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That I possess advanced knowledge of the Chinese and English languages. The attached Chinese into English translation has been translated by me and to the best of my knowledge and belief, it is a true and accurate translation of "WO2008083633A1 (Xiong).pdf".

I declare that all statements made herein of my knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willfully false statements and the like are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code.

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(54) Title: A METHOD AND A DEVICE FOR INTRA FRAME PREDICTION ENCODING/DECODING

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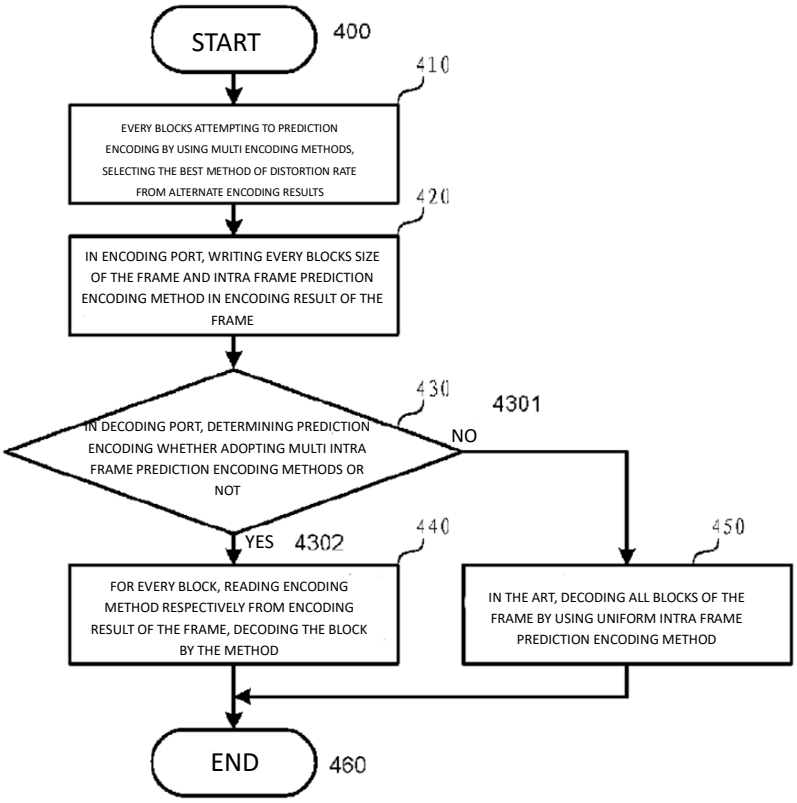

400 START
410 EVERY BLOCKS ATTEMPTING TO PREDICTION ENCODING BY USING MULTI ENCODING METHODS, SELECTING THE BEST METHOD OF DISTORTION RATE FROM ALTERNATE ENCODING RESULTS
420 IN ENCODING PORT, WRITING EVERY BLOCKS SIZE OF THE FRAME AND INTRA FRAME PREDICTION ENCODING METHOD IN ENCODING RESULT OF THE FRAME
430 IN DECODING PORT, DETERMINING PREDICTION ENCODING WHETHER ADOPTING MULTI INTRA FRAME PREDICTION ENCODING METHODS OR NOT
4301 NO
4302 YES
440 FOR EVERY BLOCK, READING ENCODING METHOD RESPECTIVELY FROM ENCODING RESULT OF THE FRAME, DECODING THE BLOCK BY THE METHOD
450 IN THE ART, DECODING ALL BLOCKS OF THE FRAME BY USING UNIFORM INTRA FRAME PREDICTION ENCODING METHOD
460 END

(57) Abstract: A method and a device for intra frame prediction encoding /decoding, which can optimize the encoding result of the intra frame encoding. Prediction encoding by at least two kinds of intra frame prediction methods in a same frame, and writing the intra frame prediction encoding method information of using to encoded result in the frame, so encoding by the most appropriate method for the different blocks. In the case of using at least two kinds of intra frame prediction methods, needing to write in correlational indicative information, in order to decoding in accurately. When decoding, reading intra frame prediction encoding method of blocks for every block in the same frame, and decoding the blocks by using the method. By organizing every blocks in hierarchy tree form, it could acquiring the optimization encoding capability while reducing the amount of information of information of intra frame prediction method of the every blocks in the encoding result.

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(57) Abstract

A method and a device for intra frame prediction encoding /decoding, which can optimize the encoding result of the intra frame encoding. Prediction encoding by at least two kinds of intra frame prediction methods in a same frame, and writing the intra frame prediction encoding method information of using to encoded result in the frame, so encoding by the most appropriate method for the different blocks. In the case of using at least two kinds of intra frame prediction methods, needing to write in correlational indicative information, in order to decoding in accurately. When decoding, reading intra frame prediction encoding method of blocks for every block in the same frame, and decoding the blocks by using the method. By organizing every blocks in hierarchy tree form, it could acquiring the optimization encoding capability while reducing the amount of information of information of intra frame prediction method of the every blocks in the encoding result.

A Method and a Device for Intra Frame Prediction Encoding/Decoding

Technical Field

The present invention relates to the field of video encoding and decoding, and particularly to a method and a device for intra frame prediction encoding/decoding.

Background Art

Since the amount of information in a video is relatively large, during video encoding, if the encoder performs intra frame encoding without relying on information from previously encoded frames of the same frame and encodes independently, the decoder can directly decode the current frame without knowing the decoded information of the previous frames. However, when adopting this method, the compression rate of intra frame encoding is very low, and the amount of encoded information is extremely large. In order to improve the compression rate of encoding, during intra frame encoding, surrounding information can be used to perform prediction for the encoding blocks; or, for inter-frame predicted frames, especially motion-compensated frames, inter-frame encoded blocks can also be used as predictive references for intra frame encoding of the current encoded frame. If a frame is encoded solely using intra frame encoding, it can serve as a starting point for a video sequence. For example, in the standard H.264/Advanced Video Coding (hereinafter referred to as AVC), an Instantaneous Decoder Refresh (IDR) picture is used as such a starting point.

A brief introduction to the intra frame prediction encoding technology of H.264/AVC is provided below. The main purpose of intra frame encoding in H.264/AVC is to reduce the spatial redundancy of images. In order to improve the efficiency of intra frame encoding in H.264/AVC, the spatial correlation of adjacent macroblocks in a given frame is fully utilized, as adjacent macroblocks usually contain similar properties. Therefore, when encoding a given macroblock, prediction can first be made based on surrounding macroblocks, and then the difference between the predicted value and the actual value is encoded. As shown in Figure 1, which is a schematic diagram of the intra frame prediction encoding method in the prior art of H.264/AVC, it can be seen from Figure 1 that this method, compared to directly encoding the frame, can significantly reduce the bit rate.

H.264/AVC supports intra frame prediction for 4x4, 8x8, and 16x16 pixel macroblocks, providing various prediction modes, including one DC prediction mode and multiple directional prediction modes. Through intra frame prediction, the spatial redundancy of images is significantly reduced, and the compression rate of encoding is improved.

In addition to the intra frame prediction encoding method of H.264/AVC, the prior art also proposes a displacement intra prediction encoding method for H.264/AVC. This method applies the concept of variable block size inter-frame prediction in H.264/AVC to intra frame prediction. Within a strip, the current block can refer to previously encoded regions through a displacement vector labeling approach. That is to say, when encoding the current block, a similar block can first be searched for within the already encoded region to serve as a candidate block. This candidate block is indicated using a displacement vector labeling method, which identifies the differences between the current block and the candidate block. Since the candidate block has been decoded prior to the current block, the decoder can obtain the current block based on the decoded information of the candidate block and the displacement vector information. As shown in Figure 2, this is a schematic diagram of the displacement intra prediction encoding method in the prior art. The method shown in Figure 2 is generally applied at the macroblock level.

Furthermore, the prior art also proposes an intra prediction encoding method using template matching. As shown in Figure 3, which is a schematic diagram of the template matching intra prediction encoding method in the prior art, in this method, self-similar regions within the predicted image area are used for intra prediction through template matching, where the predicted image area is also referred to as the object region. Specifically, the adjacent region of the predicted image area is used as a template. In an already encoded region, an iterative search is performed to find the region with pixel values most similar to that of the template. This similar region is referred to as a candidate neighboring region, and the already encoded region is also referred to as the search region. At the decoding end, the candidate neighboring region can be found from the search region. Since the pixel values of the candidate neighboring region are similar to those of the adjacent region of the object area, no additional header information is needed, and the decoding end can thus obtain the prediction of the object area. This template matching method can serve as an additional mode for H.264/AVC, and it is applicable to intra 4x4 blocks or intra 8x8 prediction blocks.

