(19) DANMARK

(10) **DK/EP 4120685 T3**

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: ***H 04 N 19/52 (2014.01)*** ***H 04 N 19/61 (2014.01)***

(45) Oversættelsen bekendtgjort den: **2024-10-28**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2024-10-02**

(86) Europæisk ansøgning nr.: **22194608.0**

(86) Europæisk indleveringsdag: **2011-12-20**

(87) Den europæiske ansøgnings publiceringsdag: **2023-01-18**

(30) Prioritet: **2011-01-07 JP 2011002205**

(62) Stamansøgningsnr: **20217808.3**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

(73) Patenthaver: **NTT DOCOMO, INC., 11-1 Nagatacho 2-chome, Chiyoda-Ku, Tokyo 100-6150, Japan**

(72) Opfinder: **FUJIBAYASHI, Akira, , Tokyo, 100-6150, Japan**
SUZUKI, Yoshinori, , Tokyo, 100-6150, Japan
Boon, Choong Seng, , Tokyo, 100-6150, Japan

(74) Fuldmægtig i Danmark: **Plougmann Vingtoft A/S, Strandvejen 70, 2900 Hellerup, Danmark**

(54) Benævnelse: **FORUDSIGELSESKODNINGSFREMGANGSMÅDE, FORUDSIGELSESKODNINGSINDRETNING OG FORUDSIGELSESKODNINGSPROGRAM AF BEVÆGELSESVEKTOR, OG FORUDSIGELSESAFKODNINGSFREMGANGSMÅDE, FORUDSIGELSESAFKODNINGSINDRETNING OG FORUDSIGELSESAFKODNINGSPROGRAM AF BEVÆGELSESVEKTOR**

(56) Fremdragne publikationer:

AMONOU (FT) I ET AL: "Video coding technology proposal by France Telecom, NTT, NTT DoCoMo, Panasonic and Technicolor", 1. JCT-VC MEETING; 15-4-2010 - 23-4-2010; DRESDEN; (JOINTCOLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11 AND ITU-TSG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/,, no. JCTVC-A114, 7 May 2010 (2010-05-07), XP030007553, ISSN: 0000-0049
BOSSEN F ET AL: "Simplified motion vector coding method", 2. JCT-VC MEETING; 21-7-2010 - 28-7-2010; GENEVA; (JOINT COLLABORATIVETEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11 AND ITU-T SG.16); URL:HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/,, no. JCTVC-B094, 17 July 2010 (2010-07-17), XP030007674, ISSN: 0000-0046
JIAN-LIANG LIN ET AL: "Motion vector coding techniques for HEVC", MULTIMEDIA SIGNAL PROCESSING (MMSP), 2011 IEEE 13TH INTERNATIONAL WORKSHOP ON, IEEE, 17 October 2011 (2011-10-17), pages 1 - 6, XP032027557, ISBN: 978-1-4577-1432-0, DOI: 10.1109/MMSP.2011.6093817
J-L LIN ET AL: "Improved Advanced Motion Vector Prediction", 4. JCT-VC MEETING; 95. MPEG MEETING; 20-1-2011 - 28-1-2011; DAEGU;(JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/,, no. JCTVC-D125, 15 January 2011 (2011-01-15), XP030008165, ISSN: 0000-0015
FUJIBAYASHI (NTT DOCOMO) A ET AL: "CE9: 3.2d Simplified motion vector prediction", 4. JCT-VC MEETING;

Fortsættes ...

95. MPEG MEETING; 20-1-2011 - 28-1-2011; DAEGU;(JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IEC JTC1/SC29/WG11AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/,, no. JCTVC-D231, 15 January 2011 (2011-01-15), XP030008271, ISSN: 0000-0013
WIEGAND T ET AL: "High Efficiency Video Coding (HEVC) text specification Working Draft 1", 3. JCT-VC MEETING; 95. MPEG MEETING; 7-10-2010 - 15-10-2010;GUANGZHOU; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IECJTC1/SC29/WG11 AND ITU-T SG.16); URL: HTTP://WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/,, no. JCTVC-C403, 6 January 2011 (2011-01-06), XP030008032, ISSN: 0000-0018

DESCRIPTION

Description

Technical Field

[0001] Embodiments of the present invention relate to a predictive decoding method.

Background Art

[0002] Motion compensated prediction technology is occasionally used in video encoding and video decoding. In the motion compensation technology, a frame of a processing target in a video sequence is divided into a plurality of partitions. These partitions are sequentially selected as a partition of a processing target (target partition). A motion vector is then determined for the target partition. In the motion compensated prediction technology, a motion vector predictor is determined using motion vectors of neighboring partitions to the target partition and the motion vector of the target partition is predictively encoded or predictively decoded in some cases.

[0003] Figs. 1A and 1B are drawings to illustrate rectangular neighboring partitions used in the motion compensated prediction. In Fig. 1A, the shape of target partition BT is identical to the shape of neighboring partitions BL, BA, and BRA. The left-neighboring partition BL includes a neighboring pixel existing on the left side of the top left pixel in the target partition BT; the above-neighboring partition BA includes a neighboring pixel existing above the top left pixel in the target partition BT; the above-right-neighboring partition BRA includes a neighboring pixel existing above and on the right side of the top right pixel in the target partition BT. The conventional technology H.264/AVC employs a motion vector predictor having median values of horizontal components and vertical components of motion vectors of the left-neighboring partition BL, the above-neighboring partition BA, and the above-right-neighboring partition BRA.

[0004] On the other hand, Fig. 1B illustrates a case where there are a plurality of neighboring partitions having respective shapes different from the shape of the target partition BT. The plurality of neighboring partitions in Fig. 1B include neighboring partitions BL1, BL2, BA1, BA2, BD, and BE, in addition to the left-neighboring partition BL, the above-neighboring partition BA, and the above-right-neighboring partition BRA. According to the technology described in Patent Literature 1, the plurality of neighboring partitions are scanned in a predetermined spatial order to specify a neighboring partition with the best spatial similarity to a pixel signal of the target partition, and a motion vector of the neighboring partition thus specified is used as a motion vector predictor. In the technology of Patent Literature 1, the spatial similarity to be used is the sum of absolute differences (SAD) between the pixel signal of the target partition and the pixel signal of the neighboring partition.

Citation List

Patent Literature

[0005] Patent Literature 1: Japanese Translation of PCT Application Laid-open No. 2010-515399

Non-Patent Literature

[0006] Non-Patent Literature 1: WIEGAND T ET AL: "High Efficiency Video Coding (HEVC) text specification Working Draft 1", 3. JCT-VC MEETING; 95. MPEG MEETING; 7-10-2010 - 15-10-2010; GUANGZHOU; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IECJTC1/SC29/WG11 AND ITU-TSG16); URL: HTTP:// WFTP3.ITU.INT/AV-ARCH/JCTVC-SITE/,, no. JCTVC-C403, 6 January 2011 (2011-01-06), XP030008032, ISSN: 0000-0018.

