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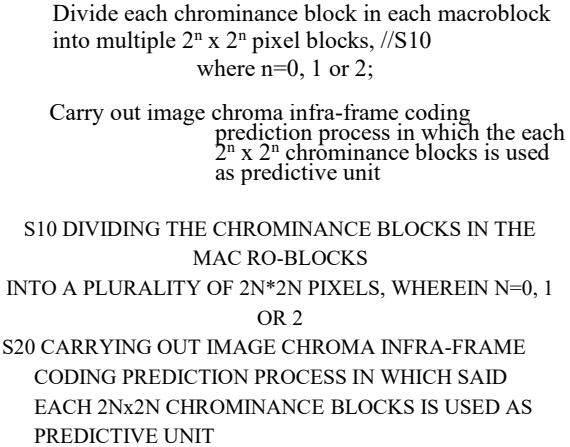
(54) Title: METHOD FOR IMAGE CHORMINANCE PREDICTION BASED ON INTRA-FRAME CODING

(54) **Title of Invention**: **METHOD FOR IMAGE CHORMINANCE PREDICTION BASED ON INTRA-FRAME CODING**

(57) Abstract: A method for image chrominance prediction based on intra-frame coding. The method is used for image chrominance prediction process during the intra-frame process and includes the steps as following: dividing the chrominance blocks in the macro-blocks into a plurality of 2^nx2^n pixels, where n = 0, 1 or 2; carrying out image chrominance infra-frame coding prediction process in which said each 2^nx2^n chroma blocks is used as predictive unit. The present invention can effectively improve coding efficiency of image chrominance in the video image coding technique.



(57) Abstract:

A method for image chrominance prediction based on intra-frame coding. The method is used for image chrominance prediction process during the intra-frame process and includes the steps as following: dividing the chrominance blocks in the macro-blocks into a plurality of 2^nx2^n pixels, where n = 0, 1 or 2; carrying out image chrominance infra-frame coding prediction process in which said each 2^nx2^n chroma blocks is used as predictive unit. The present invention can effectively improve coding efficiency of image chrominance in the video image coding technique.

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METHOD FOR IMAGE CHORMINANCE PREDICTION BASED ON INTRA-FRAME CODING

Technical Field

The present invention relates to the technical field of video coding and decoding, and further to a method for method for image chrominance prediction based on intra-frame coding.

Background Technology

With the gradual development and rapid promotion of multimedia communication technology and multimedia communication application services, a series of video image compression standard technologies have received widespread attention. In particular, the advanced video compression standard H.264, jointly developed by the Motion Picture Experts Group (MPEG) and the International Telecommunications Union (ITU), has become a popular standard for video compression due to its advanced compression coding technology and good compression performance. It has been widely used in the fields of conference television, videophone, streaming media, high-definition laser video disc (HD DVD, High-definition digital video disc) and video surveillance, and will be widely promoted and applied in the extremely rapidly developing fields of broadcasting and television technology and third-generation mobile communication (3G) technology.

Please refer to FIG. 1, which is a schematic diagram of the process of compressing and encoding an image using the H.264 compression encoding technology in the prior art. As shown in FIG. 1, H.264 compression coding technology divides the image to be processed into basic processing macroblocks of 16x16 pixels. The divided macroblocks are processed with advanced image processing technologies such as multi-frame reference, intra-frame prediction, multi-macroblock mode, 4x4 integer transform/scaling/quantization, deblocking filter, 1/4-pixel motion estimation, context-based adaptive variable length coding (CAVLC) and context-based adaptive binary arithmetic coding (CABAC). Its compression coding efficiency is more than doubled compared to MPEG-2 compression coding technology, H.263 compression coding technology and MPEG-4 ASP (Advanced simple profile) compression coding technology.

It can be seen from the above process that one of the main features of the encoding process of H.264 compression coding technology is that it performs intra-frame coding (INTRA) prediction on the image data to be processed, which greatly improves the coding efficiency of INTRA frames. In the process of intra-frame coding prediction of image data,

the image luminance prediction process includes two prediction units: 16x16 block prediction and 4x4 block prediction.

Please refer to FIG. 2, which is a schematic diagram of four prediction modes used in 16x16 block prediction in the prior art luminance prediction process. In the H.264 compression coding technology, the 16x16 block prediction process includes:

vertical prediction (vertical), as shown in FIG. 2 (a);

horizontal prediction (horizontal), as shown in FIG. 2 (b);

horizontal and vertical average predictions (DC), as shown in FIG. 2 (c); and

horizontal and vertical weighted prediction (Plane), as shown in FIG. 2 (d);

Therefore, the 16x16 block prediction process includes the above four prediction modes.

Please refer to FIG. 3, which is a schematic diagram of nine prediction modes used in 4x4 block prediction in the luminance prediction process in the prior art. In the H.264 compression coding technology, the 4x4 block prediction process includes:

Vertical prediction (vertical), as shown in FIG. 3 (a);

Horizontal prediction (horizontal), as shown in FIG. 3 (b);

Horizontal and vertical average predictions (DC) are shown in FIG. 3 (c);

Diagonal Down-Left prediction, as shown in FIG. 3 (d);

Diagonal Down-Right prediction, as shown in FIG. 3 (e);

Vertical-Right prediction, as shown in FIG. 3 (f);

Vertical-Left prediction (Vertical-Left), as shown in FIG. 3 (g);

Horizontal-Down prediction, as shown in FIG. 3 (h); and

Horizontal-Up prediction, as shown in FIG. 3 (i);

Therefore, the 4x4 block prediction process includes the above nine prediction modes.

In the intra-frame coding prediction process of H.264, the image chrominance prediction process is only performed on 8x8 blocks as prediction units, which includes four prediction modes: vertical prediction (vertical), horizontal prediction (horizontal), horizontal and vertical average prediction (DC) and horizontal and vertical weighted prediction (plane). The four prediction modes are similar to the four prediction modes used in the 16 x 16 block prediction in the luminance prediction process. Refer to the four prediction modes shown in FIG. 2 for details.

It can be seen that in the H.264 intra-frame coding prediction, the image chrominance prediction is only carried out with 8x8 blocks as prediction units, but there is no further consideration of using 4x4 blocks as prediction units for intra-frame coding prediction, as in the luminance prediction. That is, the local correlation between the image chrominance 4x4 blocks is not fully utilized (the so-called local correlation between blocks refers to the similarity between the pixels of the current block and the pixels of the nearby blocks). This results in the defect the image chrominance coding having low efficiency in the H.264 intra-frame coding prediction technology.

Summary of the Invention

The technical problem to be solved by the present invention is to propose a method for image chrominance based on intra-frame coding which can effectively improve the image chrominance coding efficiency in video image coding technology.

To solve the above problem, the present invention proposes a method for image chrominance prediction based on intra-frame coding, which is used for image chrominance prediction in the intra-frame coding prediction process, comprising:

(A1) dividing each chrominance block in the macroblock into a plurality of $2^n x 2^n$ pixel blocks, where n=0, 1 or 2;

(A2) performing image chrominance intra-frame coding prediction using each $2^n x 2^n$ pixel block as a prediction unit;

Where, the multiple $2^n x 2^n$ pixel blocks divided from each macroblock adopt the same prediction mode to perform image chrominance intra-frame coding prediction, and each macroblock only encodes and transmits the same chrominance intra-frame coding prediction mode once;

Where, the step (A1) and (A2) further comprise:

(A1-1) determining whether to use the 16x16 pixel luminance block as the prediction unit for image luminance intra-frame coding prediction, and if yes, go to step (A1-2); otherwise go to step (A2);

(A1-2) using each 8 x 8-pixel chrominance block as a prediction unit for image chrominance intra-frame coding prediction;

Where, the step (A1) and (A2) further comprise:

(a1) calculating the $2^n x 2^n$ pixel blocks respectively as prediction units based on rate-distortion optimization, where the coding efficiency of the image chroma intra-frame coding prediction process is E1,

and the coding efficiency of the image chroma intra-frame coding prediction process using a chroma block of 8 x 8 pixels as the prediction unit is E2;

(a2) comparing whether El is greater than E2, and if yes, going to step (A2); otherwise going to step (a3);

(a3) using each 8x8 pixel chrominance block as a prediction unit for image chrominance intra-frame coding prediction.