During the implementation of the present invention, the inventors discovered that the prior art has at least the following problems:

Regardless of whether it is H.264/AVC intra frame prediction encoding, displacement intra frame prediction encoding, or template matching intra frame prediction encoding, each method has its own characteristics and is suitable for certain scenarios. Different intra frame prediction techniques are applicable to different local regions of an encoded image. The intra frame prediction technique in H.264/AVC is suitable for texture image regions where the encoded block has an extended structure in the same direction as its boundary pixels. The displacement intra frame prediction technique is suitable for regions within the image that have repeating structures. The template matching technique is suitable for mode prediction when the referenced neighboring region contains similar structures. It can be seen that the encoding result obtained by using only one intra frame prediction encoding method is not optimal. However, there is currently no technology capable of combining the characteristics of these three methods to flexibly perform combined encoding.

Summary of the Invention

The technical problem to be solved by the embodiments of the present invention is to provide a method and a device for intra frame prediction encoding/decoding, which can optimize the encoding result of intra frame encoding.

To solve the above technical problem, an embodiment of the present invention provides an intra frame prediction encoding method, which comprises the following steps:

Performing prediction encoding on the same frame by using at least two kinds of intra frame prediction encoding methods;

Writing into the encoding result of the frame information indicating the intra frame prediction encoding method used for each block in the frame, wherein only one intra frame prediction encoding method is used for each block in the encoding result, and at least two encoding methods are applied in the encoding result of the frame.

An embodiment of the present invention provides an intra frame prediction decoding method, comprising the following steps:

For each block in a frame, respectively reading from the encoding result of the frame the information indicating the intra frame prediction encoding method used for the block, and decoding the block by using that method.

An embodiment of the present invention further provides an intra frame prediction encoding device, comprising:

A unit configured to perform prediction encoding on the same frame by using at least two kinds of intra frame prediction encoding methods;

A unit configured to write into the encoding result of the frame information indicating the intra frame prediction encoding method used for each block in the frame, wherein only one intra frame prediction encoding method is used for each block in the encoding result, and at least two encoding methods are applied in the encoding result of the frame.

An embodiment of the present invention provides an intra frame prediction decoding device, comprising:

At least two decoders, each decoder being used to decode one kind of intra frame prediction encoding method;

A first reading unit, configured to read from the encoding result of the frame the information indicating the intra frame prediction encoding method used for each block within the same frame, and to instruct the decoder corresponding to the intra frame prediction encoding method to decode the block.

Compared with the prior art, the embodiments of the present invention have the following main distinctions and advantageous effects:

By using at least two kinds of intra frame prediction encoding methods to perform prediction encoding on the same frame, and by writing into the encoding result the information of the intra frame prediction encoding method corresponding to each block, different blocks can be encoded using the most appropriate method. Compared with the prior art solution where only one method is used to perform intra frame encoding for all blocks within a frame, the encoding result obtained by the embodiments of the present invention is optimized in performance.

If, within the same media stream, some frames use at least two kinds of intra frame prediction encoding methods while other frames use only one intra frame prediction encoding method, it is necessary to write into the encoding result of the former frames information indicating that at least two kinds of intra frame prediction encoding methods have been used, in order to enable accurate decoding.

For frames that have used at least two kinds of intra frame prediction encoding methods, during decoding, for each block within the same frame, the information indicating the intra frame prediction encoding method used for the block is first read, and then that method is used to decode the block, thereby ensuring that each block is correctly decoded.

Information indicating the size of each block can be written into the encoding result, so that the blocks within the same frame are not limited to a fixed partitioning scheme, which is beneficial for using different intra frame prediction encoding methods to achieve improved encoding performance.

Prediction encoding can be attempted for each block using various intra frame prediction encoding methods to obtain multiple candidate encoding results. Based on predetermined performance indicators, such as rate-distortion performance, the optimal candidate encoding result can be selected as the final encoding result, thereby ensuring that the final encoding result has optimal performance.

By organizing every blocks in hierarchy tree form, it could acquiring the optimization encoding capability while reducing the amount of information of information of intra frame prediction method of the every blocks in the encoding result.

The technical solution of the embodiments of the present invention can be applied to frames in the spatial domain or frames in the frequency domain. The frequency domain includes various frequency domains generated by transformations, such as Discrete Cosine Transform (DCT), Discrete Fourier Transformation (DFT), wavelet transform, and others. Therefore, the embodiments of the present invention have a relatively broad scope of application.

Description of the Drawings

Figure 1 is a schematic diagram of the intra frame prediction encoding method of H.264/AVC in the prior art;

Figure 2 is a schematic diagram of the displacement intra frame prediction encoding method in the prior art;

Figure 3 is a schematic diagram of the template matching intra frame prediction encoding method in the prior art;

Figure 4 is a flowchart of the intra frame prediction encoding/decoding method according to the first embodiment of the present invention;

Figure 5 is a schematic diagram of macroblock partitioning in the intra frame prediction encoding/decoding method according to the first embodiment of the present invention;

Figure 6 is a flowchart illustrating a decoding example in the intra frame prediction encoding/decoding method according to the first embodiment of the present invention;

Figure 7 is a schematic diagram showing the rate-distortion performance gain brought by the intra frame prediction encoding/decoding method according to the first embodiment of the present invention;

Figure 8 is a structural diagram of the intra frame prediction encoding device according to the second embodiment of the present invention;

Figure 9 is a structural diagram of the intra frame prediction decoding device according to the second embodiment of the present invention.

Detailed Embodiments

In order to make the objectives, technical solutions, and advantages of the present invention clearer, the present invention will be further described in detail below with reference to the accompanying drawings.

In the embodiments of the present invention, at least two kinds of intra frame prediction encoding methods are used to perform prediction encoding on the same frame, and the information of the intra frame prediction encoding method corresponding to each block is written into the encoding result, so that different blocks can be encoded using the most suitable method. Compared with the prior art solution where only one method is used to perform intra frame encoding for all blocks in a frame, the technical solution of the present invention yields an encoding result with optimized performance.

The first embodiment of the present invention will now be described. The first embodiment of the present invention relates to a method for intra frame prediction encoding/decoding, as shown in Figure 4.

In step 410, for each block within the same frame, the encoding end attempts to perform prediction encoding using all available intra frame prediction encoding methods, respectively obtaining the corresponding candidate encoding results. From these candidate encoding results, the one with the best performance indicator is selected as the final encoding result for that block. This approach essentially encodes different blocks using the most suitable method. Compared with the prior art solution where only one method is used for intra frame encoding of all blocks within a frame, the encoding result obtained in this embodiment has optimized performance. The performance indicator herein may be the rate-distortion performance. The intra frame prediction encoding methods used may include the directional prediction method of H.264/AVC, the displacement intra frame prediction method, the template matching prediction method, and others.

Specifically, the block to be encoded can be the basic encoding unit—a macroblock—or a sub-block obtained by dividing a macroblock. After performing prediction encoding for each block using multiple methods and selecting the one with the best performance indicator as the final encoding result, the intra frame prediction encoding method corresponding to the final encoding result of each block is organized in a hierarchical tree structure. This arrangement reduces the amount of information needed to represent the intra frame prediction encoding method of each block in the encoding result while achieving optimal encoding performance. Taking a 16×16 macroblock as an example, a 16×16 macroblock can be hierarchically divided into four 8×8 sub-blocks, and each 8×8 sub-block can be further divided into four 4×4 sub-blocks. The encoding end performs multiple prediction encodings on the 16×16 macroblock, the 8×8 sub-blocks within the macroblock, and the 4×4 sub-blocks within the macroblock. From the combinations of candidate encoding results, the combination with the best rate-distortion performance is selected as the final encoding result of the macroblock and is organized in a hierarchical tree structure. Figure 5 is a schematic diagram of macroblock partitioning in the intra frame prediction encoding/decoding method according to the first embodiment of the present invention. An example of the encoding result of a 16×16 macroblock is shown in Figure 5. The final encoding result of the 8×8 sub-block in the upper-left corner is obtained using the displacement intra frame prediction method; the final encoding result of the 8×8 sub-block in the lower-left corner is obtained using the directional prediction method of H.264/AVC; the final encoding result of the 8×8 sub-block in the lower-right corner is obtained using the template matching prediction method; the final encoding result of the 4×4 sub-block in the upper-right corner is obtained using the displacement intra frame prediction method; and the remaining three 4×4 sub-blocks have their optimal encoding results obtained using the directional prediction method of H.264/AVC.