Summary of Invention

Technical Problem

[0007] Since the foregoing technology of Patent Literature 1 involves calculating the spatial similarity while scanning the plurality of neighboring partitions in the predetermined order, it requires a considerable number of calculations for determination of the motion vector predictor.

[0008] The foregoing technology of Non-Patent Literature 1 involves a derivation process for motion vector predictor candidates. Motion vector predictor candidates are determined from motion vectors of partitions belonging to a neighboring region located on the left side of the target partition and from motion vectors of partitions belonging to a neighboring region located above the target partition, whereby the partitions belonging to the neighboring region located above the target partition are scanned from left to right. A motion vector predictor indication information is restored that specifies an optimum vector predictor of the target partition.

[0009] There are demands for reduction in computational complexity necessary for the determination of the motion vector predictor in the technical fields concerned.

Solution to Problem

[0010] The present invention relates to a predictive decoding technology of motion vectors.

[0011] A method for predictively decoding a motion vector is defined in claim 1.

[0012] The predictive decoding technology may be configured as follows: one or more partitions in a left-neighboring region are scanned in an upward direction from a bottom of the left-neighboring region, whereby a motion vector satisfying a predetermined criterion used in determination of motion vector predictor candidates is determined as the first motion vector predictor candidate from motion vectors of the one or more partitions. A subsequent scan in the left-neighboring region may be terminated upon detection of the motion vector satisfying the predetermined criterion of determination of motion vector predictor candidates. The first motion vector predictor candidate with a small error from the motion vector of the target partition can be efficiently determined by scanning the left-neighboring region in the foregoing scan order.

[0013] In an embodiment, the predictive decoding technology may be configured as follows: partitions in the above-neighboring region are scanned in a direction from right to left, whereby a motion vector satisfying the predetermined criterion used in determination of motion vector predictor candidates is determined as a second motion vector predictor candidate from motion vectors of the partitions. The subsequent scan in the above-neighboring region may be terminated upon detection of the motion vector satisfying the predetermined criterion used in determination of motion vector predictor candidates. The second motion vector predictor candidate with a small error from the motion vector of the target partition can be efficiently determined by scanning the above-neighboring region in the foregoing scan order.

[0014] In the above embodiment, the number of one or more motion vector predictor candidates may not be more than 3. This embodiment may further reduce the bit count of the motion vector predictor indication information.

[0015] In the above embodiment, the optimum motion vector predictor may be used as a motion vector of a target partition. This embodiment may reduce a data volume of encoded data because a residual signal of the motion vector is not encoded.

Advantageous Effects of Invention

[0016] As described above, the aspects and the embodiments of the present invention provide the predictive decoding method capable of reducing the computational complexity necessary for the determination of motion vector predictors.

Brief Description of Drawings

[0017]

Fig. 1A is a drawing illustrating rectangular neighboring partitions used in motion compensated prediction, however Fig. 1A is not according to the present invention but useful for understanding the present invention.

Fig. 1B is a drawing illustrating rectangular neighboring partitions used in motion compensated prediction.

Fig. 2 is a drawing showing a configuration of a video encoding device, however Fig. 2 is not according to the present invention but useful for understanding the present invention.

Fig. 3 is a flowchart showing an example of a predictive encoding method of motion vectors. Fig. 3 is as such (encoding method) not according to the present invention, but includes parts also relevant for the present invention.

Fig. 4 is a drawing illustrating rectangular neighboring partitions used in motion compensated prediction.

Fig. 5 is a flowchart showing a first example of a process of step S302 in Fig. 3 in detail, whereby step S302 may also be relevant for the present invention.

Fig. 6 is a flowchart showing a first example of a process of step S303 in Fig. 3 in detail, whereby step S303 is also relevant for the present invention.

Fig. 7 is a drawing showing a configuration of a video decoding device capable for performing the present invention.

Fig. 8 is a flowchart showing an example of a predictive decoding method of motion vector, wherein Fig. 8 provides a basis for the present invention.

Fig. 9 is a flowchart showing a determination process of motion vector predictor candidates in a predictive encoding method of motion vector in a second example, wherein Fig. 9 is as such (encoding method) not according to the present invention, but is useful for understanding the present invention.

Fig. 10 is a flowchart showing a predictive decoding method of motion vector in the second example, wherein Fig. 10 is not necessarily according to the present invention, but is useful for understanding the present invention.

Fig. 11 is a drawing showing a configuration of a video encoding program, however Fig. 11 is not showing the present invention but is useful for understanding the present invention.

Fig. 12 is a drawing showing a configuration of a video decoding program, however Fig. 12 is not showing the present invention but is useful for understanding the present invention.

Fig. 13 is a drawing showing a hardware configuration of a computer, however Fig. 13 is not showing the present invention but is useful for understanding the present invention.

Fig. 14 is a perspective view showing a computer, however Fig. 13 is not showing the present invention but is useful for understanding the present invention.

Description of Examples

[0018] Various embodiments will be described below in detail with reference to the drawings. In the drawings identical or equivalent portions will be denoted by the same reference signs.

[0019] Fig. 2 is a drawing showing a configuration of a video encoding device not part of the present invention but useful for understanding the present invention. The video encoding device 20 shown in Fig. 2 is an example of a device that predictively encodes a motion vector.

[0020] A video sequence input into the video encoding device 20 is composed of a temporal sequence of frame pictures. A frame picture signal targeted for encoding will be referred to hereinafter as "current frame." In the video encoding device 20, a current frame is divided into rectangular partitions of variable size and the processing described below is carried out in each of partition units.

[0021] The video encoding device 20 can use any one of an inter-frame prediction mode and a plurality of intra-frame prediction modes, switching the prediction mode for each partition among them. For example, the video encoding device 20 selects a prediction mode with a high encoding efficiency among the inter-frame prediction mode and the intra-frame prediction modes, for each partition. The "inter-frame prediction mode" herein is a mode in which a motion vector is detected with reference to a plurality of previously-encoded frame picture signals (reference frame picture signals) different in time from a frame picture signal, thereby to perform motion-compensated inter-frame prediction. The "intra-frame prediction mode" is a mode in which spatial prediction is carried out using pixel values of neighborhood regions previously encoded on the same frame. In the "inter-frame prediction mode," respective processes of motion detection, motion prediction, and motion compensation are carried out for each of sub- partitions, for example, obtained by further dividing a partition of N×N pixels in an optional size (e.g., (N/2) pixels × N lines or (N/4) pixels × (N/4) lines).