The plurality of $2^n \times 2^n$ pixel blocks divided from each macroblock adopt the same prediction mode to perform image chrominance intra-frame coding prediction; or

different prediction modes are used to perform image chroma intra-frame coding prediction;

Where, the method further comprises the following steps between steps (A1) and (A2):

(A11) calculating respectively the coding efficiency E1, E2 and E3 of the image chrominance intra-frame coding prediction with 8x8 pixel chrominance blocks as prediction units based on rate-distortion optimization, the coding efficiency E2 of image chrominance intra-frame coding prediction using the $2^n x 2^n$ pixel block as a prediction unit in the same prediction mode, and the coding efficiency E3 of image chrominance intra-frame coding prediction using the $2^n x 2^n$ pixel block as a prediction unit in different prediction modes;

(A12) if E1 is greater than E2 and E3, going to step (A13); if E2 is greater than E1 and E3, then each of the $2^n \times 2^n$ pixel blocks executing step (A2) under the condition of adopting the same prediction mode; if E3 is greater than E1 and E2, each of the $2^n \times 2^n$ pixel blocks performing step (A2) under different prediction mode conditions;

(A13) using each 8x8 pixel chrominance block is used as a prediction unit to perform image chrominance intra-frame coding prediction.

The same prediction mode is determined as follows:

calculating respectively the coding efficiency of image chrominance intra-frame coding prediction in various prediction modes with each 8x8 pixel chrominance block as a prediction unit, and taking the prediction mode corresponding to the highest coding efficiency as the same prediction mode based on rate-distortion optimization; or

calculating respectively the coding efficiency of the image chrominance intra-frame coding prediction in various prediction modes with the $2^n \times 2^n$ pixel block as the prediction unit, and taking the prediction mode corresponding to the highest coding efficiency as the same prediction mode based on rate-distortion optimization; or

establishing a first mapping relationship table between a prediction mode adopted by using a 16x16 pixel luminance block as a prediction unit in an image luminance intra-frame coding prediction process

and a prediction mode adopted by using the $2^n x 2^n$ pixel block as a prediction unit in an image chrominance intra-frame coding prediction process; and establishing a second mapping relationship table between the prediction mode combination used in the image luminance intra-frame coding prediction process using the 4x4 pixel luminance block as the prediction unit and the prediction mode used in the image chrominance intra-frame coding prediction process using the $2^n x 2^n$ pixel block as the prediction unit; and

querying the first mapping relationship table or the second mapping relationship table to determine the corresponding prediction mode as the same prediction mode according to the prediction mode or prediction mode combination adopted by the luminance block in the image luminance intra-frame coding prediction.

Where, the prediction modes used by the $2^n x 2^n$ pixel block include vertical prediction, horizontal prediction, horizontal and vertical average prediction, and horizontal and vertical weighted prediction.

Where, in the process of performing image chrominance intra-frame coding prediction using the $2^n x 2^n$ pixel block as a prediction unit, the prediction value of the corresponding point of the corresponding reference block at that time is used as the prediction reference value. Alternatively, in the process of performing image chrominance intra-frame coding prediction using the $2^n x 2^n$ pixel block as a prediction unit, the reconstructed pixel value of the corresponding point of the corresponding reference block is used as the prediction reference value.

The method for image chrominance prediction based on intra-frame coding according to the present invention proposes to divide each chrominance block in a macroblock into a plurality of $2^n x 2^n$ pixel blocks, where n=0, 1 or 2. Then, each $2^n x 2^n$ pixel block is used as a prediction unit to perform image chroma intra-frame coding prediction. Based on this scheme, the image chrominance intra-frame coding prediction in the H.264 compression coding standard is improved, and 4x4 pixel blocks, 2x2 pixel blocks or 1x1 pixel blocks are used as prediction units for image chrominance intra-frame coding prediction. This makes full use of the local correlation between multiple blocks divided into the chrominance image, thereby improving the coding efficiency of the image chrominance without increasing the coding overhead under various prediction modes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 is a schematic diagram of a process of compressing and encoding an image using the H.264 compression encoding technology in the prior art;

FIG.2 is a schematic diagram of four prediction modes used in 16x16 block prediction in the prior art luminance prediction;

FIG. 3 is a schematic diagram showing the nine prediction modes used in 4x4 block prediction in the prior art luminance prediction.

FIG.4 is a schematic diagram of the format of macroblocks involved in a method for image chrominance prediction based on intra-frame coding of the present invention;

FIG.5 is a flow chart of the main implementation principle of a method for image chrominance prediction based on intra-frame coding of the present invention;

FIG.6 is a flow chart of a first embodiment of a method for image chrominance prediction based on intra-frame coding according to the present invention;

FIG.7 is a flow chart of a second embodiment of a method for image chrominance prediction based on intra-frame coding according to the present invention;

FIG.8 is a flow chart of a third embodiment of a method for image chrominance prediction based on intra-frame coding according to the present invention;

FIG.9 is a schematic diagram of determining a prediction value according to a method for image chrominance prediction based on intra-frame coding according to the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

The present invention improves the intra-frame coding (INTRA) prediction in the H.264 compression coding standard by using a 4x4 pixel block, or a smaller 2x2 pixel block and a 1x1 pixel block as a prediction unit to perform image chrominance intra-frame coding prediction. The four-pixel blocks can use the same prediction mode, so that the local correlation between the multiple pixel blocks divided by the chrominance block can be fully utilized to improve the coding efficiency of the image chrominance without increasing the coding overhead under various prediction modes. The four-pixel blocks can also use different prediction modes.

The specific implementation of the method for image chrominance prediction based on intra-frame coding of the present invention is described in detail below in conjunction with the accompanying drawings. The macroblocks in the multimedia video images mentioned in the method for image chrominance prediction based on intra-frame coding of the present invention refer to macroblocks in 4:2:0 format, that is, one macroblock includes sixteen 4x4 pixel luminance blocks Y, four 4x4 pixel chrominance blocks Cb and four 4x4 pixel chrominance blocks Cr. Please refer to FIG. 4, which is a schematic diagram of the format of macroblocks involved in the method for image chrominance prediction based on intra-frame coding of the present invention, where: numbers 0 to 15 are sixteen 4x4 pixel luminance blocks Y; numbers 16 to 19 are four 4x4 pixel chrominance blocks Cb; and numbers 20 to 23 are four 4x4 pixel chrominance blocks Cr.

Please refer to FIG. 5, which is a flow chart of the main implementation principle of the method for image chrominance prediction based on intra-frame coding of the present invention, the main implementation process comprising:

Step S10, dividing each chrominance block (including chrominance blocks Cb and Cr) in the video image macroblock into a plurality of 2^nx2^n pixel blocks, where n=0, 1 or 2; that is, based on each 8x8 pixel chrominance block 0, 1 and 2 in the macroblock in the prior art, if n=0, dividing each chrominance block into sixty-four 1x1 pixel blocks; if n=1, dividing each chrominance block into sixteen 2x2 pixel blocks; if n=2, dividing each chrominance block into four 4x4 pixel blocks. After multiple experimental tests and analyses, the present invention here describes n=2, i.e., dividing each chrominance block into four 4x4 pixel blocks, as the most preferred implementation.

Step S20, performing image chrominance intra-frame coding prediction using each 2^nx2^n pixel block divided in Step S10 as a prediction unit; In this way, during the image chrominance intra-frame coding prediction process, since the 2^nx2^n pixel block can better utilize the local correlation between different pixel blocks when n=0, 1 or 2, compared with the 8x8 pixel chrominance block in the prior art as the prediction unit, the image chrominance coding efficiency can be improved.