Of course, the macroblock here is not necessarily limited to a 16×16 macroblock; it can also be of other sizes, such as a 32×32 macroblock. Similarly, the sub-blocks do not necessarily need to be organized in a four-level hierarchical structure; other organizational forms may also be used, such as a two-level hierarchical structure. In a two-level hierarchical structure, a 16×16 macroblock can contain two 8×16 sub-blocks or two 16×8 sub-blocks.

The specific prediction encoding methods used in step 410 may refer to the prior art. For example: the directional prediction encoding method of H.264/AVC can refer to “Advanced Video Coding for Generic Audiovisual Services” (ITU-T Rec. H.264, 2005); the displacement intra frame prediction encoding method can refer to “New Intra Prediction using Intra-Macroblock Motion Compensation” (S.-L. Yu and C. Chrysafis, JVT meeting Fairfax, doc JVT-C151, May 2002); the template matching prediction encoding method can refer to “Intra Prediction by Template Matching” (T.K. Tan, C.S. Boon, and Y. Suzuki, ICIP 2006).

It should be noted that during displacement intra frame prediction, a method similar to motion compensation in inter-frame prediction is used, and the displacement vector is encoded using the motion vector encoding method of the H.264/AVC standard.

In addition, in this embodiment, the scanning order of the macroblock sub-blocks is the same as the scanning order of the sub-blocks of the P_8×8 macroblock type in H.264/AVC.

Next, in step 420, the encoding result of the frame includes information indicating the size of each block in the frame, as well as information indicating the intra frame prediction encoding method used for each block. Since the information indicating the block size is included, the blocks within the same frame are not limited to a fixed partitioning scheme, which facilitates the use of different intra frame prediction encoding methods to achieve better encoding performance.

Specifically, if multiple blocks in the frame are encoded using at least two different intra frame prediction encoding methods, with each method applied to one or more blocks in the frame, information indicating that multiple intra frame prediction encoding methods were used for prediction encoding is written into the encoding result of the frame. This allows the technical solution of the present invention to coexist with the prior art solution where only one method is used for intra frame encoding of all blocks within a frame, while still enabling the decoding end to correctly distinguish and decode.

If the root node of a branch in the hierarchical tree corresponds to a block, which may be a macroblock or a sub-block, that uses only one intra frame prediction encoding method, meaning that all sub-blocks within that macroblock or sub-block have their optimal encoding result obtained using the same intra frame prediction encoding method, or if that macroblock or sub-block is a block corresponding to a leaf node of a branch, information indicating the size of the block and the intra frame prediction encoding method used for the block is written into the encoding result of the frame. Otherwise, the subordinate branches of that branch are further processed.

It should be noted that for the displacement intra frame prediction encoding method, its displacement vector also needs to be recorded.

The storage structure of the frame represented by the syntax table is shown in Table 1 below. In this table, the macroblock type that uses multiple intra frame prediction encoding methods for prediction encoding is represented as I_EXT, and NumMbPart(I_EXT) = 1.

In Table 1, ext_intra_pred_flag indicates whether multiple intra frame prediction encoding methods are used for prediction encoding in the frame. A value of ext_intra_pred_flag equal to 1 indicates that multiple intra frame prediction encoding methods are used for prediction encoding;

ext_16x16_pred_flag equal to 1 indicates that the macroblock for this intra prediction type is partitioned as 16×16; ext_16x16_pred_flag equal to 0 indicates that the macroblock is further divided into 8×8 blocks;

ext_16x16_pred_mode indicates the intra frame prediction encoding method for a macroblock partitioned as 16×16; ext_8x8_pred_flag[ ] equal to 1 indicates prediction with an 8×8 partition, and ext_8x8_pred_flag[ ] equal to 0 indicates that the sub-block is further divided into 4×4 sub-blocks;

ext_8x8_pred_mode[ ] indicates the intra frame prediction encoding method for each sub-block partitioned as 8×8; ext_4x4_pred_mode[ ][ ] indicates the intra frame prediction encoding method for each sub-block partitioned as 4×4;

dvd[ ][ ][ ] represents the displacement vector used when the encoding method of displacement intra frame prediction (DIP) is applied.

Table 1

mb_pred(mb_type) {	C	Descriptor
ext_intra_pred_flag	2	u(1) | ae(v)
if(ext_intra_pred_flag) {		
ext_16x16_pred_flag	2	u(1) | ae(v)
if(ext_16x16_pred_flag)		
ext_16x16_pred_mode	2	ue(v) | ae(v)
if(ext_16x16_pred_mode == DIP)		
for(compIdx = 0; compIdx < 2; compIdx++)		
dvd[0][0][compIdx]	2	ue(v) | ae(v)
else {		
for(luma8x8BlkIdx=0; luma8x8BlkIdx<4; luma8x8BlkIdx++) {		
ext_8x8_pred_flag[luma8x8BlkIdx]	2	u(1) | ae(v)
if(ext_8x8_pred_flag[luma8x8BlkIdx]) {		
ext_8x8_pred_mode[luma8x8BlkIdx]	2	ue(v) | ae(v)
if(ext_8x8_pred_mode[luma8x8BlkIdx] == DIP)		
for(compIdx = 0; compIdx < 2; compIdx++)		
dvd[luma8x8BlkIdx][0][compIdx]	2	ue(v) | ae(v)
} else {		
noSubMbPartSizeLessThan8x8Flag = 0		
for(luma4x4BlkIdx=0; luma4x4BlkIdx<4; luma4x4BlkIdx++) {		
ext_4x4_pred_mode[luma8x8BlkIdx][luma4x4BlkIdx]	2	ue(v) | ae(v)
if(ext_4x4_pred_mode[luma8x8BlkIdx][luma4x4BlkIdx] == DIP)		
for(compIdx = 0; compIdx < 2; compIdx++)		
dvd[luma8x8BlkIdx][luma4x4BlkIdx][compIdx]	2	ue(v) | ae(v)
}		
}		
}		
}		
} else {		
…		

In addition, ae(v): a syntax element encoded using context-based adaptive binary arithmetic coding;

u(n): an n-bit unsigned integer. In the syntax table, if n is “V”, the number of bits is determined by the value of other syntax elements. The parsing process is defined by the return value of the function read_bits(n), and this return value is expressed in binary with the most significant bit first.

ue(v): an unsigned integer syntax element encoded using Exp-Golomb coding.

Next, in step 430, at the decoding end, it is first determined whether multiple intra frame prediction encoding methods were used for prediction encoding of the frame. If information indicating that at least two intra frame prediction encoding methods were used is read from the encoding result of the frame, the process proceeds to step 440. Otherwise, it proceeds to step 450, where all blocks in the frame are decoded using a uniform intra frame prediction encoding method according to the prior art.

In step 440, the decoding end reads the encoding result of the frame and sequentially searches for the information indicating block size. Based on the information indicating block size and the intra frame prediction encoding method used for each block, decoding is performed. Since the blocks contained within the frame are organized in a hierarchical tree structure, if information indicating block size is read from the encoding result of the frame, and the block includes either a macroblock or a sub-block, this indicates that the block of that size uses the same intra frame prediction encoding method. The information indicating the intra frame prediction encoding method used for that block is further read, and decoding is performed on the block of that size using the corresponding method.

Next, an example is provided based on the encoding structure of Table 1. As shown in Figure 6, which is a decoding example flowchart of the intra frame prediction encoding/decoding method according to the first embodiment of the present invention, the decoding end first determines whether the current code stream has used multiple intra frame prediction encoding methods for prediction encoding by parsing the ext_intra_pred_flag indicator bit. If not, all blocks of the frame are decoded using a uniform intra frame prediction encoding method according to the prior art, for example, decoding according to the H.264/AVC standard. If multiple methods were used, the process continues by determining the intra macroblock partitioning condition based on the ext_16x16_pred_flag indicator bit.