[0022] As shown in Fig. 2, the video encoding device 20 can be provided with an input unit 201, a motion detection unit 202, a motion vector predictor candidate determination unit 203, a motion vector predictor determination unit 204, a motion vector difference unit 205, a motion compensation unit 206, a memory 207, a spatial prediction unit 208, a prediction method determination unit 209, a subtraction unit 210, a transform unit 211, a quantization unit 212, an entropy encoding unit 213, an inverse quantization unit 214, an inverse transform unit 215, and an addition unit 216.

[0023] The input unit 201 receives an input video signal as a video signal input from the outside and decomposes the video signal into frame picture signals. The input unit 201 outputs each frame picture signal through line L201a and through line L201b to the subtraction unit 210 and to the motion detection unit 202.

[0024] The memory 207 is a part that stores frame picture signals having been encoded in the past, information (motion vectors, reference picture list identifications, reference picture identifications) and other data used in the prediction thereof.

[0025] The motion detection unit 202 performs detection of motion vector. More specifically, the motion detection unit 202 searches a reference frame picture signal input via line L207a from the memory 207, for a picture signal pattern similar to a picture signal pattern of a target partition in the current frame input via line L201a. The motion detection unit 202 searches in a predetermined search range in the reference frame. The motion detection unit 202 detects a motion vector representing a spatial displacement quantity between the target partition and the picture signal pattern obtained by the search, and a reference picture list identification and a reference picture identification for specifying a frame number of the reference frame used. The detected motion vector, reference picture list identification, and reference picture identification are output via line L202a to the motion compensation unit 206 and via line L202c to the motion vector difference unit 205. Furthermore, the motion detection unit 202 outputs the detected reference picture list identification and reference picture identification via line L202b to the motion vector predictor candidate determination unit 203. In the video encoding device 20, frame numbers to specify respective reference frame picture signals can be managed in the form of lists. A frame number is specified using a reference picture list identification (Reference Picture List) to specify a list, and, a reference picture identification (Reference Index) as an index of the frame number in the list. This technology is well-known technology in H.264/AVC and others.

[0026] The motion vector predictor candidate determination unit 203 determines motion vector predictor candidates using motion vectors of previously-encoded neighboring partitions input via line L207b. The details about the determination of motion vector predictor candidates will be described later. The motion vector predictor candidate determination unit 203 outputs the determined motion vector predictor candidates via line L203 to the motion vector predictor determination unit 204.

[0027] The motion vector predictor determination unit 204 determines an optimum motion vector predictor (motion vector predictor values) from the motion vector predictor candidates input via line L203. More specifically, the motion vector predictor determination unit 204 determines a motion vector predictor candidate with the smallest difference from the motion vector of the target partition input via line L202c, as an optimum motion vector predictor PMVopt, out of the motion vector predictor candidates. The determined optimum motion vector predictor PMVopt is fed via line L204a to the motion vector difference unit 205. Furthermore, the number of motion vector predictor candidates and motion vector predictor indication information to specify the optimum motion vector predictor PMVopt out of the motion vector predictor candidates are fed via line L204b to the entropy encoding unit 213.

[0028] The motion vector predictor candidate with the smallest difference from the motion vector of the target partition may be selected as the optimum motion vector predictor PMVopt. Alternatively the motion vector predictor determination unit 204 may select as the optimum motion vector predictor PMVopt a motion vector predictor candidate with the smallest number of bits assigned to a calculated motion vector difference.

[0029] The optimum motion vector predictor may be determined after the motion detection of the target partition. Alternatively, the optimum motion vector predictor may be detected before the motion detection. Specifically, as indicated by the formula (1) below, the optimum motion vector predictor may be calculated based on the sum of absolute differences (SADpmv) between the predicted picture signal in execution of the motion compensation using each of the actually-calculated motion vector predictor candidates, and the target picture signal and a cost function using the bit count Rpmv in encoding of the motion vector predictor candidate and λ as a weight for the bit count. In this case, the picture signal of the target partition is input through line L201a and each reference frame picture signal is input through line L207a to the motion vector predictor determination unit 204 in Fig. 2.

$$Cost_{pmv} = SAD_{pmv} + \lambda R_{pmv} \qquad (1)$$

[0030] The motion vector difference unit 205 calculates motion vector difference values which are difference information between the motion vector input via line L202c and the optimum motion vector predictor input via line L204a. The motion vector difference unit 205 transmits a signal including the calculated motion vector difference values, and the reference picture list identification and reference picture identification, as prediction information via line L205a to the entropy encoding unit 213. Furthermore, the motion vector difference unit 205 transmits a signal including the motion vector, and the reference picture list identification and reference picture identification, via line L205b to the memory 207.

[0031] The motion compensation unit 206 generates a predicted picture signal of the target partition, referring to the reference frame picture signal of the frame number specified by the reference picture list identification and the reference picture identification received from the motion detection unit 202 and using the motion vector received from the motion detection unit 202. This predicted picture signal is output to the prediction method determination unit 209.

[0032] The spatial prediction unit 208 generates a predicted picture signal, referring to picture signals (reference frame picture signals) of previously-encoded neighboring regions input via line L207a. The spatial prediction unit 208 outputs the generated predicted picture signal to the prediction method determination unit 209.

[0033] The prediction method determination unit 209 compares the predicted picture signals received from the motion compensation unit 206 and the spatial prediction unit 208, to select either one of the predicted picture signals, and outputs the selected predicted picture signal to the subtraction unit 210. The prediction method determination unit 209 outputs prediction mode information indicative of a prediction method used for the generation of the selected predicted picture signal, via line L209b to the entropy encoding unit 213.

[0034] The subtraction unit 210 generates a difference value (prediction residual signal) between the frame picture signal input via line L201b and the predicted picture signal input via line L209a and outputs the prediction residual signal to the transform unit 211.

[0035] The transform unit 211 performs an orthogonal transform of the prediction residual signal input via line L210, to generate orthogonal transform coefficients, and outputs the orthogonal transform coefficients to the quantization unit 212. The quantization unit 212 quantizes the orthogonal transform coefficients input via line L211, to generate quantized orthogonal transform coefficients, and transmits the quantized orthogonal transform coefficients to the entropy encoding unit 213 and the inverse quantization unit 212.

[0036] The entropy encoding unit 213 performs entropy encoding of the quantized orthogonal transform coefficients input via line L212, the prediction mode information received from the prediction method determination unit 209, the prediction information transmitted from the motion vector difference unit 205, and the motion vector predictor indication information output from the motion vector predictor determination unit 204, multiplexes generated encoded data into a compressed stream, and transmits the compressed stream to the outside.