The multiple 2^nx2^n pixel blocks divided from each macroblock can use the same prediction mode to perform image chrominance intra-frame coding prediction, and each macroblock only encodes and transmits the same chrominance intra-frame coding prediction mode once. The same prediction mode used can be selected from four prediction modes: horizontal prediction (vertical), vertical prediction (horizontal), horizontal and vertical prediction (DC) and horizontal and vertical weighted prediction (plane). The Plane prediction mode applied to the 2^nx2^n pixel block can be similar to the Plane prediction mode applied to the 8x8 pixel chroma block.

In the case where the same prediction mode is used for the image chroma intra-frame coding prediction of the above-mentioned multiple 2^nx2^n pixel blocks, it is naturally possible that in the image chroma intra-frame coding prediction process, the image chroma intra-frame prediction using the 8x8 pixel chroma block as the prediction unit is better than using the 2^nx2^n pixel block (such as 4x4 pixel block) as the prediction unit. Therefore, depending on the specific situation, either an 8x8 pixel chroma block or a 2^nx2^n pixel block can be used as the prediction unit during the image chroma intra-frame coding prediction process. Please refer to FIG. 6, which is a flow chart of a first embodiment of an method for image chrominance prediction based on intra-frame coding of the present invention; the specific implementation process of the first embodiment comprising:

Step S1, dividing each chrominance block (including chrominance blocks Cb and Cr)

in the video image macroblock into a plurality of $2^n x 2^n$ pixel blocks, where n1=0, 1 or 2;

Step S12, determining whether, during the image luminance intra-frame coding prediction, the image luminance intra-frame coding prediction is performed using a luminance block of 16x16 pixels as a prediction unit, and if yes, executing step S13; otherwise, executing step S14;

Step S13, performing image chrominance intra-frame coding prediction with each 8×8-pixel chrominance block (i.e., the entire chrominance block Cb and Cr) as a prediction unit;

Step S14, using each divided $2^n x 2^n$ pixel block as a prediction unit to perform image chrominance intra-frame coding prediction.

Please refer to FIG. 7, which is a flow chart of a second embodiment of a method for image chrominance prediction based on intra-frame coding according to the present invention, the specific implementation process of the second embodiment comprising:

Step S21, dividing each chrominance block (including chrominance blocks Cb and Cr) in the video image macroblock into a plurality of $2^n x 2^n$ pixel blocks, where n=0, 1 or 2;

Step S22, calculating respectively the coding efficiency E1 of the image chroma intra-frame coding prediction using a $2^n x 2^n$ pixel block as a prediction unit, and the coding efficiency E2 of the image chroma intra-frame coding prediction using an 8×8-pixel chroma block (i.e., the entire chroma block Cb and Cr) as a prediction unit based on rate-distortion optimization (RDO);

Step S23, comparing the size of E1 and E2 to determine whether E1 is greater than E2, if yes, executing step S25; otherwise, executing step S24;

Step S24, performing image chrominance intra-frame coding prediction with each 8x8 pixel chrominance block (i.e., the entire chrominance block Cb and Cr) as a prediction unit;

Step S25, using each divided $2^n x 2^n$ pixel block as a prediction unit to perform image chrominance intra-frame coding prediction.

Naturally, the multiple $2^n x 2^n$ pixel blocks divided from each macroblock can also use different prediction modes to perform image chrominance intra-frame coding prediction. In this case, when the same prediction mode or different prediction modes are used for image chrominance intra-frame coding prediction based on multiple $2^n x 2^n$ pixel blocks in each macroblock, it is also possible that in the image chrominance intra-frame coding prediction, the multiple $2^n x 2^n$ pixel blocks divided from the chrominance block (including the chrominance block Cr or Cb) in each macroblock use different prediction modes, which is more efficient than using the same prediction mode for image chrominance intra-frame coding prediction. Thus, a syntax element can be established to indicate that in the process of image chrominance intra-frame coding prediction, in which

a chrominance block of 8x8 pixels is selected as a prediction unit, or a 2^n x 2^n pixel block is selected as a prediction unit in the same prediction mode, or a 2^n x 2^n pixel block is selected as a prediction unit in different prediction modes. Based on RDO, the image chroma coding efficiency of the three prediction methods for image chroma intra-frame coding prediction is calculated respectively, and then the coding efficiency of the three prediction methods is compared, and the prediction method with the highest coding efficiency is selected for the final image chroma coding processing.

Please refer to FIG.8, which is a flow chart of a third embodiment of a method for image chrominance prediction based on intra-frame coding according to the present invention; the specific implementation process of the third embodiment comprising:

Step S31, dividing each chrominance block (including chrominance blocks Cb and Cr) in the video image macroblock into a plurality of 2^n x 2^n pixel blocks, where n=0, 1 or 2;

Step S32, calculating the coding efficiency E1 of the image chroma intra-frame coding prediction using the chroma block of 8x8 pixels as the prediction unit based on the rate-distortion optimization RDO;

Step S33, calculating the coding efficiency E2 of the image chrominance intra-frame coding prediction using 2^n x 2^n pixel blocks as prediction units under the same prediction mode (i.e., all 2^n x 2^n pixel blocks divided from each macroblock use the same prediction mode) based on the rate-distortion optimization RDO;

Step S34, calculating the coding efficiency E3 of the image chrominance intra-frame coding prediction using 2^n x 2^n pixel blocks as prediction units under different prediction modes (i.e., all 2^n x 2^n pixel blocks divided from each macroblock use different prediction modes) based on the rate-distortion optimization RDO;

Step S35, comparing the sizes of E1, E2 and E3 to determine whether E1 is greater than E2 and E3, if so, executing step S36; otherwise, executing step S37;

Step S36, performing image chrominance intra-frame coding prediction with each 8×8-pixel chrominance block (i.e., the entire chrominance block Cb and Cr) as a prediction unit;

Step S37, determining whether E2 is greater than E1 and E3, if yes, executing step S38; otherwise, executing step S39;

Step S38, taking each 2^n x 2^n pixel block as a prediction unit, and using the same prediction mode for all 2^n x 2^n pixel blocks divided from each chrominance block (including chrominance blocks Cb and Cr) to perform image chrominance intra-frame coding prediction;

Step S39, using each 2^n x 2^n pixel block as a prediction unit, and processing all 2^n x 2^n pixel blocks divided from each chrominance block (including the chrominance blocks Cb and Cr)

for image chrominance intra-frame coding prediction using different prediction modes.

In the above, when all 2^n x 2^n pixel blocks divided from each chroma block (including chroma blocks Cb and Cr) adopt the same prediction mode, the same prediction mode adopted by them can be determined by the following method:

1) calculating the coding efficiency of image chrominance intra-frame coding prediction under various prediction modes (including vertical, horizontal, DC and Plane prediction modes) with each 8x8 pixel chrominance block (including chrominance blocks Cb and Cr) as the prediction unit based on rate-distortion optimization (RDO), and using the prediction mode corresponding to the highest coding efficiency as the same prediction mode to be determined. That is, according to the rate distortion optimized (RDO) in the H.264 compression coding standard, the coding efficiency of the image chrominance intra-frame coding prediction under various prediction modes with the 8x8 pixel chrominance block as the prediction unit is calculated respectively, and the most efficient coding mode is used as the same prediction mode to be adopted by all 2^n x 2^n pixel blocks in each chrominance block. That is, "determine the prediction mode based on the 8 x 8-pixel chrominance block as the prediction unit, and perform prediction based on the 2^n x 2^n pixel block as the prediction unit."