If ext_16x16_pred_flag equals 1, this indicates that the macroblock is partitioned as 16×16. The ext_16x16_pred_mode is then parsed to obtain the encoding method of the current block. The decoding method corresponding to this encoding method is used to decode the 16×16 macroblock. If the encoding method of the current block is the displacement intra frame prediction encoding method, the displacement vector dvd must also be parsed from the code stream, and decoding is performed using the corresponding decoding method. If ext_16x16_pred_flag equals 0, this indicates that the 16×16 macroblock is divided into 8×8 blocks, and further parsing of each 8×8 block of the macroblock is required.

For each 8×8 block, based on its ext_8x8_pred_flag, if ext_8x8_pred_flag equals 1, the intra frame prediction encoding method ext_8x8_pred_mode of the 8×8 block is parsed from the code stream. The corresponding decoding method is then selected based on the encoding method to perform decoding. If the encoding method of the current block is the displacement intra frame prediction encoding method, the displacement vector dvd of each 8×8 block must also be parsed from the code stream, and decoding is performed using the corresponding decoding method. If ext_8x8_pred_flag equals 0, this indicates that the current block is further divided into 4×4 sub-blocks, and the intra frame prediction encoding method ext_4x4_pred_mode of each 4×4 block is parsed.

For each 4×4 block, its intra frame prediction encoding method ext_4x4_pred_mode is parsed, and the corresponding decoding method is selected based on the encoding method to perform decoding. If the encoding method of the current block is the displacement intra frame prediction encoding method, the displacement vector dvd of each 4×4 block must also be parsed from the code stream, and decoding is performed using the corresponding decoding method.

Figure 7 illustrates the rate-distortion performance gain achieved by using the intra frame prediction encoding/decoding method of this embodiment.

It is worth mentioning that the frame referred to in this embodiment can be either a spatial domain frame or a frequency domain frame. The frequency domain includes various frequency domains generated by transformations, such as DCT, DFT, and wavelet transform. Therefore, this embodiment has a relatively broad application scope.

The second embodiment of the present invention relates to an intra frame prediction encoding device. As shown in Figure 8, which is a structural diagram of the intra frame prediction encoding device according to the second embodiment of the present invention, the device comprises: an encoding unit configured to perform prediction encoding on the same frame using at least two kinds of intra frame prediction encoding methods, wherein each method is applied to at least one block within the frame. Using multiple intra frame prediction encoding methods for prediction encoding makes it possible to encode different blocks using the most suitable method. Compared with the prior art solution that uses only one method to perform intra frame encoding for all blocks within a frame, the encoding result obtained by this encoding device has optimized performance. The encoding unit further comprises: at least two encoders, each encoder being used to perform prediction encoding for each block using one kind of intra frame prediction encoding method; and a selector configured to select, from the candidate encoding results output by the encoders, the one with the best rate-distortion performance as the final encoding result of the block, thereby ensuring that the final encoding result achieves optimal performance. The intra frame prediction encoding device further includes a writing unit configured to write into the encoding result of the frame the information indicating the intra frame prediction encoding method used for each block in the frame and the information indicating the size of each block. By writing the information indicating the size of each block into the encoding result, the blocks within the same frame are not limited to a fixed partitioning scheme, which facilitates the use of different intra frame prediction encoding methods to achieve improved encoding performance. If, within the same media stream, some frames use at least two kinds of intra frame prediction encoding methods while other frames use only one intra frame prediction encoding method, when at least two kinds of intra frame prediction encoding methods are used for prediction encoding in a frame, the writing unit writes into the encoding result of that frame information indicating that at least two kinds of intra frame prediction encoding methods have been used for prediction encoding, in order to enable accurate decoding. Wherein, the aforementioned frame can be a frame in the spatial domain or in the frequency domain, the performance indicator can be the rate-distortion performance, and the intra frame prediction encoding methods at least include: directional prediction method, displacement intra frame prediction method, and template matching prediction method.

In addition, the writing unit can also organize the blocks in a hierarchical tree structure, thereby reducing the amount of information representing the intra frame prediction encoding method for each block in the encoding result while achieving optimal encoding performance.

The third embodiment of the present invention relates to an intra frame prediction decoding device. As shown in Figure 9, which is a structural diagram of the intra frame prediction decoding device according to the second embodiment of the present invention, this embodiment of the intra frame prediction decoding device comprises:

A decoding unit, which includes at least two decoders, each decoder being used to decode one intra frame prediction encoding method;

A first reading unit, configured to read, for each block within the same frame, from the encoding result of the frame, the information indicating the intra frame prediction encoding method used for that block, and to instruct the decoder corresponding to that intra frame prediction encoding method to decode the block;

A second reading unit, configured to attempt to read from the encoding result of the frame the information indicating that at least two intra frame prediction encoding methods were used for prediction encoding of the frame. If information indicating that at least two intra frame prediction encoding methods were used for prediction encoding is read, the second reading unit instructs the first reading unit and each decoder to respectively decode each block within the frame. Otherwise, it instructs one of the decoders to decode all blocks within the frame using a uniform intra frame prediction encoding method.

The frame herein can likewise be a frame in the spatial domain or in the frequency domain. The frequency domain includes various frequency domains generated by transformations, such as DCT, DFT, and wavelet transform. Therefore, the application scope of this embodiment is relatively broad.

The intra frame prediction encoding methods at least include: directional prediction method, displacement intra frame prediction method, and template matching prediction method.

It should be noted that the units in the above two device embodiments are all logical units. In practical applications, they can have different physical implementation forms.

In summary, in the embodiments of the present invention, at least two kinds of intra frame prediction encoding methods are used to perform prediction encoding on the same frame, and the information of the intra frame prediction encoding method corresponding to each block is written into the encoding result, so that different blocks can be encoded using the most suitable method. Compared with the prior art solution where only one method is used to perform intra frame encoding for all blocks in a frame, the technical solution of the present invention yields an encoding result with optimized performance.

If, within the same media stream, some frames use at least two kinds of intra frame prediction encoding methods while other frames use only one intra frame prediction encoding method, it is necessary to write into the encoding result of the former frames information indicating that at least two kinds of intra frame prediction encoding methods have been used, in order to enable accurate decoding.

For frames that have used at least two kinds of intra frame prediction encoding methods, during decoding, for each block within the same frame, the information indicating the intra frame prediction encoding method used for the block is first read, and then that method is used to decode the block, thereby ensuring that each block is correctly decoded.

Information indicating the size of each block can be written into the encoding result, so that the blocks within the same frame are not limited to a fixed partitioning scheme, which is beneficial for using different intra frame prediction encoding methods to achieve improved encoding performance.

Prediction encoding can be attempted for each block using various intra frame prediction encoding methods to obtain multiple candidate encoding results. Based on predetermined performance indicators, such as rate-distortion performance, the optimal candidate encoding result can be selected as the final encoding result, thereby ensuring that the final encoding result has optimal performance.

By organizing every blocks in hierarchy tree form, it could acquiring the optimization encoding capability while reducing the amount of information of information of intra frame prediction method of the every blocks in the encoding result.

The technical solution of the present invention can be applied to frames in the spatial domain or frames in the frequency domain. The frequency domain includes various frequency domains generated by transformations, such as DCT, DFT, and wavelet transform. Therefore, the application scope of the present invention is relatively broad.

Finally, it should be noted that the above embodiments are provided solely to illustrate the technical solution of the present invention and are not intended to limit it. Although the present invention has been described in detail with reference to preferred embodiments, those of ordinary skill in the art should understand that modifications or equivalent substitutions can be made to the technical solution of the present invention without departing from the spirit and scope of the technical solution of the present invention.

Claims

1. An intra frame prediction encoding method, characterized in that it comprises the following steps:

   Performing prediction encoding on the same frame by using at least two kinds of intra frame prediction encoding methods;

   Writing into the encoding result of the frame information indicating the intra frame prediction encoding method used for each block in the frame, wherein only one intra frame prediction encoding method is used for each block in the encoding result, and at least two encoding methods are applied in the encoding result of the frame.

2. The intra frame prediction encoding method according to claim 1, characterized in that it further comprises the following step:

   Writing into the encoding result of the frame information indicating that at least two intra frame prediction encoding methods were used for prediction encoding of the frame.