[0037] The inverse quantization unit 214 performs inverse quantization of the quantized orthogonal transform coefficients input via line L212, to generate orthogonal transform coefficients, and transmits the orthogonal transform coefficients to the inverse orthogonal transform unit 215. Then the inverse orthogonal transform unit 215 applies an inverse orthogonal transform to the orthogonal transform coefficients input via line L214, to generate a prediction residual signal, and transmits the prediction residual signal to the addition unit 216.

[0038] The addition unit 216 performs addition of the prediction residual signal input via line L215 and the predicted picture signal input via line L209a, to generate a frame picture signal, and transmits the frame picture signal to the memory 207. This frame picture signal is stored in the memory 207 and is used as a reference frame picture signal in the subsequent encoding process. In the memory 207, the motion vector, the reference picture list identification, the reference picture identification, etc. input via line L205b are also stored in association with the reference frame picture signal.

[0039] Next, a predictive encoding method of motion vector applicable in the video encoding device 20 will be described below, however the described predictive encoding method is not part of the present invention, but useful for understanding the present invention.

[0040] First, partitions adjacent to a target partition will be described with reference to Fig. 1B. Partitions BL, BL1, and BL2 are partitions in contact with a left boundary of the target partition BT. Partition BD is a partition including neighboring pixels existing below and on the left side of the bottom left pixel in the target region BT. Partition BE is a partition including neighboring pixels existing above and on the left side of the top left pixel in the target partition BT. Partitions BA, BA1, and BA2 are partitions in contact with an upper boundary of the target partition BT. Partition BRA is a partition including neighboring pixels existing above and on the right side of the top right pixel in the target partition BT. The partitions neighboring the target partition may be partitions of the same size as the target partition BT, as shown in Fig. 1A.

[0041] Next, reference is made to Fig. 3. Fig. 3 is a flowchart showing one example of the predictive encoding method of motion vector, the predictive encoding method is as such (encoding method) not according to the present invention, but includes parts used in the present invention. As shown in Fig. 3, in the predictive encoding method of motion vector, first, the reference picture list identification and reference picture identification are input into the motion vector predictor candidate determination unit 203 (step S301).

[0042] Next, the motion vector predictor candidate determination unit 203 determines a motion vector predictor candidate PMV1 from a motion vector or motion vectors of one or more partitions included in the left-neighboring region located to the left of the target partition BT (step S302). The details about the determination method of the motion vector predictor candidate PMV1 will be described later.

[0043] Next, the motion vector predictor candidate determination unit 203 determines a motion vector predictor candidate PMV2 from a motion vector or motion vectors of one or more partitions included in the above-neighboring region located above the target partition BT (step S303). The details about the determination method of the motion vector predictor candidate PMV2 will be described later.

[0044] Next, the motion vector predictor candidate determination unit 203 determines a motion vector predictor candidate PMV3 (step S304). A motion vector of a partition existing in the reference frame and at a position spatially identical to the target partition may be determined as the motion vector predictor candidate PMV3.

[0045] The motion vector predictor candidate PMV3 may be a motion vector of another partition spatially adjacent to the target partition, instead of the motion vector of the partition at the same position as the target partition in the reference frame. It is also possible to use average values or the like calculated based on the motion vector predictor candidate PMV1 and the motion vector predictor candidate PMV2, as the motion vector predictor candidate PMV3.

[0046] The number of motion vector predictor candidates may be three or more. In this case, a plurality of motion vector predictor candidates may be determined by different methods from each of the left-neighboring region and the above-neighboring region. More specifically, a plurality of motion vector predictor candidates may be determined by searching partitions of each of the regions in a plurality of different scan directions, in each of the left-neighboring region and the above-neighboring region. It is also possible to use a motion vector of another neighboring region as a motion vector predictor candidate.

[0047] Referring back to Fig. 3, the motion vector predictor candidate determination unit 203 then determines only non-identical motion vector predictor candidates from among the motion vector predictor candidate PMV1, the motion vector predictor candidate PMV2, and the motion vector predictor candidate PMV3, as final motion vector predictor candidates (step S305). As a specific example, where the motion vector predictor candidate PMV1 is identical to the motion vector predictor candidate PMV3, only PMV1 and PMV2 are selected as motion vector predictor candidates. If there is no motion vector predictor candidates determined to satisfy the conditions in steps S302 to S304, a zero motion vector is defined as a motion vector predictor candidate.

[0048] Then the motion vector predictor determination unit 204 determines the optimum motion vector predictor, as described above, out of the motion vector predictor candidates determined by the motion vector predictor candidate determination unit 203 (step S306).

[0049] Then the encoding unit 213 encodes the motion vector predictor indication information to specify which motion vector predictor candidate is the optimum motion vector predictor (step S307).

[0050] The motion vector predictor indication information can be encoded into encoded data of a bit count according to the number of motion vector predictor candidates selected by the motion vector predictor determination unit 204. For example, when the number of motion vector predictor candidates is 0 or 1, the motion vector predictor indication information is neither encoded nor transmitted. When the number of motion vector predictor candidates is 2 or 3, the motion vector predictor indication information is encoded in two bits at most.

[0051] The motion vector predictor indication information may be encoded based on a fixed encoding table irrespective of the number of motion vector predictor candidates. In this case, the motion vector predictor indication information may be encoded using an encoding table below.

<Table 1. Encoding Table>

Bit value	Optimum motion vector predictor
0	motion vector predictor candidate 1 (PMV1)
10	motion vector predictor candidate 2 (PMV2)
11	motion vector predictor candidate 3 (PMV3)

[0052] The order in which the motion vector predictor candidate PMV1, the motion vector predictor candidate PMV2, and the motion vector predictor candidate PMV3 are determined may be changed. For example, a process may be used in which the target partition is divided into a plurality of sub- partitions and the encoding process is carried out for each of the sub-partitions. Specifically, when the target partition is divided into upper and lower sub-partitions, and the lower sub-partition can be used as a target partition, or when the target partition is divided into left and right sub-partitions, and the left sub-partition can be used as a target partition, the motion vector predictor candidates can be determined in an order of the left-neighboring region, the above-neighboring region, and another region (e.g., a partition in a reference frame at the same position as the target partition). On the other hand, when the target partition is divided into upper and lower sub-partitions, and the upper sub-partition can be used as a target partition, or the target partition is divided into left and right sub-partitions, and the right sub-partition can be used as a target partition, the motion vector predictor candidates can be determined in an order of the above-neighboring region, the left-neighboring region, and another region (e.g., a partition in a reference frame at the same position as the target partition), for these target partitions.