2) calculating the coding efficiency of image chrominance intra-frame coding prediction under various prediction modes (including vertical, horizontal, DC and Plane prediction modes) respectively with 2^n x 2^n pixel blocks as prediction units based on rate-distortion optimization (RDO), and using the prediction mode corresponding to the highest coding efficiency as the same prediction mode to be determined. That is, according to the RDO in the H.264 compression coding standard, the coding efficiency of the image chrominance intra-frame coding prediction under various prediction modes is calculated with 2^n x 2^n pixel blocks as the prediction unit, and then the prediction mode with the highest coding efficiency is taken as the final prediction mode to be determined.

3) establishing a first mapping relationship table between the prediction mode (including four prediction modes, vertical, horizontal, DC and Plane) adopted by the 16x16 pixel luminance block as the prediction unit in the image luminance intra-frame coding (INTRA) prediction process and the prediction mode (including four prediction modes, vertical, horizontal, DC and Plane) adopted by the 2^n x 2^n pixel block as the prediction unit in the image chrominance intra-frame coding (INTRA) prediction process; and

establishing the prediction mode combination used in the image luminance intra-frame coding prediction process with 4x4 pixel luminance blocks as the prediction unit (including vertical prediction, horizontal prediction, horizontal and vertical average prediction, DC, and lower left diagonal prediction.

Down-Left, a prediction mode combination consisting of nine prediction modes: Diagonal Down-Right, Vertical-Left, Horizontal-Down, Vertical-Right and Horizontal-Up) and a second mapping relationship table between prediction modes (including four prediction modes: vertical, horizontal, DC and Plane) adopted in the image chrominance intra-frame coding prediction process with the 2^n x 2^n pixel block as a prediction unit.

During the intra-frame coding prediction, querying the first mapping relationship table or the second mapping relationship table established above according to the prediction mode or prediction mode combination adopted by the luminance block (including the chrominance blocks Cb and Cr) in the image luminance intra-frame coding prediction, so as to determine the corresponding prediction mode as the same prediction mode to be selected.

In the above process of image chrominance intra-frame coding prediction using 2^n x 2^n pixel blocks as prediction units, due to the chrominance DC HADAMARD transformation, when the required reference pixel value is unavailable due to the HADAMARD transformation, the prediction value of the corresponding point of the 2^n x 2^n pixel block itself can be taken as the prediction reference value. Please refer to FIG. 9, which is a schematic diagram of determining a prediction value by a method for image chrominance prediction based on intra-frame coding according to the present invention. As shown in the drawing, the horizontal reference pixels of block 2 and block 4 in the four 4x4 pixel blocks take the predicted values of the right most column pixels of block 1 and block 3 at that time as the predicted reference values (indicated by the vertical dotted lines of block 1 and block 3 in the drawing). The vertical reference pixels of block 3 and block 4 take the predicted values of the bottom row of pixels of block 1 and block 2 as the prediction reference values (shown by the horizontal dotted lines of block 1 and block 2 in the drawing). For example, the intra-frame prediction of the image chrominance of block 4 can be performed by referring to the horizontal reference pixels of block 2 and the vertical reference pixels of block 3. In this way, the intra-frame prediction coding method still uses the original coding method for encoding and transmission, and will not increase the coding overhead or the processing complexity.

If the HADAMARD transform of the chrominance DC component is ignored during the intra-frame coding prediction, then when the image chrominance intra-frame coding prediction is performed with a 2^n x 2^n pixel block as the prediction unit, the prediction method of the image luminance intra-frame coding prediction with a 4x4 pixel block as the prediction unit can be referred to, that is, the reconstructed pixel value of the 2^n x 2^n pixel block is directly taken as the prediction value for prediction calculation.

After many experimental tests and analyses, the present invention found that when n=2, that is, each chrominance block (including chrominance blocks Cb and Cr) is divided into four 4×4-pixel blocks, and each 4×4-pixel block is used as a prediction unit to perform image chrominance intra-frame coding prediction, thereby creating the best effect of implementation.

The following experimental results are obtained only for the above-mentioned implementation of "determining the prediction mode according to the 8x8 pixel chrominance block as the prediction unit, and predicting according to the 4x4 pixel block as the prediction unit". Since the present invention is only for the INTRA frame coding technology, the coding mode of all test sequences is taken as I-frames.

Using this embodiment of the present invention, performance tests and comparisons were performed on seven image sequences, namely bus.yuv, football.yuv, foreman.yuv, mobile.yuv, news.yuv, paris.yuv and tempete.yuv. For the four cases of Common Intermediate Format (CIF) 30 FPS (30 frame per second), CIF 15FPS, QCIF (1/4 CIF) 15FPS and QCIF 5FPS, the performance test results are shown in the table below. It can be seen from the data in the table that the overall performance that the present invention can achieve has an average gain of 0.01505 compared with the prior art.

Video Sequence	CIF 30fps gain	CIF 15fps gain	QCIF 15 fps gain	QCIF 5 fps gain
bus	-0.001478	-0.004155	0.000397	0.002708
football	0.012205	0.014652	0.015041	0.017764
foreman	0.009198	0.005866	0.014642	0.009637
mobile	0.031122	0.025907	0.041631	0.042214
news	0.016307	0.007621	0.014482	0.005836
paris	0.010274	0.007317	0.031661	0.031424
tempete	0.011389	0.010626	0.018882	0.018239
Average gain:	0.0127167	0.009690571	0.0195337	0.018260286

The above description is only a preferred embodiment of the present invention. It should be pointed out that, for a person with ordinary skill in the art, several improvements and modifications can be made without departing from the principle of the present invention. These improvements and modifications should also be regarded as the protection scope of the present invention.

CLAIMS

1. A method for image chrominance prediction based on intra-frame coding, used for image chrominance prediction in an intra-frame coding prediction process, comprising:

(A1) dividing each chrominance block in the macroblock into a plurality of 2^n x 2^n pixel blocks, where n=0, 1 or 2;

(A2) performing image chrominance intra-frame coding prediction with each 2^n x 2^n pixel block as a prediction unit.

2. The method for image chrominance prediction based on intra-frame coding according to Claim 1, wherein the multiple 2^n x 2^n pixel blocks divided from each macroblock adopt the same prediction mode to perform image chrominance intra-frame coding prediction, and each macroblock only encodes and transmits the same chrominance intra-frame coding prediction mode once.

3. The method for image chrominance prediction based on intra-frame coding according to Claim 2, wherein, between the steps (A1) and (A2), there is further comprising:

(A1-1) determining whether to use the 16x16 pixel luminance block as the prediction unit for image luminance intra-frame coding prediction, and if yes, going to step (A1-2); otherwise going to step (A2); and

(A1-2) using each 8x8 pixel chrominance block as a prediction unit for image chrominance intra-frame coding prediction.

4. The method for image chrominance prediction based on intra-frame coding according to Claim 2, wherein, between the steps (A1) and (A2), there is further comprising:

(a1) calculating respectively based on rate-distortion optimization the coding efficiency E1 of image chrominance intra-frame coding prediction using the 2^n x 2^n pixel block as a prediction unit and the coding efficiency E2 of image chrominance intra-frame coding prediction using the 8×8-pixel chrominance block as a prediction unit;

(a2) comparing whether E1 is greater than E2, and if yes, going to step (A2); otherwise, going to step (a3);

(a3) using each 8 x 8-pixel chrominance block as a prediction unit for image chrominance intra-frame coding prediction.