3. The intra frame prediction encoding method according to claim 1, characterized in that it further comprises writing into the encoding result of the frame information indicating the size of each block.

4. The intra frame prediction encoding method according to claim 1, characterized in that at least two intra frame prediction encoding methods are used for prediction encoding on the same frame by:

   For each block in the frame, attempting to perform prediction encoding using all available intra frame prediction encoding methods to obtain at least two candidate encoding results for the block, and selecting from the candidate encoding results the one with the best performance indicator as the final encoding result of the block.

5. The intra frame prediction encoding method according to claim 4, characterized in that the performance indicator is the rate-distortion performance.

6. The intra frame prediction encoding method according to any one of claims 1 to 5, characterized in that the intra frame prediction encoding methods include:

   Directional prediction method, displacement intra frame prediction method, and template matching prediction method.

7. The intra frame prediction encoding method according to any one of claims 1 to 5, characterized in that the frame is a frame in the spatial domain or in the frequency domain.

8. The intra frame prediction encoding method according to any one of claims 1 to 5, characterized in that the blocks are organized in a hierarchical tree structure;

If the block corresponding to the root node of a branch in the hierarchical tree uses only one intra frame prediction encoding method, information indicating the size of the block and information indicating the intra frame prediction encoding method used for the block is written into the encoding result of the frame; otherwise, the subordinate branches of that branch are further processed.

9. An intra frame prediction decoding method, characterized in that it comprises the following steps:

   For each block in a frame, respectively reading from the encoding result of the frame the information indicating the intra frame prediction encoding method used for the block, and decoding the block by using that method.

10. The intra frame prediction decoding method according to claim 9, characterized in that it further comprises the following step:

    Before decoding the frame, if information indicating that at least two intra frame prediction encoding methods were used for prediction encoding of the frame is read from the encoding result of the frame, each block in the frame is decoded using the intra frame prediction encoding method corresponding to that block; otherwise, all blocks in the frame are decoded using a uniform intra frame prediction encoding method.

11. The intra frame prediction decoding method according to claim 9, characterized in that the blocks are organized in a hierarchical tree structure;

    If information indicating the block size is read from the encoding result of the frame, information indicating the intra frame prediction encoding method used for that block is further read, and decoding is performed on the block of that size using the corresponding method.

12. The intra frame prediction decoding method according to claim 9, characterized in that the intra frame prediction encoding methods include:

    Directional prediction method, displacement intra frame prediction method, and template matching prediction method.

13. The intra frame prediction decoding method according to claim 9, characterized in that the frame is a frame in the spatial domain or in the frequency domain.

14. An intra frame prediction encoding device, characterized in that it comprises:

    A unit configured to perform prediction encoding on the same frame by using at least two kinds of intra frame prediction encoding methods;

    A unit configured to write into the encoding result of the frame information indicating the intra frame prediction encoding method used for each block in the frame, wherein only one intra frame prediction encoding method is used for each block in the encoding result, and at least two encoding methods are applied in the encoding result of the frame.

15. The intra frame prediction encoding device according to claim 14, characterized in that it further comprises a unit configured to write into the encoding result of the frame information indicating that at least two intra frame prediction encoding methods were used for prediction encoding of the frame.

16. The intra frame prediction encoding device according to claim 14, characterized in that it further comprises a unit configured to write into the encoding result of the frame information indicating the size of each block.

17. The intra frame prediction encoding device according to claim 14, characterized in that the unit configured to perform prediction encoding on the same frame using at least two intra frame prediction encoding methods further comprises:

    At least two encoders, each encoder being used to perform prediction encoding for each block using one intra frame prediction encoding method;

    A selector configured to select, from the candidate encoding results output by the encoders, the one with the best rate-distortion performance as the final encoding result of the block.

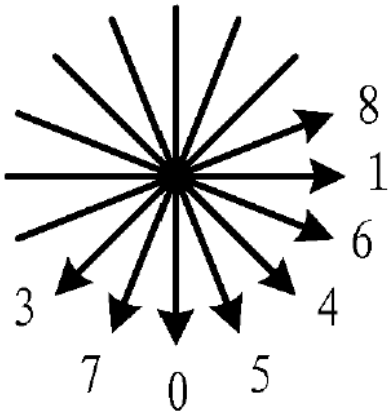
18. An intra frame prediction decoding device, characterized in that it comprises:

    At least two decoders, each decoder being used to decode one kind of intra frame prediction encoding method;

    A first reading unit, configured to read from the encoding result of the frame the information indicating the intra frame prediction encoding method used for each block within the same frame, and to instruct the decoder corresponding to the intra frame prediction encoding method to decode the block.

19. The intra frame prediction decoding device according to claim 18, characterized in that it further comprises:

    A second reading unit, configured to attempt to read from the encoding result of the frame information indicating that at least two intra frame prediction encoding methods were used for prediction encoding of the frame. If information indicating that at least two intra frame prediction encoding methods were used for prediction encoding is read, the second reading unit instructs the first reading unit and each decoder to respectively decode each block within the frame; otherwise, it instructs one of the decoders to decode all blocks within the frame using a uniform intra frame prediction encoding method.


