR "20100086027" OR "20100111182" OR "20110032991" OR "20110200108" OR "20120051431" OR "20120063515" OR "20130142262" OR "20130182763" OR "6404815" OR "6512523" OR "6539058" OR "6950469" OR "7580456" OR "8005137" OR "8149910" OR "8284835" OR "8428133" OR "8498336" OR "8660174" OR "8676000" OR "8711939" OR "8750378" OR "8995526" OR "9014280" OR "9161057" OR "9237355" OR "9307122" OR "9432693" OR "9877037").pn.					

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

Substitute for form SB08 (Revised 07/09)	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*	Application Number	17/328,750
	Filing Date	May 24, 2021
	First Named Inventor	Ugur et al.
	Art Unit	2488
	Examiner Name	Peter D. Le
Sheet 1 of 2	Attorney Docket Number	042933/560470

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-2004/0208247 A1	10-21-2004	Barrau et al.	
	2	US-2008/0075169 A1	03-27-2008	Ugur et al.	
	3	US-2009/0092188 A1	04-09-2009	Lee et al.	
	4	US-2011/0090966 A1	04-21-2011	Chujoh 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
	5	CN 101523922 A	09-02-2009	Qualcomm Inc.		Abstract; corresponds to US-2008/0089417 A1 (previously cited)
	6	CN 101816183 A	08-25-2010	Samsung Electronics Co Ltd		Abstract; corresponds to US-2009/0092188 A1
	7	RU 2004103743 A	06-10-2005	Koninkleike Philips Electronics N.V.		Abstract only; corresponds to US-2004/0208247 A1
	8	RU 2008138706 A	04-10-2010	Kabusyki Kaysia Tosyba		Abstract; corresponds to US-2009/0087111 A1 (previously cited)
	9	WO 2010/001832 A1	01-07-2010	Toshiba KK		

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
	10	Decision to Grant for Chinese Application No. 201280009695.9 dated June 21, 2017, 4 pages.	Yes

Examiner Signature	/PETER D LE/	Date Considered	06/08/2023

*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.

Submitted June 2, 2023

LEGAL02/43010790v1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.D.L/

Substitute for form SB08 (Revised 07/09) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*	**Complete if Known**	
	Application Number	17/328,750
	Filing Date	May 24, 2021
	First Named Inventor	Ugur et al.
	Art Unit	2488
	Examiner Name	Peter D. Le
Sheet 2 of 2	Attorney Docket Number	042933/560470

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
	11	Decision to Grant for Russian Application No. 2013136693/08 dated June 4, 2015, 12 pages.	Yes
	12	Minutes of the Oral Proceedings for European Application No. 12731927.5 dated December 9, 2021, 27 pages.	
	13	Notice of Allowance for Vietnamese Application No. 1-2013-02120 dated August 31, 2017, 2 pages.	Yes
	14	Office Action for Chinese Application No. 201280009695.9 dated February 15, 2016, 10 pages.	Yes
	15	Yoshino et al., "Enhanced Switching of Interpolation Filter for HEVC", Joint Collaborative Team on Video Coding (JCT-VC) or ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 3rd Meeting, JCTVC-C183, (October 7-15, 2010), 4 pages.	

Examiner Signature	/PETER D LE/	Date Considered	06/08/2023

*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.

Submitted June 2, 2023

LEGAL02/43010790v1

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.D.L/

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
17/328,750	**09/01/2023 01:01:21 PM ET**	**042933/560470**

Title of Invention

MOTION PREDICTION IN VIDEO CODING

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	8335	FILED BY	Torrey Wyatt
PATENT CENTER #	62723581	FILING DATE	05/24/2021
CUSTOMER #	10949	FIRST NAMED INVENTOR	Kemal Ugur
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Guy Gosnell

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
560470_Issue_Fee_Transmittal.pdf	1	Issue Fee Payment (PTO-85B)	129 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
560470_Issue_Fee_Transmittal.pdf	49236C04E655867F97A5BCE3567C742C721EA15DC6235252AC922F56FBE7988D1AB2F657EC82F5A60EB2241C113BC00C88A79BC93A0EE21B44C69725644A2BCD

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 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.