[0053] A first example of the determination process of motion vector predictor candidate will be described below in detail. First, the first example of the process of step S302 in Fig. 3 will be described with reference to Figs. 1B, 4, and 5. It is assumed herein, as shown in Fig. 1B, that the left-neighboring region is composed of the below-left-neighboring partition BD to the target partition and the left-neighboring partitions BL, BL1, and BL2 to the target partition. It is also assumed that the partitions in the left-neighboring region are scanned in increasing order of index i shown in (a) of Fig. 4. Namely, the partitions in the left-neighboring region are assumed to be scanned in order from bottom to top.

[0054] The below-left-neighboring partition BD may be excluded from the left-neighboring region. Furthermore, a partition further below the below left-neighboring partition BD may be included in the left-neighboring region. Furthermore, the partition BE or a partition located above the partition BE may be included in the left-neighboring region. Furthermore, a partition located on the left side of the target partition and at a predetermined distance from the target partition may be included in the left-neighboring region.

[0055] Referring back to (a) of Fig. 4 and Fig. 5, in the process of step S302, first, the motion vector predictor candidate determination unit 203 sets 0 in index i (step S501). The motion vector predictor candidate determination unit 203 increases the index i by an increment of 1 in the subsequent step S502.

[0056] Next, the motion vector predictor candidate determination unit 203 determines whether there is the i-th partition in the scan order in the left-neighboring region and whether the partition has a motion vector (step S503). If there is the i-th partition in the left-neighboring region and if the partition has a motion vector, the motion vector predictor candidate determination unit 203 determines, in the subsequent step S504, whether the i-th partition and the target partition have the same reference picture list identification and reference picture identification. When the determination condition in step S504 is satisfied, the motion vector predictor candidate determination unit 203 determines the motion vector of the i-th partition as motion vector predictor candidate PMV1 in the subsequent step S505 and then outputs the motion vector predictor candidate PMV1 in the subsequent step S506, followed by termination of processing.

[0057] On the other hand, when the determination condition in step S503 is not satisfied or when the determination condition in step S504 is not satisfied, the processing transfers to step S507. In step S507, the motion vector predictor candidate determination unit 203 determines whether the index i is over the number N of partitions in the left-neighboring region. When the determination condition in step S507 is not satisfied, the motion vector predictor candidate determination unit 203 carries on the processing from step S502. On the other hand, when the determination condition in step S507 is satisfied, the motion vector predictor candidate determination unit 203 terminates the processing.

[0058] The partitions in the left-neighboring region are scanned in order from the bottom of the left-neighboring region in the embodiment shown in (a) of Fig. 4, but in one embodiment, as shown in (c) of Fig. 4, they may be scanned in order from the top of the left-neighboring region.

[0059] Either of the scan order shown in (a) of Fig. 4 and the scan order shown in (c) of Fig. 4 may be adaptively selected. For example, the scan order may be determined based on a relation of motion vectors of neighboring partitions. Specifically, it is possible to adopt a method of comparing an absolute difference α between the motion vector of the partition BL and the motion vector of the partition BA with an absolute difference β between the motion vector of the partition BRA and the motion vector of the partition BD in Fig. 1B, and selecting the scan order in (c) of Fig. 4 if the absolute difference α is smaller than the absolute difference β. In the opposite case, on the other hand, the scan order in (a) of Fig. 4 may be selected.

[0060] In an embodiment, step S502 may be configured to increase the index i by an increment of two or more, thereby decimating the partitions to be scanned.

[0061] The first example of the process of step S303 in Fig. 3 will be described below in detail with reference to Figs. 1B, 4, and 6. It is assumed herein, as shown in Fig. 1B, that the above-neighboring region is composed of the above-left-neighboring partition BE to the target partition and the above-neighboring partition BA, BA1, and BA2 to the target partition. It is also assumed that the partitions in the above-neighboring region are scanned in increasing order of index j shown in (a) of Fig. 4. Namely, the partitions in the above-neighboring region are assumed to be scanned in order from right to left.

[0062] The above-left-neighboring partition BE may be excluded from the above-neighboring region. Furthermore, a partition further left to the above-left-neighboring partition BE may be included in the above-neighboring region. Furthermore, a partition located above the target partition and at a predetermined distance from the target partition may be included in the above-neighboring region.

[0063] Referring back to (a) of Fig. 4 and Fig. 6, in the process of step S303, first, the motion vector predictor candidate determination unit 203 sets 0 in the index j (step S601). The motion vector predictor candidate determination unit 203 increases the index j by an increment of 1 in the subsequent step S602.

[0064] Next, the motion vector predictor candidate determination unit 203 determines whether there is the j-th partition in the scan order in the above-neighboring region and whether the partition has a motion vector (step S603). When there is the j-th partition in the above-neighboring region and when the partition has a motion vector, the motion vector predictor candidate determination unit 203 determines, in the subsequent step S604, whether the j-th partition and the target partition have the same reference picture list identification and reference picture identification. When the determination condition in step S604 is satisfied, the motion vector predictor candidate determination unit 203 determines, in the subsequent step S605, whether the motion vector of the j-th partition is identical to the motion vector predictor candidate PMV1. When the motion vector of the j-th partition is different from the motion vector predictor candidate PMV1, the motion vector predictor candidate determination unit 203 determines in the subsequent step S606 that the motion vector of the j-th partition is the motion vector predictor candidate PMV2, and then outputs the motion vector predictor candidate PMV2 in the subsequent step S607, followed by termination of processing.

[0065] On the other hand, when the determination condition in step S603 is not satisfied, when the determination condition in step S604 is not satisfied, or when the determination condition in step S605 is satisfied, the processing transfers to step S608.

[0066] In step S608, the motion vector predictor candidate determination unit 203 determines whether the index j is over the number M of partitions in the above-neighboring region. When the determination condition in step S608 is not satisfied, the motion vector predictor candidate determination unit 203 carries on the processing from step S602. On the other hand, when the determination condition in step S608 is satisfied, the motion vector predictor candidate determination unit 203 terminates the processing.

[0067] The partitions in the above-neighboring region are scanned in order from right to left in the embodiment shown in (a) of Fig. 4, but in an example not forming part of the invention the partitions may be scanned in order from left to right, as shown in (c) of Fig. 4.

[0068] Either of the scan order shown in (a) of Fig. 4 or the scan order shown in (c) of Fig. 4 may be adaptively selected. For example, the scan order may be determined based on a relation of motion vectors of neighboring partitions. Specifically, it is possible to adopt a method of comparing an absolute difference α between the motion vector of the partition BL and the motion vector of the partition BA with an absolute difference β between the motion vector of the partition BRA and the motion vector of the partition BD in Fig. 1B, and selecting the scan order in (c) of Fig. 4 if the absolute difference α is smaller than the absolute difference β. In the opposite case, on the other hand, the scan order in (a) of Fig. 4 may be selected.