8
1
6
3
4
7
0
5

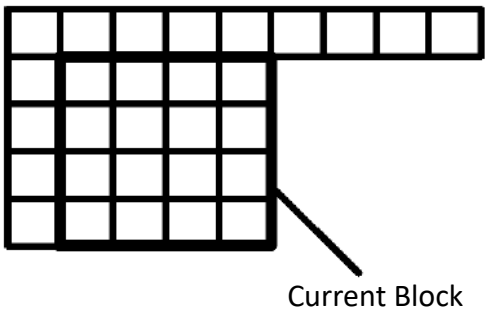

Current Block

Fig. 1

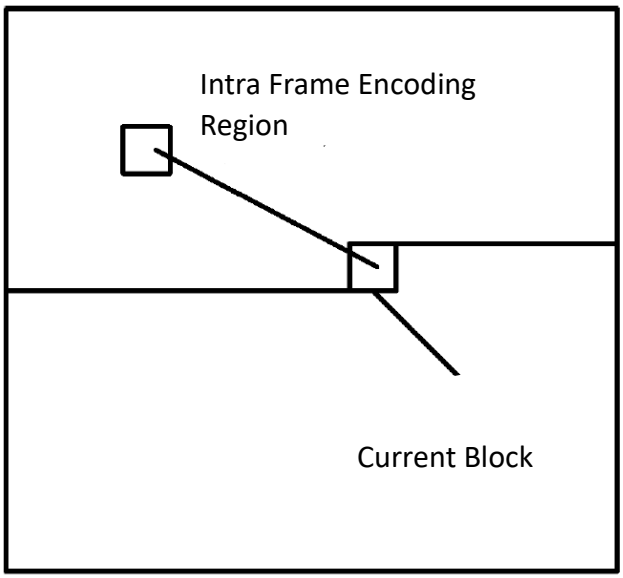

Intra Frame Encoding
Region
Current Block

Fig. 2

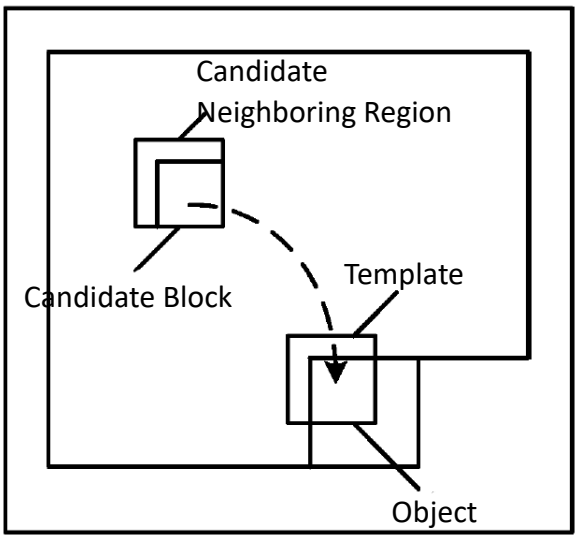

Candidate
Neighboring Region
Candidate Block
Template
Object

Fig. 3

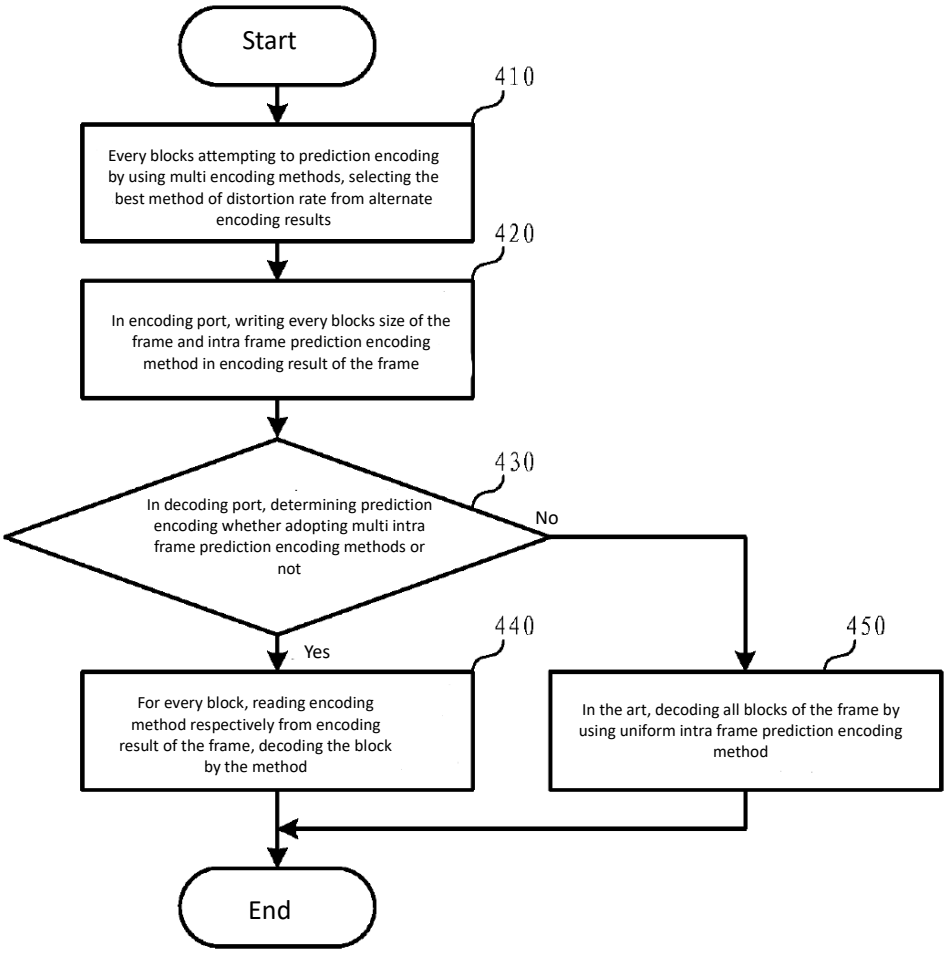

Start
410
Every blocks attempting to prediction encoding by using multi encoding methods, selecting the best method of distortion rate from alternate encoding results
420
In encoding port, writing every blocks size of the frame and intra frame prediction encoding method in encoding result of the frame
430
In decoding port, determining prediction encoding whether adopting multi intra frame prediction encoding methods or not
No
Yes
440
For every block, reading encoding method respectively from encoding result of the frame, decoding the block by the method
450
In the art, decoding all blocks of the frame by using uniform intra frame prediction encoding method
End

Fig. 4

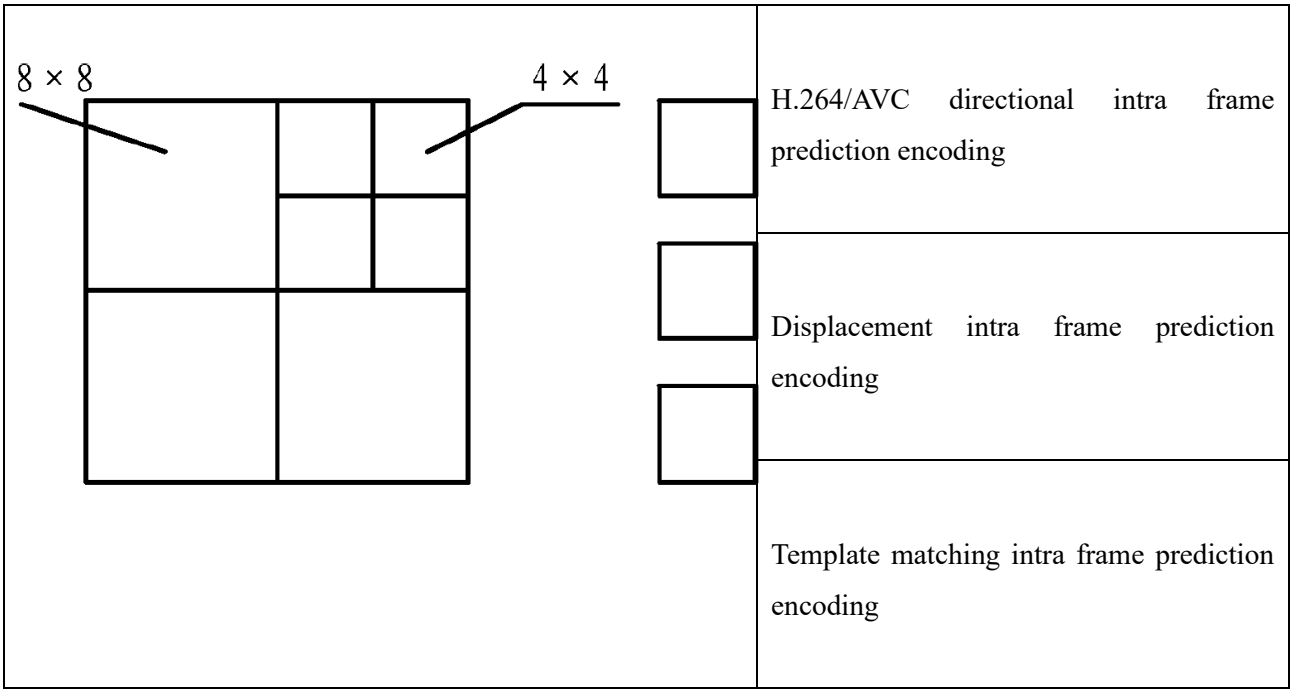

8 × 8
4 × 4
H.264/AVC directional intra frame prediction encoding
Displacement intra frame prediction encoding
Template matching intra frame prediction encoding