UNITED STATES PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
17/328,750	**09/01/2023 01:01:21 PM ET**	**042933/560470**

Title of Invention

MOTION PREDICTION IN VIDEO CODING

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	8335	FILED BY	Torrey Wyatt
PATENT CENTER #	62723581	AUTHORIZED BY	Guy Gosnell
CUSTOMER #	10949	FILING DATE	05/24/2021
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Kemal Ugur

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
DA / 160605	E202391D02125639	Torrey Wyatt

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
1501	UTILITY ISSUE FEE	1200.00	1	1200.00
			TOTAL AMOUNT:	**$1,200.00**

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 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.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (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 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. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

10949 7590 06/22/2023

Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street
Suite 300
Charlotte, NC 28203-6818

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

Torrey L. Wyatt (Typed or printed name)
/Torrey L. Wyatt/ (Signature)
September 1, 2023 (Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/328,750	05/24/2021	Kemal Ugur	042933/560470	8335

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	$1200	$0.00	$0.00	$1200	09/22/2023

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/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or 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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). 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. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required)

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via Patent Center or EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 16-0605

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 /Guy R. Gosnell/ Date September 1, 2023

Typed or printed name Guy R. Gosnell Registration No. 34,610

PTOL-85 Part B (08-18) Approved for use through 01/31/2020 OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Substitute for form SB08 (Revised 07/09) **INFORMATION DISCLOSURE STATEMENT BY APPLICANT** *(Use as many sheets as necessary)*	**Complete if Known**	
	Application Number	17/328,750
	Filing Date	May 24, 2021
	First Named Inventor	Ugur et al.
	Art Unit	2488
	Examiner Name	Peter D. Le
Sheet 1 of 1	Attorney Docket Number	042933/560470

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

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

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 for European Application No. 22173168.0 dated September 11, 2023, 6 pages.	

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.

Submitted September 19, 2023

Electronic Patent Application Fee Transmittal	
Application Number:	17328750
Filing Date:	24-May-2021
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Filer:	Guy Randall Gosnell/Kristen Mims
Attorney Docket Number:	042933/560470
Filed as Large Entity	
Filing Fees for **Utility under 35 USC 111(a)**	

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
PETITION FEE- 37 CFR 1.17(H) (GROUP III)	1464	1	140	140
RCE- 2ND AND SUBSEQUENT REQUEST	1820	1	2000	2000
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2140**

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Decision Date : September 19, 2023

In re Application of :

Kemal Ugur

DECISION ON PETITION

UNDER CFR 1.313(c)(2)

Application No : 17328750

Filed : 24-May-2021

Attorney Docket No : 042933/560470

This is an electronic decision on the petition under 37 CFR 1.313(c)(2), filed September 19, 2023, to withdraw the above-identified application from issue after payment of the issue fee.

The petition is **GRANTED.**

The above-identified application is withdrawn from issue for consideration of a submission under 37 CFR 1.114 (request for continued examination). See 37 CFR 1.313(c)(2).

Petitioner is advised that the issue fee paid in this application cannot be refunded. If, however, this application is again allowed, petitioner may request that it be applied towards the issue fee required by the new Notice of Allowance.

Telephone inquiries concerning this decision should be directed to the Patent Electronic Business Center (EBC) at 866-217-9197.

This application file is being referred to Technology Center AU 2488 for processing of the request for continuing examination under 37 CFR 1.114 .