[0069] The partition BE is included in the above-neighboring region in the above-described embodiment, but the partition BE may be included in the left-neighboring region. It is also possible to define the partition BE as a region independent of the above-neighboring region and the left-neighboring region, and treat the motion vector of the partition BE as another motion vector predictor candidate.

[0070] The foregoing example employs both of the reference picture list identification and the reference picture identification as a determination condition for selecting the motion vector of the partition in the neighboring region as a motion vector predictor candidate, but the present invention is not limited to this. For example, either of the reference picture list identification or the reference picture identification may be used for the determination condition. When the reference picture identification is not used, scaling of motion vectors of partitions in the neighboring region may be implemented according to a distance between the reference frame and the target frame. It is also possible to use information of another intra-frame prediction. Specifically, the size of the target partition and the sizes of the neighboring partitions may be added as one in the aforementioned determination condition. Specifically, when the size of the target partition is N×N pixels, a determination condition may be that the size of a partition in the neighboring region is N×N pixels, or a determination condition may be that the size of a partition is from N/2×N/2 pixels to 2N×2N pixels.

[0071] In the foregoing example the calculation of the motion vector predictor candidate PMV2 in the above-neighboring region is performed after the calculation of the motion vector predictor candidate PMV1 in the left-neighboring region, but the present invention is not limited to this. The motion vector predictor candidate PMV2 in the above-neighboring region may be determined prior to the determination of the motion vector predictor candidate PMV1 in the left-neighboring region. In this case, a process of determining whether a motion vector of a partition in the left-neighboring region is identical to the motion vector predictor candidate PMV2 in the above-neighboring region can be carried out in the process of determining the motion vector predictor candidate PMV1 in the left-neighboring region.

[0072] In the above example it is determined in step S605, whether the motion vector of the j-th partition in the above-neighboring region is identical to the motion vector predictor candidate PMV1 in the left-neighboring region, but this determination may be omitted. In this case, the process of step S606 can be directly performed when the determination condition in step S604 is satisfied.

[0073] The step S602 may be configured to increase the index j by an increment of two or more, thereby decimating the partitions to be scanned.

[0074] The below will describe a video decoding device which decodes a compressed stream generated by the video encoding device 20, to restore a video sequence. Fig. 7 is a drawing showing a configuration of the video decoding device not being part of the present invention, but capable of performing the present invention. The video decoding device 30 shown in Fig. 7 is an example of a device that predictively decodes a motion vector according to the present invention.

[0075] As shown in Fig. 7, the video decoding device 30 can be provided with an entropy decoding unit 301, a motion vector predictor candidate determination unit 302, a motion vector predictor determination unit 303, a motion vector addition unit 304, a motion compensation unit 305, a frame memory 306, a spatial prediction unit 307, a prediction method determination unit 308, an inverse quantization unit 309, an inverse orthogonal transform unit 310, and an addition unit 311.

[0076] The entropy decoding unit 301 receives a compressed stream, then detects a synchronization word indicative of the beginning of each frame in the compressed stream, and thereafter restores the prediction mode information and the quantized orthogonal transform coefficients from encoded data in the compressed stream, in each of divided partition units. When the prediction mode specified by the prediction mode information is "inter-frame prediction mode," the entropy decoding unit 301 decodes the encoded data in the compressed stream to also restore the motion vector difference, reference picture list identification, and reference picture identification.

[0077] The entropy decoding unit 301 transmits the restored quantized orthogonal transform coefficients via line L301a to the inverse quantization unit 309. The entropy decoding unit 301 transmits the prediction mode information, the reference picture list identification, and the reference picture identification via line L301b to the motion vector predictor candidate determination unit 302. Furthermore, the entropy decoding unit 301 transmits the restored motion vector difference via line L301d to the motion vector addition unit 304. The entropy decoding unit 301 transmits the restored prediction mode information via line L301e to the prediction method determination unit 308.

[0078] When the prediction mode specified by the received prediction mode information is "inter-frame prediction mode," the motion vector predictor candidate determination unit 302 determines motion vector predictor candidates from motion vectors of previously-decoded neighboring partitions. Since the processing about the determination of motion vector predictor candidates carried out by the motion vector predictor candidate determination unit 302 is the same as the processing described above as to the motion vector predictor candidate determination unit 203, the description thereof is omitted herein. This motion vector predictor candidate determination unit 302 outputs the determined motion vector predictor candidates via line L302b to the motion vector predictor determination unit 303. Furthermore, the motion vector predictor candidate determination unit 302 outputs the number of motion vector predictor candidates via line L302a to the entropy decoding unit 301.

[0079] The entropy decoding unit 301, when receiving the number of motion vector predictor candidates via line L302a, decodes the encoded data in the compressed stream according to the number of motion vector predictor candidates, to restore the motion vector predictor indication information. The entropy decoding unit 301 transmits the restored motion vector predictor indication information to the motion vector predictor determination unit 303. More specifically, when the number of motion vector predictor candidates is 0 or 1, no motion vector predictor indication information is transmitted and therefore the restoring process is not carried out. When the number of motion vector predictor candidates is 2 or 3, the encoded data of two bits at most is entropy-decoded to restore the motion vector predictor indication information.

[0080] The entropy decoding unit 301 is configured to restore the motion vector predictor indication information by decoding the encoded data according to the number of motion vector predictor candidates selected by the motion vector predictor candidate determination unit 302, but the present invention is not limited to this. For example, the motion vector predictor indication information may be restored using the fixed encoding table of Table 1 described above, independent of the number of motion vector predictor candidates. It should be noted that the setting of the fixed encoding table is not limited to this example. The motion vector predictor indication information may be restored prior to the calculation of motion vector predictor candidates.

[0081] The motion vector predictor determination unit 303 determines the optimum motion vector predictor PMVopt on the basis of the motion vector predictor indication information input via line L301c, out of the motion vector predictor candidates input via line L302b. The determined optimum motion vector predictor PMVopt is transmitted via line L303 to the motion vector addition unit 304.

[0082] The motion vector addition unit 304 performs addition of the motion vector difference transmitted from the entropy decoding unit 301 and the optimum motion vector predictor PMVopt transmitted from the motion vector predictor determination unit 303, to restore the motion vector. The motion vector addition unit 304 transmits a signal including the restored motion vector via line L304 to the motion compensation unit 305.