5. The method for image chrominance prediction based on intra-frame coding according to Claim 1, wherein: the plurality of 2^n x 2^n pixel blocks divided from each macroblock adopt the same prediction mode to perform image chrominance intra-frame coding prediction; or

different prediction modes are used to perform image chroma intra-frame coding prediction;

6. The method for image chrominance prediction based on intra-frame coding according to Claim 5, wherein, between the steps (A1) and (A2), there is further comprising:

(A11) calculating respectively the coding efficiency E1 of the image chroma intra-frame coding prediction process using the 8x8 pixel chroma block as the prediction unit, the coding efficiency E2 of the image chroma intra-frame coding prediction process using the 2^n x 2^n pixel block as the prediction unit in the same prediction mode, and the coding efficiency E3 of the image chroma intra-frame coding prediction process using the 2^n x 2^n pixel block as the prediction unit in different prediction modes based on rate-distortion optimization;

(A12) if E1 is greater than E2 and E3, going to step (A13); if E2 is greater than E1 and E3, then each of the 2n x 2n pixel blocks executing step (A2) under the condition of adopting the same prediction mode; if E3 is greater than E1 and E2, each of the 2^n x 2^n pixel blocks executing step (A2) under different prediction mode conditions; and

(A13) using each 8 x 8-pixel chrominance block as a prediction unit for image chrominance intra-frame coding prediction.

7. The method for image chrominance prediction based on intra-frame coding according to Claim 2 or 6, wherein the same prediction mode is determined in the following manner:

calculating respectively the coding efficiency of each 8x8 pixel chrominance block as a prediction unit for image chrominance intra-frame coding prediction in various prediction modes based on rate-distortion optimization, and taking the prediction mode corresponding to the highest coding efficiency as the same prediction mode; or

calculating respectively the coding efficiency of image chrominance intra-frame coding prediction in various prediction modes using the 2^n x 2^n pixel block as a prediction unit based on rate-distortion optimization, and taking the prediction mode corresponding to the highest coding efficiency as the same prediction mode; or

establishing a first mapping relationship table between the prediction mode adopted by the 16x16 pixel luminance block as the prediction unit in the image luminance intra-frame coding prediction process and the prediction mode adopted by the 2^n x 2^n pixel block as the prediction unit in the image chrominance intra-frame coding prediction process; and

establishing a second mapping relationship table between the prediction mode combination adopted by taking the 4x4 pixel luminance block as the prediction unit in the image luminance intra-frame coding prediction and the prediction mode adopted by taking the 2^n x 2^n pixel block as the prediction unit in the image chrominance intra-frame coding prediction; and

querying the first mapping relationship table or the second mapping relationship table to determine the corresponding prediction mode as the same prediction mode according to the prediction mode or prediction mode combination adopted by the luminance block in the image luminance intra-frame coding prediction.

8. The method for image chrominance prediction based on intra-frame coding according to Claim 7, wherein the feature of the invention is that the prediction modes adopted by the $2^n \times 2^n$ pixel block include vertical prediction, horizontal prediction, horizontal and vertical average prediction and horizontal and vertical weighted prediction.

9. The method for image chrominance prediction based on intra-frame coding according to Claim 1, wherein, in the process of performing image chrominance intra-frame coding prediction using the $2^n \times 2^n$ pixel block as the prediction unit, the prediction value of the corresponding point of the corresponding reference block at that time is used as the prediction reference value.

10. The method for image chrominance prediction based on intra-frame coding according to Claim 1, wherein in the process of performing image chrominance intra-frame coding prediction with the $2^n \times 2^n$ pixel block as the prediction unit, the reconstructed pixel value of the corresponding point of the corresponding reference block is used as the prediction reference value.

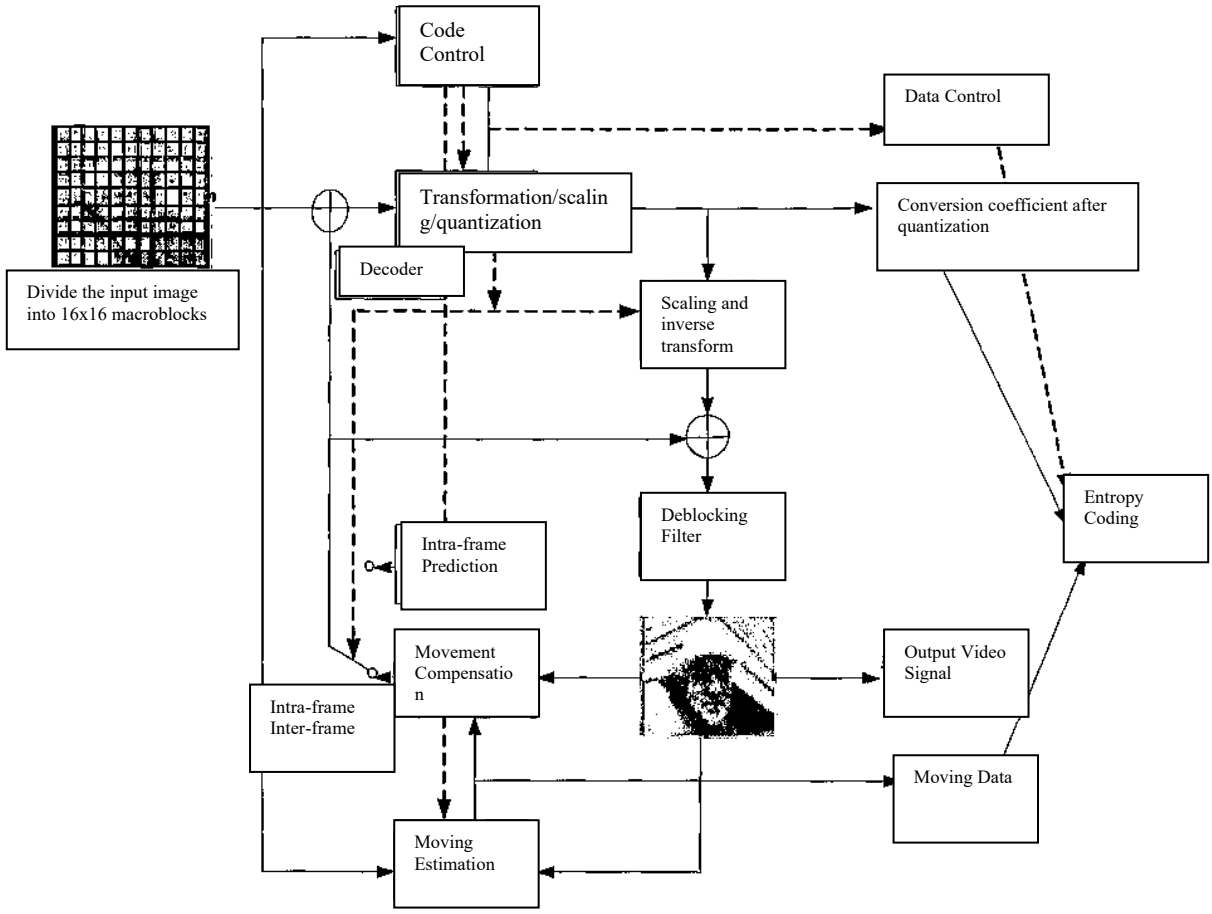
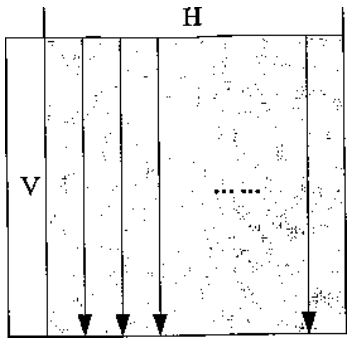
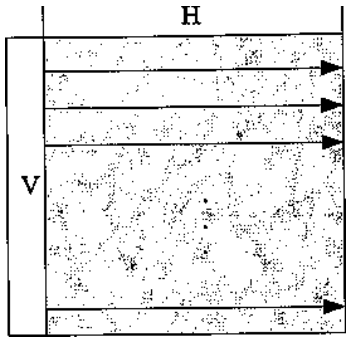

Code Control
Data Control
Transformation/scaling/quantization
Conversion coefficient after quantization
Decoder
Divide the input image into 16x16 macroblocks
Scaling and inverse transform
Deblocking Filter
Entropy Coding
Intra-frame Prediction
Movement Compensation
Output Video Signal
Intra-frame Inter-frame
Moving Data
Moving Estimation