Office of Petitions

Electronic Acknowledgement Receipt

EFS ID:	48608680
Application Number:	17328750
International Application Number:	
Confirmation Number:	8335
Title of Invention:	MOTION PREDICTION IN VIDEO CODING
First Named Inventor/Applicant Name:	Kemal Ugur
Customer Number:	10949
Filer:	Guy Randall Gosnell/Kristen Mims
Filer Authorized By:	Guy Randall Gosnell
Attorney Docket Number:	042933/560470
Receipt Date:	19-SEP-2023
Filing Date:	24-MAY-2021
Time Stamp:	20:24:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	$2140
RAM confirmation Number	E20239IK24415201
Deposit Account	
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	ePetition Request Form	petition-request.pdf	39891 d60070026ba00c9e9999c9142a5cb5f5ddb070a6	no	2
Warnings:					
Information:					
2	Quick Path Information Disclosure Statement	560470_QPIDS.pdf	167472 37e7f7b033319f80586d937637a9220e402426bc	no	2
Warnings:					
Information:					
3	Request for Continued Examination (RCE)	560470_RCE.pdf	1666952 146d941a27474719d0350c8e7a5cbd7c67c07c7c	no	3
Warnings:					
Information:					
4	Information Disclosure Statement (IDS) Form (SB08)	560470_List.pdf	141919 e51eba6ee36815361c21b2191418d4b05ff238aa	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
5	Non Patent Literature	560470_EPOA.pdf	3332823 6c5107b265513c5569a8392eab9b43ca2d4422cc	no	6
Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	40348 de51aa79d9315750a04b7b909e553b4d265f53b4	no	2
Warnings:					

Information:	
Total Files Size (in bytes):	5389405

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.

Doc Code: PET.AUTO Document Description: Petition automatically granted by EFS-Web	PTO/SB/140 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**PETITION TO WITHDRAW AN APPLICATION FROM ISSUE AFTER PAYMENT OF THE ISSUE FEE UNDER 37 CFR 1.313(c)**
Application Number	17328750
Filing Date	24-May-2021
First Named Inventor	Kemal Ugur
Art Unit	2488
Examiner Name	PETER LE
Attorney Docket Number	042933/560470
Title	MOTION PREDICTION IN VIDEO CODING

An application may be withdrawn from issue for further action upon petition by the applicant. To request that the Office withdraw an application from issue, applicant must file a petition under this section including the fee set forth in § 1.17(h) and a showing of good and sufficient reasons why withdrawal of the application from issue is necessary.

APPLICANT HEREBY PETITIONS TO WITHDRAW THIS APPLICATION FROM ISSUE UNDER 37 CFR 1.313(c).

A grantable petition requires the following items:
(1) Petition fee; and
(2) One of the following reasons:
(a) Unpatentability of one or more claims, which must be accompanied by an unequivocal statement that one or more claims are unpatentable, an amendment to such claim or claims, and an explanation as to how the amendment causes such claim or claims to be patentable;
(b) Consideration of a request for continued examination in compliance with § 1.114 (for a utility or plant application only); or
(c) Express abandonment of the application. Such express abandonment may be in favor of a continuing application, but not a CPA under 37 CFR 1.53(d).

Petition Fee

○	Small Entity
○	Micro Entity
◉	Regular Undiscounted

Reason for withdrawal from issue

○ One or more claims are unpatentable

◉ Consideration of a request for continued examination (RCE) (List of Required Documents and Fees)

○ Applicant hereby expressly abandons the instant application (any attorney/agent signing for this reason must have power of attorney pursuant to 37 CFR 1.32(b)).

RCE request,submission, and fee.

☐ I certify, in accordance with 37 CFR 1.4(d)(4) that :
The RCE request ,submission, and fee have already been filed in the above-identified application on

☒ Are attached.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

◉ An attorney or agent registered to practice before the Patent and Trademark Office who has been given power of attorney in this application.

○ An attorney or agent registered to practice before the Patent and Trademark Office, acting in a representative capacity.