Fig. 5

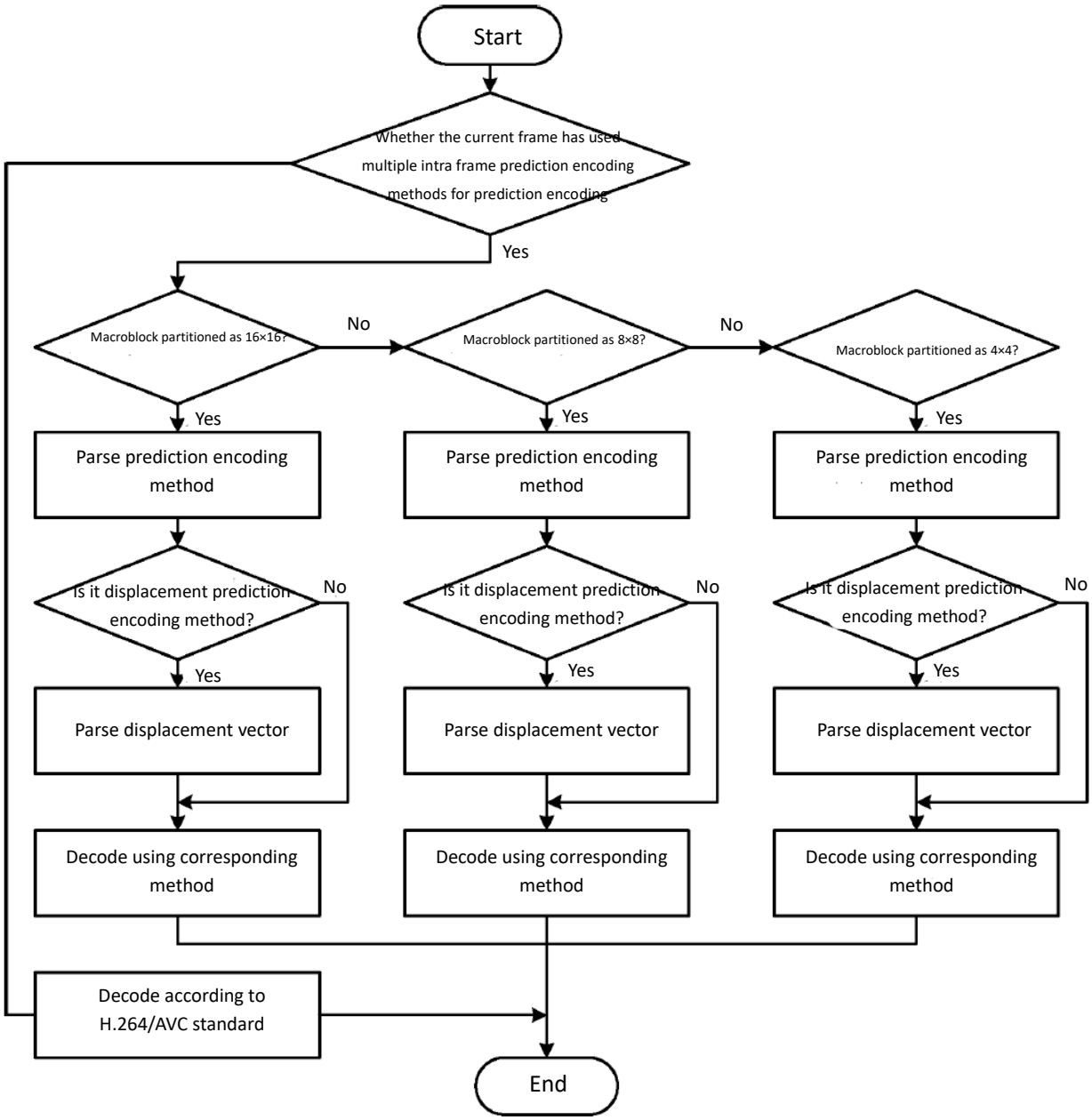

Start
Whether the current frame has used multiple intra frame prediction encoding methods for prediction encoding
Yes
Macroblock partitioned as 16×16?
No
Macroblock partitioned as 8×8?
No
Macroblock partitioned as 4×4?
Yes
Yes
Yes
Parse prediction encoding method
Parse prediction encoding method
Parse prediction encoding method
Is it displacement prediction encoding method?
No
Is it displacement prediction encoding method?
No
Is it displacement prediction encoding method?
No
Yes
Yes
Yes
Parse displacement vector
Parse displacement vector
Parse displacement vector
Decode using corresponding method
Decode using corresponding method
Decode using corresponding method
Decode according to H.264/AVC standard
End

Fig. 6

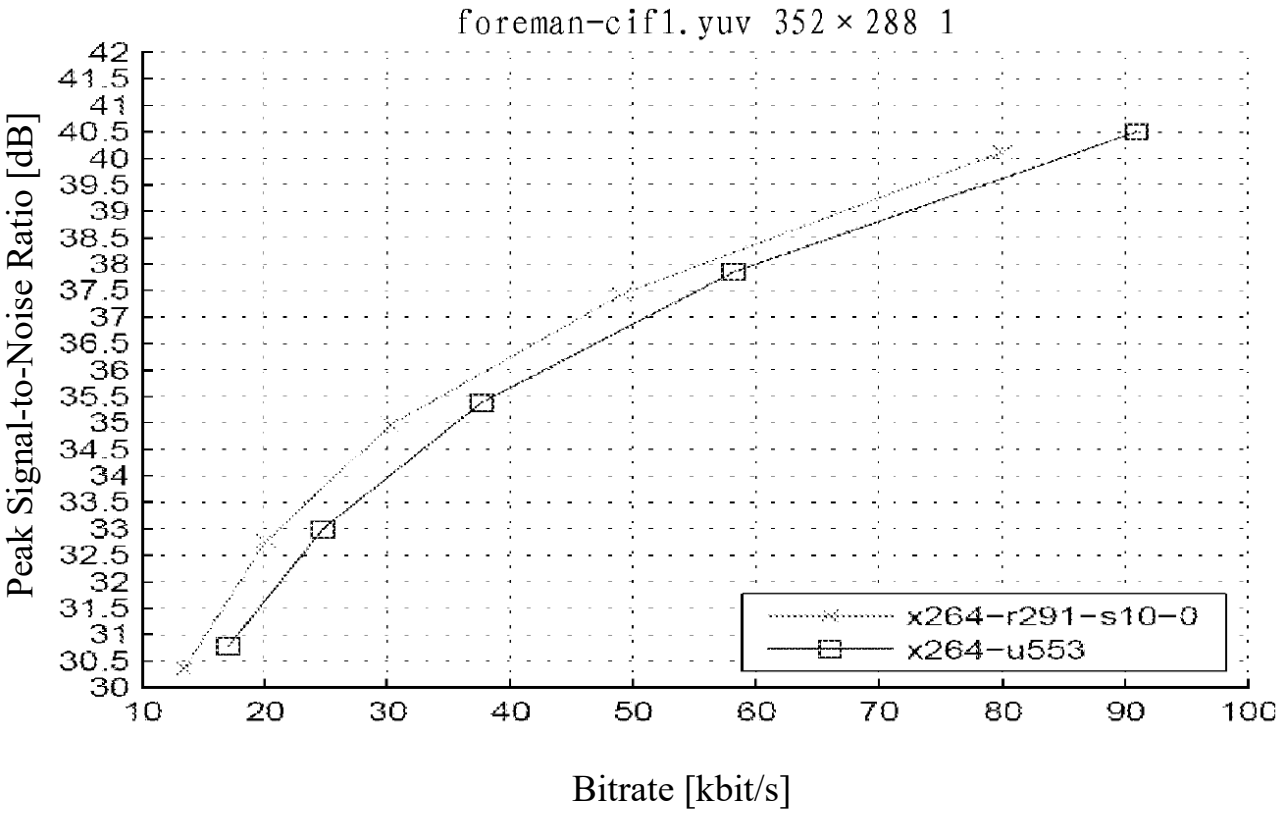

foreman-cif1.yuv 352 × 288 1
Peak Signal-to-Noise Ratio [dB]
Bitrate [kbit/s]
x264-r291-s10-0
x264-u553