FIG.1

1 2/6 1



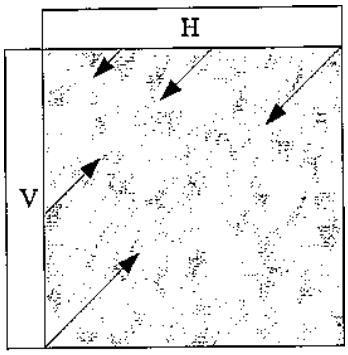
(a) Vertical



(b) Horizontal

H

V Mean(H+ V)



(c) DC

(d) Plane

FIG. 2

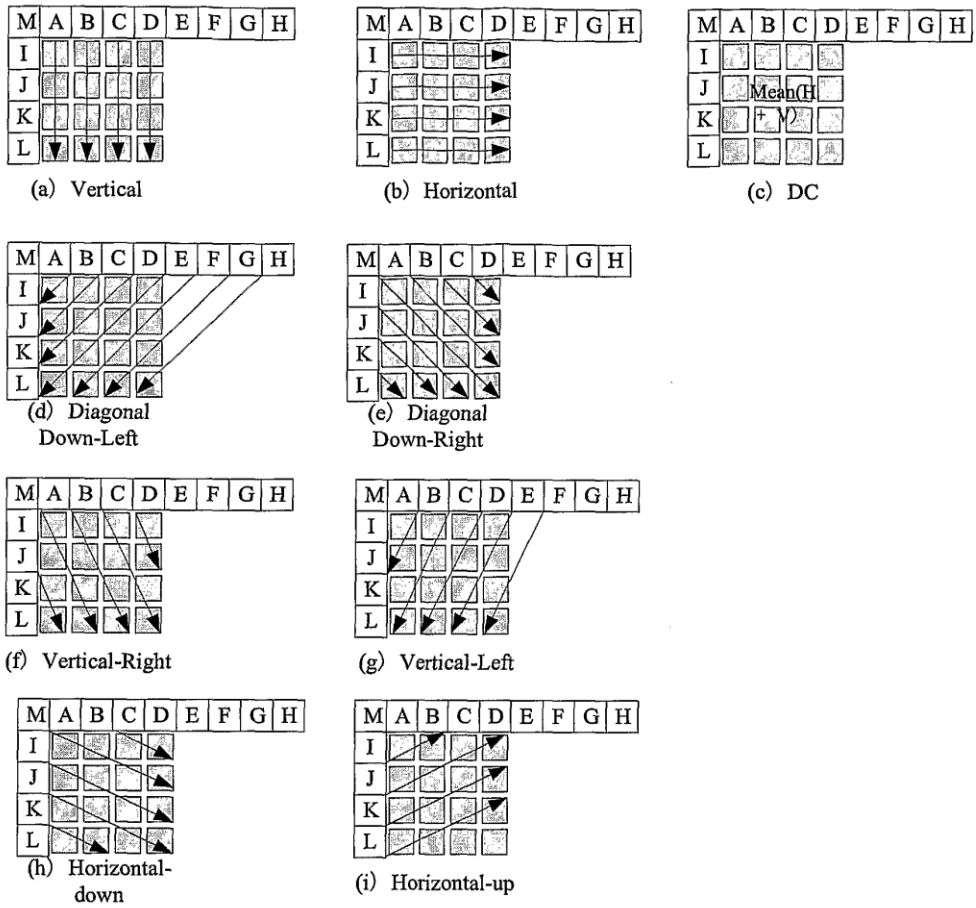

M A B C D E F G H
I
J
K
L
Mean(H + V)
(a) Vertical
(b) Horizontal
(c) DC
(d) Diagonal Down-Left
(e) Diagonal Down-Right
(f) Vertical-Right
(g) Vertical-Left
(h) Horizontal-down
(i) Horizontal-up

FIG. 3

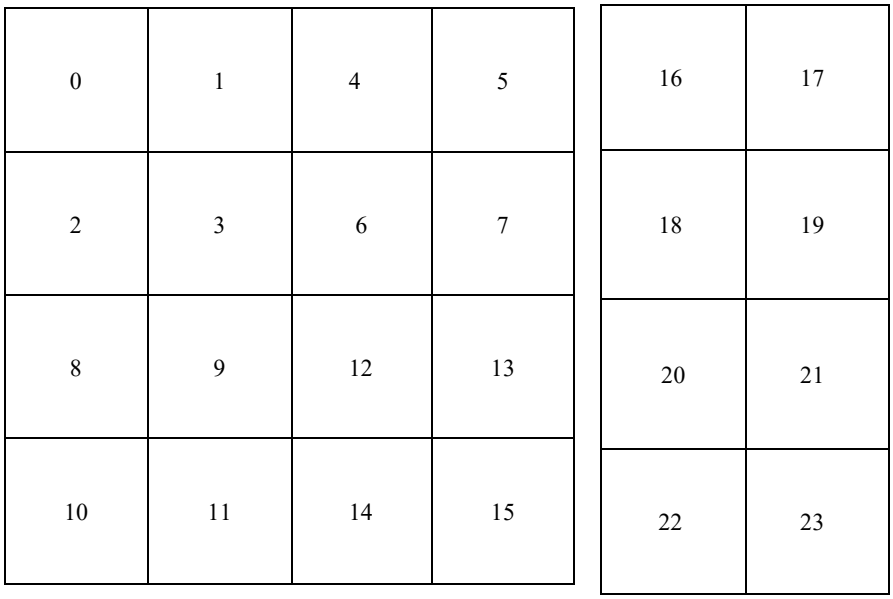

0
1
4
5
16
17
2
3
6
7
18
19
8
9
12
13
20
21
10
11
14
15
22
23

FIG. 4

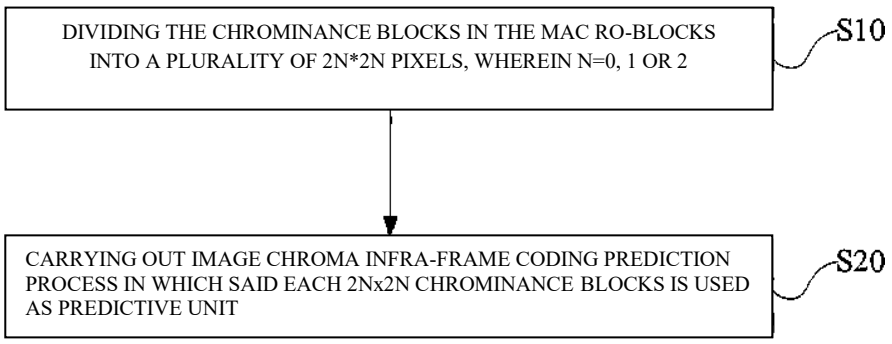

DIVIDING THE CHROMINANCE BLOCKS IN THE MAC RO-BLOCKS INTO A PLURALITY OF 2N*2N PIXELS, WHEREIN N=0, 1 OR 2
S10
CARRYING OUT IMAGE CHROMA INFRA-FRAME CODING PREDICTION PROCESS IN WHICH SAID EACH 2Nx2N CHROMINANCE BLOCKS IS USED AS PREDICTIVE UNIT
S20