○ A sole inventor

○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application

○ A joint inventor; all of whom are signing this e-petition

Signature	/Guy R. Gosnell/
Name	Guy R. Gosnell
Registration Number	34610

Doc Code: QPIDS.REQ
Document Description: QuickPath Information Disclosure Statement

PTO/SB/09 (09-18)

CERTIFICATION AND REQUEST FOR CONSIDERATION OF AN INFORMATION DISCLOSURE STATEMENT FILED AFTER PAYMENT OF THE ISSUE FEE UNDER THE QPIDS PROGRAM

Non-Provisional Application Number: 17/328,750	Filing Date: May 24, 2021
First Named Inventor: Ugur et al.	Title of Invention: MOTION PREDICTION IN VIDEO CODING

THE UNDERSIGNED HEREBY CERTIFIES AND REQUESTS THE FOLLOWING FOR THE ABOVE-IDENTIFIED APPLICATION.

1. Consideration is requested of the information disclosure statement (IDS) submitted herewith, which is being filed after payment of the issue fee.
2. Check the box next to the appropriate selection:

   ☑ Each item of information contained in the IDS 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 IDS. See 37 CFR 1.97(e)(1).

   OR

   ☐ No item of information contained in the IDS 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 IDS was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the IDS. See 37 CFR 1.97(e)(2).

   OR

   ☐ See attached certification statement in compliance with 37 CFR 1.97(e).
3. Please charge the IDS fee set forth in 37 CFR 1.17(p) to Deposit Account No. 160605.
4. A Petition to Withdraw from Issue After Payment of the Issue Fee (37 CFR 1.313(c)(2)), including the petition fee set forth in 37 CFR 1.17(h), is submitted herewith as a **Web-based ePetition**.
   WARNING: Do not submit the petition as a follow-on paper via EFS-Web. Submit the petition as a Web-based ePetition by signing on to EFS-Web as a registered user, selecting the radio button next to "Existing application/patent," and then selecting the radio button next to "ePetition (for automatic processing and immediate grant, if all petitions requirements are met)." Failure to use the Web-based ePetition interface will result in automatic entry of the RCE.
5. A request for continued examination (RCE) under 37 CFR 1.114 and the RCE fee under 37 CFR 1.17(e) are submitted herewith.
6. The RCE will be treated as a "conditional" RCE. In the event the examiner determines that any item of information contained in the IDS necessitates the reopening of prosecution in the application, the undersigned understands that (i) the RCE will be processed and treated as an RCE under 37 CFR 1.114 and therefore (ii) the IDS fee under 37 CFR 1.17(p) will be returned in accordance with 37 CFR 1.97(b)(4). In the event that no item of information in the IDS necessitates reopening prosecution, the undersigned understands that the RCE will not be processed and the RCE fee under 37 CFR 1.17(e) will be returned.
7. This certification and request is being filed as a **Web-based ePetition** and is not accompanied by an amendment to the application. Inclusion of an amendment will result in automatic entry of the RCE.

Signature /Guy R. Gosnell/	Date September 19, 2023
Name (Print/Typed) Guy R. Gosnell	Practitioner Registration Number (if applicable) 34,610

*Note: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required in accordance with 37 CFR 1.33 and 11.18. Please see 37 CFR 1.4(d) for the form of the signature. If necessary, submit multiple forms for more than one signature, see below.**

☐ *Total of ______ forms are submitted.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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.

United States Patent and Trademark Office

Office of the Chief Financial Officer

Document Code:WFEE

User :Juliet McMillan

Sale Accounting Date:09/20/2023

Sale Item Reference Number	Effective Date
17328750	09/19/2023

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method
I20239JG22247326	1806	SUBMISSION- INFORMATION DISCLOSURE STMT	$260.00	Deposit Account

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/328,750	05/24/2021	Kemal Ugur	042933/560470	8335

10949 7590 09/25/2023
Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street
Suite 300
Charlotte, NC 28203-6818

EXAMINER	
LE, PETER D	

ART UNIT	PAPER NUMBER
2488	

NOTIFICATION DATE	DELIVERY MODE
09/25/2023	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)

Notice of Allowability	**Application No.** 17/328,750	**Applicant(s)** Ugur et al.	
	Examiner PETER D LE	**Art Unit** 2488	**AIA (FITF) 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 RCE filed on 09/19/2023.
☐ 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 1-36 . 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 09/19/2023.
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/
Primary Examiner, Art Unit 2488

Substitute for form SB08 (Revised 07/09)	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*	Application Number	17/328,750
	Filing Date	May 24, 2021
	First Named Inventor	Ugur et al.
	Art Unit	2488
	Examiner Name	Peter D. Le
Sheet 1 of 1	Attorney Docket Number	042933/560470

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

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

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 for European Application No. 22173168.0 dated September 11, 2023, 6 pages.	