[0083] The motion compensation unit 305 selects the reference frame picture signal in the memory 306 on the basis of the motion vector transmitted from the motion vector addition unit 304 and the prediction mode information, the reference picture list identification, and the reference picture identification transmitted via line L301d from the entropy decoding unit 301, and generates a predicted picture signal, using the selected reference frame picture signal. The motion compensation unit 305 transmits the predicted picture signal via line L305a to the prediction method determination unit 308. Furthermore, the motion compensation unit 305 outputs the prediction mode information, reference picture list identification, and reference picture identification used in generation of the predicted picture signal via line L305b to the frame memory 306. There are the previously-decoded frame picture signals, prediction mode information, reference picture list identifications, and reference picture identifications stored in the memory 306.

[0084] When the prediction mode specified by the prediction mode information input via line L301e is "intra-frame prediction mode," the spatial prediction unit 307 generates a predicted picture signal with reference to the picture signals (reference frame picture signals) of previously-decoded neighboring partitions and transmits the predicted picture signal to the prediction method determination unit 308.

[0085] The prediction method determination unit 308 selects either of the predicted picture signal generated by the inter-frame prediction or the predicted picture signal generated by the intra-frame prediction, based on the prediction mode transmitted from the entropy decoding unit 301, and transmits the selected predicted picture signal via line L308 to the addition unit 311.

[0086] The inverse quantization unit 309 performs inverse quantization of the quantized orthogonal transform coefficients transmitted from the entropy decoding unit 301, to restore orthogonal transform coefficients. The inverse quantization unit 309 transmits the restored orthogonal transform coefficients via line L309 to the inverse orthogonal transform unit 310.

[0087] The inverse orthogonal transform unit 310 applies an inverse orthogonal transform to the received orthogonal transform coefficients to restore a prediction residual signal. The inverse orthogonal transform unit 310 transmits the restored prediction residual signal via line L310 to the addition unit 311.

[0088] The addition unit 311 performs addition of the predicted picture signal transmitted from the prediction method determination unit 308 and the prediction residual signal transmitted from the inverse orthogonal transform unit 310, to restore a frame picture signal.

[0089] The restored frame picture signal is output at predetermined display timing to a display device (not shown), whereby the input video signal (dynamic image signal) can be reproduced. Since the frame picture signal is used in the subsequent decoding process, it is stored as a reference frame picture signal into the memory 306. The frame picture signal herein can be the same value as the frame picture signal with the same number in the video encoding device 20. The information about the motion vector and the reference frame number is also simultaneously stored in association with the reference frame picture signal.

[0090] Next, one example of a predictive decoding method of motion vectors used in the video decoding device 30 will be described below with reference to Fig. 8. Fig. 8 is a flowchart showing one example of the predictive decoding method of motion vectors. Fig. 8 providing a basis for the present invention.

[0091] In the predictive decoding method of motion vector predictors according to the one example, as shown in Fig. 8, the reference picture list identification and reference picture identification are first input into the motion vector predictor candidate determination unit 302 (step S801).

[0092] Next, the motion vector predictor candidate determination unit 302 determines a motion vector predictor candidate, PMV1, from a motion vector or motion vectors of one or more partitions included in a left-neighboring region located to the left of a target partition BT (step S302).

[0093] Next, the motion vector predictor candidate determination unit 302 determines a motion vector predictor candidate, PMV2, from a motion vector or motion vectors of one or more partitions included in the above-neighboring region located above the target partition BT (step S303).

[0094] Next, the motion vector predictor candidate determination unit 302 determines a motion vector predictor candidate PMV3 (step S304). The processes of steps S302 to S304 in Fig. 8 are the same as the processes of steps S302 to S304 in Fig. 3.

[0095] In step S805, the motion vector predictor candidate determination unit 302 then defines as motion vector predictor candidates only non-identical motion vector predictor candidates from among the motion vector predictor candidate PMV1, the motion vector predictor candidate PMV2, and the motion vector predictor candidate PMV3. As a specific example, where the motion vector predictor candidate PMV1 is identical to the motion vector predictor candidate PMV3, only the motion vector predictor candidate PMV1 and the motion vector predictor candidate PMV2 are selected as motion vector predictor candidates. When the processing up to step S805 results in determining no effective motion vector predictor candidates, a zero motion vector is defined as a motion vector predictor candidate.

[0096] In step S806, as described above, the decoding unit 301 restores the motion vector predictor indication information on the basis of the number of motion vector predictor candidates. Next, in step S807, the motion vector predictor determination unit 303 selects the optimum motion vector predictor out of the motion vector predictor candidates, based on the motion vector predictor indication information.

[0097] Next, a second example of the predictive encoding method of motion vectors will be described below. Fig. 9 is a flowchart showing the determination process of motion vector predictor candidates in the predictive encoding method of motion vectors in the second example, wherein Fig. 9 is as such (encoding method) not according to the present invention, but useful for understanding the present invention. In the predictive encoding method of motion vectors according to the second example, the flow shown in Fig. 9 is used instead of steps S302 to S304 in Fig. 3.

[0098] In the present example, in step S901 the motion vector predictor candidate determination unit 203 first scans the partitions in the left-neighboring region located to the left of the target partition in a downward direction to determine a motion vector predictor candidate PMVa from the motion vectors of these partitions. In step S901, the motion vector predictor candidate determination unit 203 can detect the motion vector predictor candidate PMVa by carrying out the determination method of the motion vector predictor candidate PMV1 (step S302) described in the first example, according to the scan order of the left-neighboring region shown in (c) of Fig. 4. For determining the motion vector predictor candidate PMVa, the motion vector predictor candidate determination unit 203 can use the input reference picture list identification and reference picture identification, as in the first example.

[0099] Next, in step S902 the motion vector predictor candidate determination unit 203 scans the partitions in a left-neighboring region located to the left of the target partition in an upward direction to determine a motion vector predictor candidate PMVb from the motion vectors of these partitions. In step S902, the motion vector predictor candidate determination unit 203 can detect the motion vector predictor candidate PMVb by carrying out the determination method of the motion vector predictor candidate PMV1 (step S302) described in the first example, according to the scan order of the left-neighboring region shown in (a) of Fig. 4. For determining the motion vector predictor candidate PMVb, the motion vector predictor candidate determination unit 203 can use the reference picture list identification and reference picture identification.

[0100] Next, in step S903 the motion vector predictor candidate determination unit 203 selects a motion vector predictor candidate PMVX in the left-neighboring region from the motion vector predictor candidate PMVa and the motion vector predictor candidate PMVb. Furthermore, the motion vector predictor candidate determination unit 203 generates scan direction indication information indicative of the scan direction X used for determination of the selected motion vector predictor candidate. Specifically, the motion vector predictor candidate determination unit 203 determines as the motion vector predictor candidate PMVX, a motion vector predictor candidate with the smallest error from the motion vector predictor of the target partition, out of motion vector predictor candidate PMVa and motion vector predictor candidate PMVb. Furthermore, when the motion vector predictor candidate PMVa is selected as the motion vector predictor candidate PMVX, the motion vector predictor candidate determination unit 203 generates the scan direction indication information indicative of the downward direction; whereas when the motion vector predictor candidate PMVb is selected, it generates the scan direction indication information indicative of the upward direction.