FIG. 5

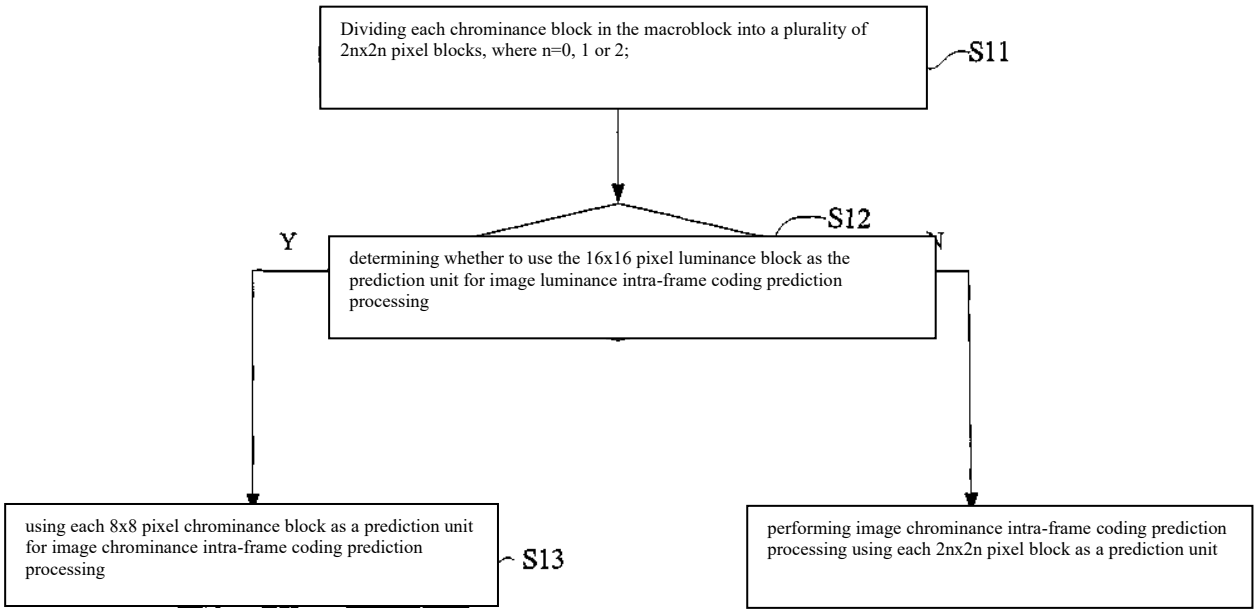

Dividing each chrominance block in the macroblock into a plurality of 2nx2n pixel blocks, where n=0, 1 or 2;
S11
S12
Y
determining whether to use the 16x16 pixel luminance block as the prediction unit for image luminance intra-frame coding prediction processing
using each 8x8 pixel chrominance block as a prediction unit for image chrominance intra-frame coding prediction processing
S13
performing image chrominance intra-frame coding prediction processing using each 2nx2n pixel block as a prediction unit

FIG. 6

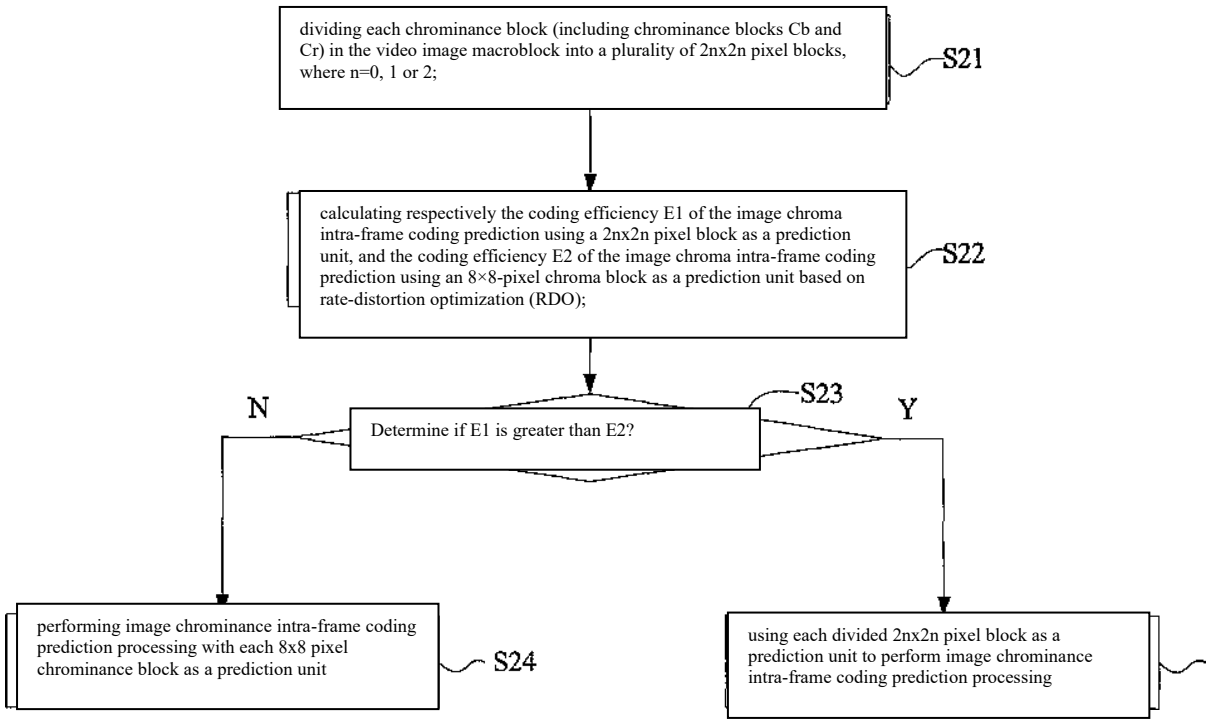

dividing each chrominance block (including chrominance blocks Cb and Cr) in the video image macroblock into a plurality of 2nx2n pixel blocks, where n=0, 1 or 2;
S21
calculating respectively the coding efficiency E1 of the image chroma intra-frame coding prediction using a 2nx2n pixel block as a prediction unit, and the coding efficiency E2 of the image chroma intra-frame coding prediction using an 8×8-pixel chroma block as a prediction unit based on rate-distortion optimization (RDO);
S22
S23
N
Determine if E1 is greater than E2?
Y
performing image chrominance intra-frame coding prediction processing with each 8x8 pixel chrominance block as a prediction unit
S24
using each divided 2nx2n pixel block as a prediction unit to perform image chrominance intra-frame coding prediction processing