Examiner Signature	/PETER D LE/	Date Considered	09/21/2023

*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.

Submitted September 19, 2023

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /P.D.L/

United States Patent and Trademark Office

Office of the Chief Financial Officer

Document Code:WFEE

User :Sengpheth Sandara

Refund Accounting Date:09/26/2023

Effective Date	Sale Item Reference Number	Refund Total
09/19/2023	17328750	$2,000.00

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method	Account Number
I20239PA14378022	1820	RCE- 2ND AND SUBSEQUENT REQUEST	$2,000.00	DA	160605

United States Patent and Trademark Office

Office of the Chief Financial Officer

Document Code:WFEE

User :Sengpheth Sandara

Sale Adjustment Accounting Date:09/26/2023

Effective Date	Sale Accounting Date	Sale Item Reference Number
09/19/2023	09/26/2023	17328750

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method
I20239PA14378022	1820	RCE- 2ND AND SUBSEQUENT REQUEST	$2,000.00	DA

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/328,750	10/31/2023	11805267	042933/560470	8335

10949 7590 10/11/2023

Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street
Suite 300
Charlotte, NC 28203-6818

ISSUE NOTIFICATION

The projected patent number and issue date are specified above. The patent will issue electronically. The electronically issued patent is the official patent grant pursuant to 35 U.S.C. § 153. The patent may be accessed on or after the issue date through Patent Center at https://patentcenter.uspto.gov/. The patent will be available in both the public and the private sides of Patent Center. Further assistance in electronically accessing the patent, or about Patent Center, is available by calling the Patent Electronic Business Center at 1-888-217-9197.

The USPTO is implementing electronic patent issuance with a transition period, during which period the USPTO will mail a ceremonial paper copy of the electronic patent grant to the correspondence address of record. Additional copies of the patent (i.e., certified and presentation copies) may be ordered for a fee from the USPTO's Certified Copy Center at https://certifiedcopycenter.uspto.gov/index.html. The Certified Copy Center may be reached at (800)972-6382.

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 0 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 Center (https://patentcenter.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 Patents Stakeholder Experience (OPSE), Stakeholder Support Division (SSD) at (571)-272-4200.

IR103 (Rev. 10/09)

INVENTOR(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional inventors):

Kemal Ugur, Tampere, FINLAND;
Jani Lainema, Tampere, FINLAND;
Antti Hallapuro, Tampere, FINLAND;

APPLICANT(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional applicants):

Nokia Technologies Oy, Espoo, FINLAND;

IR103 (Rev. 10/09)

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/328,750	05/24/2021	Kemal Ugur	042933/560470	8335

10949 7590 10/31/2023
Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street
Suite 300
Charlotte, NC 28203-6818

EXAMINER	
LE, PETER D	
ART UNIT	**PAPER NUMBER**
2488	
NOTIFICATION DATE	**DELIVERY MODE**
10/31/2023	ELECTRONIC

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APPLICATION NO.	ISSUE DATE	PATENT NO.
17/328,750	31-Oct-2023	11805267

Nokia Corporation and Alston & Bird LLP
Vantage South End
1120 South Tryon Street
Charlotte, NC 28203-6818

EGRANT NOTIFICATION

Your electronic patent grant (eGrant) is now available, which can be accessed via Patent Center at https://patentcenter.uspto.gov

The electronic patent grant is the official patent grant under 35 U.S.C. 153. For more information, please visit https://www.uspto.gov/electronicgrants

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FEE ADDRESS CHANGE

APPLICATION #	FILING OR 371(C) DATE	REQUEST ID
17/328,750	05/24/2021	162311

The following fields have been changed to Customer Number 197 on 02/08/2024 via Patent Center in view of the certification copied below that authorized the change.