Fig. 7

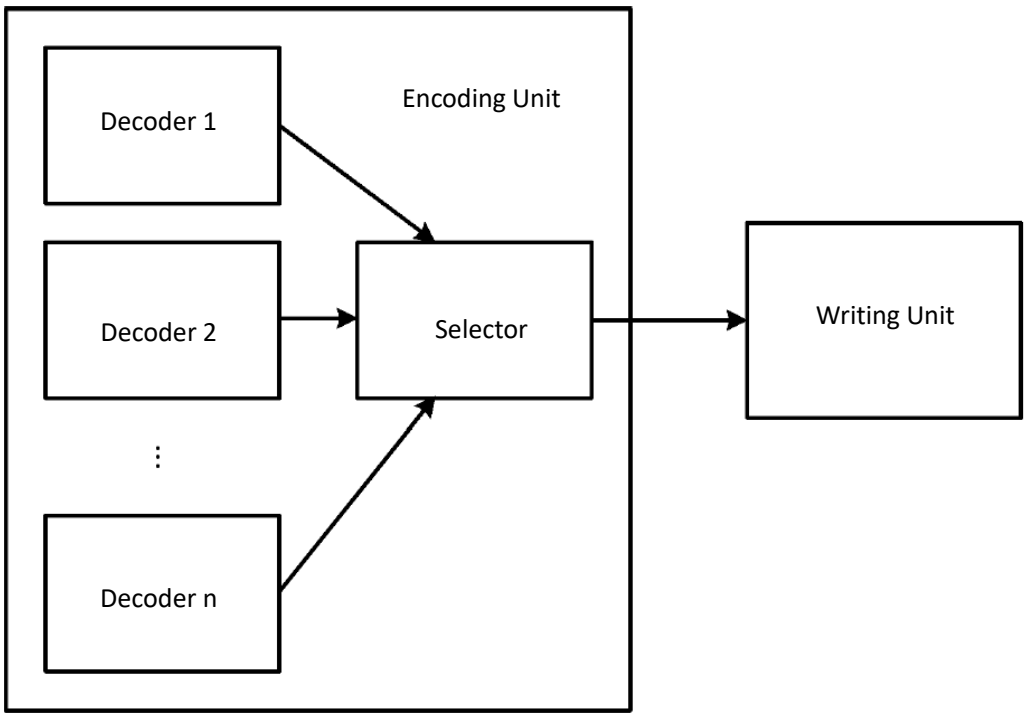

Encoding Unit
Decoder 1
Decoder 2
Decoder n
Selector
Writing Unit

Fig. 8

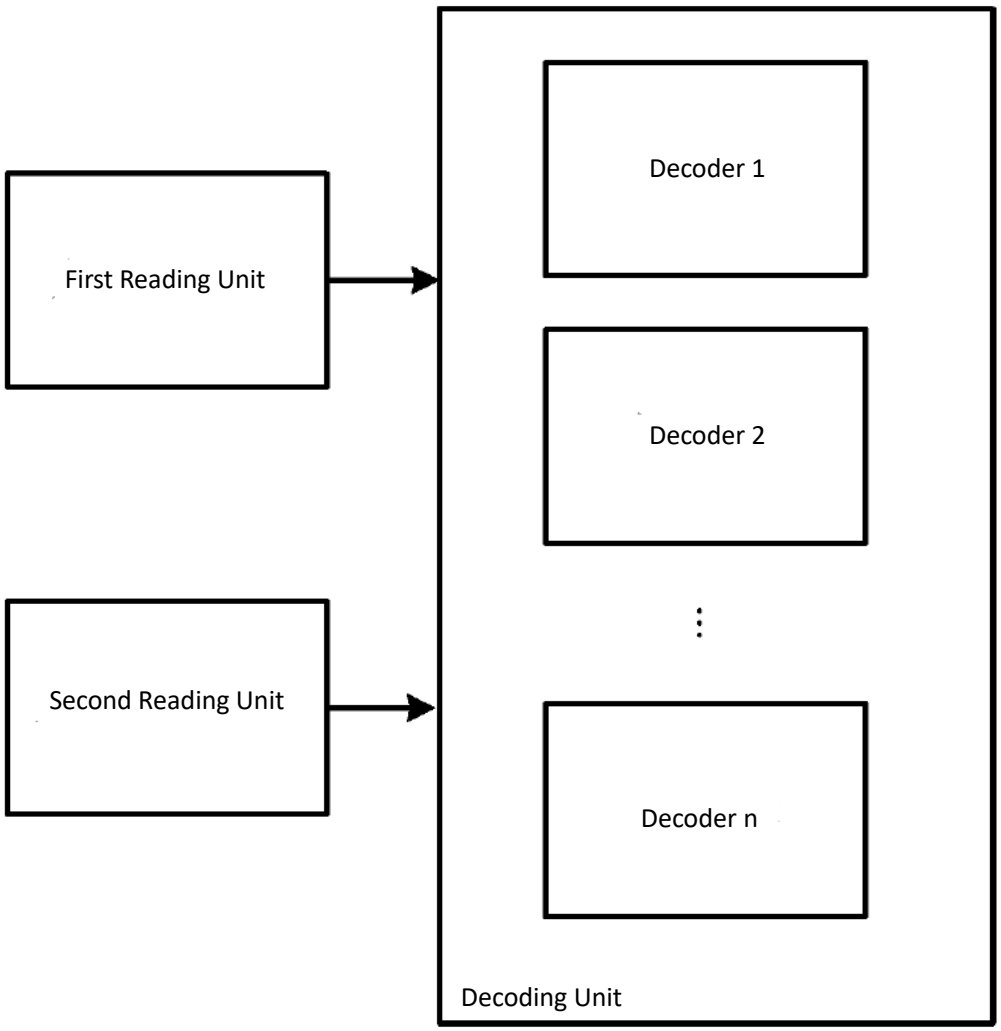

First Reading Unit
Second Reading Unit
Decoder 1
Decoder 2
Decoder n
Decoding Unit

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2008/070092

A. CLASSIFICATION OF SUBJECT MATTER

H04N 7/32 (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)

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

IPC: H04N 7/-

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

WPI; EPODOC; PAJ: FRAME, INTRA, PREDICTION, ENCODE, DECODE, VIDEO, MACRO BLOCK, PIXEL, ADAPT+, SELECT, H.264, AVC, HIBRID

CNPAT:

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN1794816A (NEC CORP) 28 June 2006 (28.06.2006) description page 8 line 16-line 28, figure 3	1-7, 9-19
Y		8
Y	JP1080186A (FUJITSU LTD) 27 March 1989 (27.03.1989) description page 5 top right corner line 20 – page 7 top left corner line 2, figure 5	8
A	CN1476253A (UNIV QINGHUA) 18 February 2004 (18.02.2004) the whole document	1-19

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

* Special categories of cited documents:

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 April 2008 (09.04.2008)	**24 Apr. 2008 (24.04.2008)**
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 WU Shuang Telephone No. (86-10)62411507

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2008/070092

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN1794816A	28.06.2006	EP1675404A2	28.06.2006
		US2006133489A1	22.06.2006
		JP2006180195A	06.07.2006
		KR20060071894A	27.06.2006
JP1080186A	27.03.1989	JP2716703B2	18.02.1998
CN1476253A	18.02.2004	None	

International Search Report	International Application No. **PCT/CN2008/070092**

A. Classification of Subject Matter
H04N 7/32 (2006.01) i
According to the International Patent Classification (IPC) or both national classification and IPC classifications

B. Fields Searched

Minimum documentation searched (indicating classification system and classification symbols)
IPC: H04N 7/-

Documentation searched other than the minimum documentation to the extent that it is included in the search field

Electronic databases consulted during the international search (name of database and search terms used, if any)
WPI; EPODOC; PAJ: FRAME, INTRA, PREDICTION, ENCODE, DECODE, VIDEO, MACRO BLOCK, PIXEL, ADAPT+, SELECT, H.264, AVC, HIBRID
CNPAT: intra frame, prediction, encoding, decoding, video, macroblock, pixel, adaptive, selection, H.264, AVC, hybrid

C. Relevant Documents

Type*	Cited document, with relevant paragraphs indicated if necessary	Relevant claims
X	CN1794816A (NEC Corporation) June 28, 2006 (06/28/2006), Specification page 8, lines 16–28, Figure 3	1-7, 9-19
Y		8
Y	JP1080186A (Fujitsu Limited) March 27, 1989 (03/27/1989), Specification page 5, right upper column, line 20 to page 7, left upper column, line 2, Figure 5	8
A	CN1476253A (Tsinghua University) February 18, 2004 (02/18/2004), Full text	1-19

□ The remaining documents are listed on the continuation sheet of section C. ☒ See attached family patent.

*Specific types of cited documents:

"A"	A document considered not particularly relevant but representing the general state of the prior art	"T"	A document published after the filing date or priority date, which does not conflict with the application but is cited to help understand the theory or principle of the invention
"E"	A prior application or patent published on or after the international filing date	"X"	A particularly relevant document, which, when considered alone, renders the claimed invention not novel or lacking inventive step
"L"	A document that may call into question the priority claim, is cited to determine the publication date of another cited document, or is cited for other special reasons	"Y"	A particularly relevant document, which, when combined with one or more other such documents, renders the claimed invention lacking inventive step as it would be obvious to a person skilled in the art
"O"	A document relating to oral disclosure, use, exhibition, or other means of making information available to the public		
"P"	A document with a publication date prior to the international filing date but later than the claimed priority date	"&"	A document from the same patent family

Date of Actual Completion of the International Search	Date of Mailing of the International Search Report
April 9, 2008 (04/09/2008)	**April 24, 2008 (04/24/2008)**
China National Intellectual Property Administration (ISA/CN) No. 6 Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China Fax Number : (86-10) 62019451	Authorized Officer WU Shuang Telephone Number: (86-10) 62411507

International Search Report
Information on Patent Families

International Application No.
PCT/CN2008/070092

Patent Documents Cited in the Search Report	Publication Date	Family Patent	Publication Date
CN1794816A	06/28/2006	EP1675404A2	06/28/2006
		US2006133489A1	06/22/2006
		JP2006180195A	07/06/2006
		KR20060071894A	06/27/2006
JP1080186A	03/27/1989	JP2716703B2	02/18/1998
CN1476253A	02/18/2004	None	

PCT/ISA/210 Form (Patent Family Attachment) (April 2007)