FIG. 7

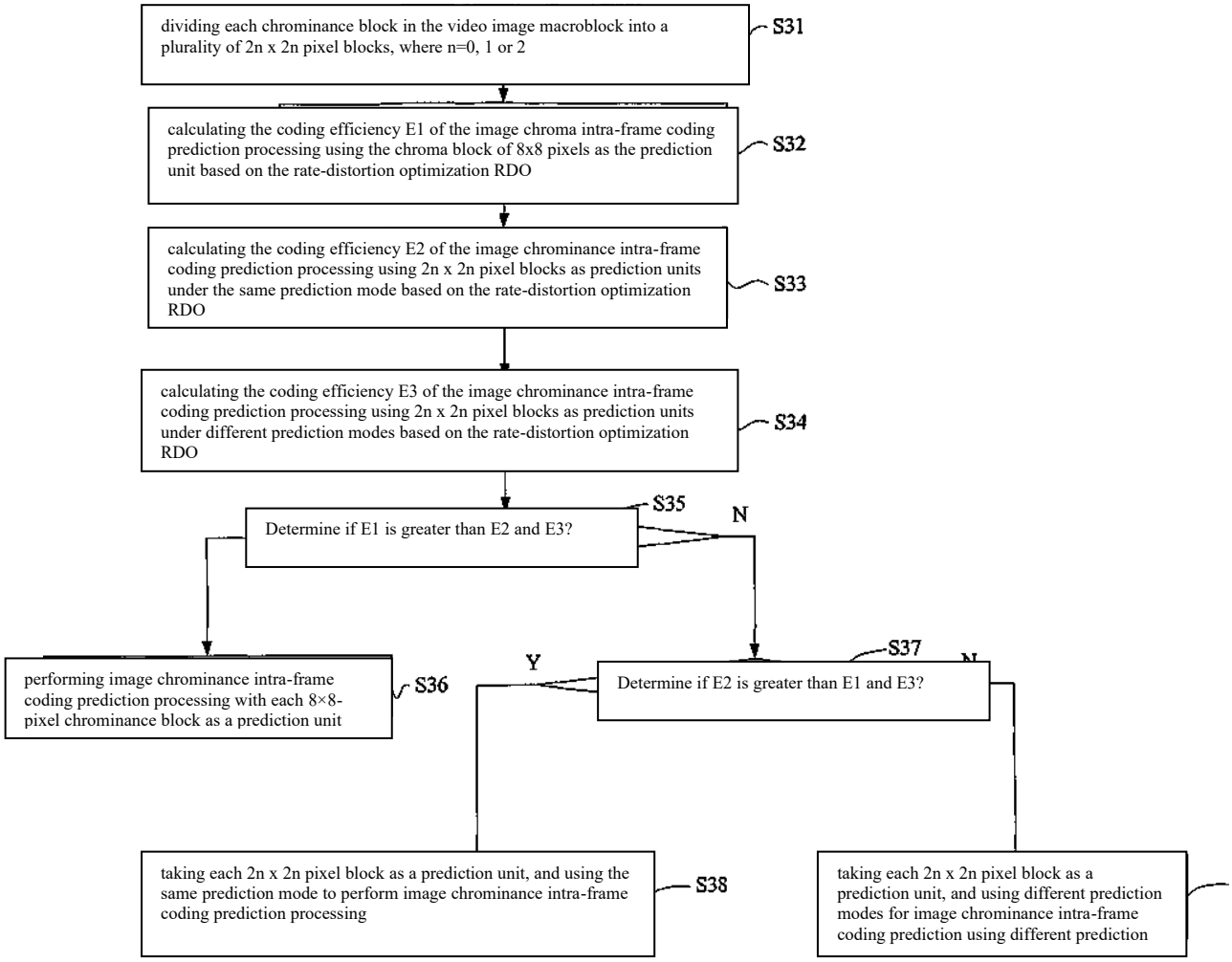

dividing each chrominance block in the video image macroblock into a plurality of 2n x 2n pixel blocks, where n=0, 1 or 2
S31
calculating the coding efficiency E1 of the image chroma intra-frame coding prediction processing using the chroma block of 8x8 pixels as the prediction unit based on the rate-distortion optimization RDO
S32
calculating the coding efficiency E2 of the image chrominance intra-frame coding prediction processing using 2n x 2n pixel blocks as prediction units under the same prediction mode based on the rate-distortion optimization RDO
S33
calculating the coding efficiency E3 of the image chrominance intra-frame coding prediction processing using 2n x 2n pixel blocks as prediction units under different prediction modes based on the rate-distortion optimization RDO
S34
Determine if E1 is greater than E2 and E3?
S35
N
Y
performing image chrominance intra-frame coding prediction processing with each 8×8-pixel chrominance block as a prediction unit
S36
Determine if E2 is greater than E1 and E3?
S37
N
taking each 2n x 2n pixel block as a prediction unit, and using the same prediction mode to perform image chrominance intra-frame coding prediction processing
S38
taking each 2n x 2n pixel block as a prediction unit, and using different prediction modes for image chrominance intra-frame coding prediction using different prediction

FIG. 8

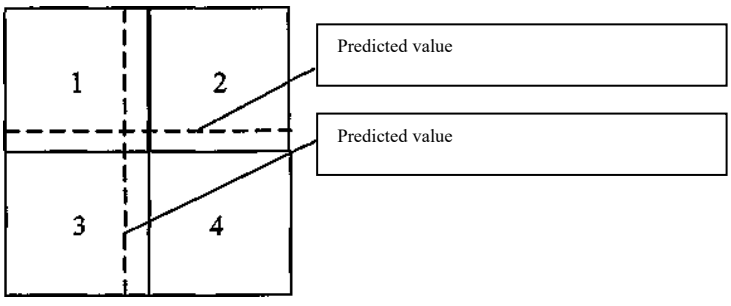

1
2
3
4
Predicted value
Predicted value

FIG. 9

dsdf

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2005/000949

A. CLASSIFICATION OF SUBJECT MATTER

IPC[7] H04N7/32

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[7] H04N7/32, H04N7/24, H04N7/26, H04N7/36

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

CN

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

CPRS; WPI;EPODOC;PAJ: macro block, divide, predict+,separate, partition, code, encode

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 1497985A(SAMSUNG ELECTRONICS CO LTD) 19.MAY2004(19.05.2004)	1-3, 5, 9, 10
A	Abstract, claims and description page 5, line20—line26	4, 6—8
X	CN1476253A(UNIV QINGHUA)18.FEB 2004(18.02.2004)	1-3, 5, 9, 10
A	Claims and description page 2, line19—page3, line25	4, 6—8
A	CN 1457606 A(NOKIA CORP) 19.NOV2003(19.11.2003)The whole document	1-10
A	US 6040865 A(SONY CORP) 21.MAR2000(21.03.2000)The whole document	1-10

☐ 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

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"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)

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"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
16.SEP2005(16.09.2005)	13 · SEP 2005 (13 · 10 · 2005)

Name and mailing address of the ISA/CN	Authorized officer
The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Ma Guili Telephone No. 86-10-62084643

Form PCT/ISA /210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2005/000949

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN1497985A	19.05.2004	US2004062445A1	01.04.2004
		JP2004129260A	22.04.2004
		KR2004028489A	03.04.2004
CN1476253A	18.02.2004	None	
CN1457606A	19.11.2003	US2004156437A1	12.08.2004
		WO0186962A1	15.11.2001
		AU200158472A	20.11.2001
		EP1282982A1	12.02.2003
		BR200110627A	18.03.2003
		KR2003011325A	07.02.2003
		JP2003533142T	05.11.2003
		HU200302617A2	28.11.2003
		MX2002010964A1	01.03.2003
		ZA200208767A	28.01.2004
		US6711211B1	23.03.2004
US6040865A	21.03.2000	JP3633159B2	30.03.2005
		JP1017845A	30.06.1998

Form PCT/ISA/210 (patent family annex) (April 2005)

International Search Report

International application number
PCT/CN2005/000949

A. Classification Subject Matter

IPC[7] H04N7/32

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[7] H04N7/32, H04N7/26, H04N7/24, H04N7/36

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
CPRS; WPI;EPODOC;PAJ: macro block, divide, predict+, separate, partition, code, encode

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A	Abstract, claims and description page 5, line20-line26	4, 6-8
X	CN1476253A(UNIV QINGHUA)18.FEB 2004(18.02.2004)	1-3, 5, 9, 10
A	Claims and description page 2, line 19-page3 , line25	4, 6-8
A	CN 1457606 A(NOKIA CORP) l 9.NOV2003(19. l 1.2003)The whole document	1-10
A	US 6040865 A(SONY CORP) 21.MAR2000(21.03.2000)The whole document	1-10

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

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"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
September 16, 2005 （16.09.2005）

Date of mailing of the international search report
[illegible] 2005

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
Ma Guili [seal] Ma Guili

TEL： (86-10)62084643

Form PCT/ISA/210 (second sheet) (April 2005)

International Search Report
Important information on patent family member

International application number
PCT/CN2005/000949

Patent Document Referred to in Report	Publication Date	Patent Family	Publication Date
CN1497985A	19.05.2004	US2004062445A1	01.04.2004
		JP2004129260A	22.04.2004
		KR2004028489A	03.04.2004
CN1476253A	18.02.2004	None	
CN1457606A	19.11.2003	US2004156437A1	12.08.2004
		WO0186962A1	15.11.2001
		AU200158472A	20.11.2001
		EP1282982A1	12.02.2003
		BR200110627A	18.03.2003
		KR2003011325A	07.02.2003
		JP2003533142T	05.11.2003
		HU200302617A2	28.11.2003
		MX2002010964A1	01.03.2003
		ZA200208767A	28.01.2004
		US6711211B1	23.03.2004
US6040865A	21.03.2000	JP3633159B2	30.03.2005
		JP1017845A	30.06.1998

Form PCT/ISA/210 (patent family annex) (April 2005)