- Maintenance Fee Address

The address for Customer Number 197 is:

197 - CPA GLOBAL
Clarivate
3133 W. Frye Rd.
STE 400
Chandler, AZ 85226

I certify, in accordance with 37 CFR 1.4(d)(4), that I am :

An attorney or Agent of Record registered to practice before the Patent and Trademark Office who has been given power of attorney in this application

Signature	Name	Registration #
/Guy R. Gosnell/	Guy Gosnell	34610

Attorney's Docket No. 042933/560470 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Kemal Ugur et al.
Appl. No.: 17/328,750
Filed: May 24, 2021
Title: MOTION PREDICTION IN VIDEO CODING

Confirmation No. 8335
Patent No.: 11,805,267
Issue Date: October 31, 2023

Certificate of Correction Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

REQUEST FOR CERTIFICATE OF CORRECTION

It is respectfully requested that a Certificate of Correction be issued for the above-identified patent, in accordance with 37 C.F.R. §1.323. This request is made in order to correct the mistakes incurred by Applicant.

The mistakes appearing in the patent are set forth on the Certificate of Correction e-filed herewith. The Certificate of Correction fee is being paid concurrently herewith. The undersigned authorizes any fee deficiencies to be charged to Deposit Account No. 16-0605.

Respectfully submitted,

/Guy R. Gosnell/

Guy R. Gosnell
Registration No. 34,610

ALSTON & BIRD LLP
Vantage South End
1120 South Tryon Street, Suite 300
Charlotte, NC 28203-6818

LEGAL02/44085961v1

PTO/SB/44 (09-07)
Approved for use through 03/31/2023. OMB 0651-0033
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

Page 1 of 1

PATENT NO. : 11,805,267

APPLICATION NO. : 17/328,750

ISSUE DATE : October 31, 2023

INVENTOR(S) : Kemal 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 sheet 7 of 11, FIG. 7, reference numeral 711, line 3, delete “decodedprediction” and insert -- decoded prediction --, therefor.

MAILING ADDRESS OF SENDER (Please do not use Customer Number below):

ALSTON & BIRD LLP
Vantage South End
1120 South Tryon Street, Suite 300
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LEGAL02/44085971v1

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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.
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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.
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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.
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
17/328,750	**02/12/2024 02:35:25 PM Z ET**	**042933/560470**

Title of Invention

MOTION PREDICTION IN VIDEO CODING

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	11805267
CONFIRMATION #	8335	FILED BY	Philip Tyson
PATENT CENTER #	64291151	FILING DATE	05/24/2021
CUSTOMER #	10949	FIRST NAMED INVENTOR	Kemal Ugur
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Guy Gosnell

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
560470_Request_for_CoC.pdf	3	Request for Certificate of Correction	191 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
560470_Request_for_CoC.pdf	8809185850E47A3F694B43814028B0C2C6C6CB9DBDE4BB5B6394F8035B901BF94E365872B8F80044822BC006D737EC5900314D9280DD502A3A0A2609F32D5786

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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 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.

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
17/328,750	**02/12/2024 02:35:25 PM Z ET**	**042933/560470**

Title of Invention

MOTION PREDICTION IN VIDEO CODING

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	11805267
CONFIRMATION #	8335	FILED BY	Philip Tyson
PATENT CENTER #	64291151	AUTHORIZED BY	Guy Gosnell
CUSTOMER #	10949	FILING DATE	05/24/2021
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Kemal Ugur

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
DA / 160605	**E20242BE35448506**	**Philip Tyson**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
1811	CERTIFICATE OF CORRECTION	160.00	1	160.00
			TOTAL AMOUNT:	**$160.00**

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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.