[0101] Next, in step S904 the motion vector predictor candidate determination unit 203 scans the partitions in the above-neighboring region to the target partition in a rightward direction to determine a motion vector predictor candidate PMVc from the motion vectors of these partitions. In step S904 the motion vector predictor candidate determination unit 203 can detect the motion vector predictor candidate PMVc by carrying out the determination method of the motion vector predictor candidate PMV2 (step S303) described in the first example, according to the scan order of the above-neighboring region shown in (c) of Fig. 4. For determining the motion vector predictor candidate PMVc, the motion vector predictor candidate determination unit 203 can use the input reference picture list identification and reference picture identification, as in the first example.

[0102] Next, in step S905 the motion vector predictor candidate determination unit 203 scans the partitions in the above-neighboring region to the target partition in a leftward direction to determine a motion vector predictor candidate PMVd from motion vectors of these partitions. In step S905, the motion vector predictor candidate determination unit 203 can detect the motion vector predictor candidate PMVd by carrying out the determination method (step S303) of the motion vector predictor candidate PMV2 described in the first example, according to the scan order of the above-neighboring region shown in (a) of Fig. 4. For determining the motion vector predictor candidate PMVd, the motion vector predictor candidate determination unit 203 can also use the reference picture list identification and reference picture identification.

[0103] Next, in step S906 the motion vector predictor candidate determination unit 203 selects a motion vector predictor candidate PMVY in the above-neighboring region from the motion vector predictor candidate PMVc and the motion vector predictor candidate PMVd. The motion vector predictor candidate determination unit 203 generates the scan direction indication information indicative of the scan direction Y used for determination of the selected motion vector predictor candidate. Specifically, the motion vector predictor candidate determination unit 203 determines a motion vector predictor candidate with the smallest error from the motion vector predictor of the target partition, out of the motion vector predictor candidate PMVc and the motion vector predictor candidate PMVd, as the motion vector predictor candidate PMVY. When the motion vector predictor candidate PMVc is selected as the motion vector predictor candidate PMVY, the motion vector predictor candidate determination unit 203 generates the scan direction indication information indicative of the rightward direction; when the motion vector predictor candidate PMVd is selected, it generates the scan direction indication information indicative of the leftward direction.

[0104] Next, in step S907 the motion vector predictor candidate determination unit 203 acquires a motion vector predictor candidate PMVZ of a partition in a reference frame at a position spatially identical to the target partition, in the same manner as the process of step S304. The process in this step S907 may be the same as the aforementioned modification form of the process of step S304 in the first example.

[0105] Next, in step S908 the motion vector predictor candidate determination unit 203 defines only non-identical motion vector predictor candidates out of the motion vector predictor candidate PMVX, the motion vector predictor candidate PMVY, and the motion vector predictor candidate PMVZ, as motion vector predictor candidates. Then the motion vector predictor candidate determination unit 203 outputs the motion vector predictor candidates, the number of motion vector predictor candidates, and the scan direction indication information. As a specific example, where the motion vector predictor candidate PMVX is identical to the motion vector predictor candidate PMVZ, only the motion vector predictor candidate PMVX and the motion vector predictor candidate PMVY are selected as motion vector predictor candidates. If no effective motion vector predictor candidate is determined in steps S901 to S907, a zero motion vector is defined as a motion vector predictor candidate.

[0106] Thereafter, the same processing as in step S306 in the first example is carried out in the second example. Finally, in step S307 the encoding unit 213 encodes the motion vector predictor indication information to specify which motion vector predictor candidate is the optimum motion vector predictor. In the second example the encoding unit 213 also encodes the scan direction indication information in step S307.

[0107] In the second example, the partitions constituting the left-neighboring region and the partitions constituting the above-neighboring region may be modified as described above in the first example. The number of motion vector predictors may also be changed as described above in the first example. As described above in the first example, the determination order of the motion vector predictor candidates PMVX, PMVY, and PMVZ may be changed based on the mode of division of the target partition into sub- partitions and the positions of the sub-partitions.

[0108] A predictive decoding method of motion vectors according to the second example will be described below, not making necessarily use of the present invention, but useful for understanding the present invention. Fig. 10 is a flowchart showing the predictive decoding method of motion vectors according to the second example. The predictive decoding method shown in Fig. 10 is a method of predicting a motion vector from encoded data generated by the predictive encoding method of motion vectors according to the second example.

[0109] In the present example, as shown in Fig. 10, in step S1001 the motion vector predictor candidate determination unit 302 first receives input of the restored reference picture list identification, reference picture identification, and scan direction indication information (scan direction X, scan direction Y).

[0110] Next, in step S1002 the motion vector predictor candidate determination unit 302 determines a motion vector predictor candidate PMVX in the left-neighboring region, according to the reference picture list identification, the reference picture identification, and the scan direction indication information to specify the scan direction X. The motion vector predictor candidate PMVX is determined by the same process as the determination of the motion vector predictor candidate PMV1 in the first example, by sequentially scanning the partitions in the left-neighboring region in the scan direction X specified by the scan direction indication information.

[0111] Next, in step S1003, the motion vector predictor candidate determination unit 302 determines a motion vector predictor candidate PMVY in the above-neighboring region, according to the reference picture list identification, the reference picture identification, and the scan direction indication information to specify the scan direction Y The motion vector predictor candidate PMVY is determined by the same process as the determination of the motion vector predictor candidate PMV2 in the first example, by sequentially scanning the partitions in the above-neighboring region in the scan direction Y specified by the scan direction indication information.

[0112] Next, in step S1004 the motion vector predictor candidate determination unit 302 determines a motion vector predictor candidate PMVZ of a partition in a reference frame spatially identical to the target partition. The process of step S1004 is the same as the process of step 304.

[0113] Next, in step S1005 the motion vector predictor candidate determination unit 302 defines only non-identical motion vector predictor candidates, out of the motion vector predictor candidate PMVX, the motion vector predictor candidate PMVY, and the motion vector predictor candidate PMVZ, as motion vector predictor candidates. As a specific example, where the motion vector predictor candidate PMVX is identical to the motion vector predictor candidate PMVZ, only the motion vector predictor candidate PMVX and the motion vector predictor candidate PMVY are selected as motion vector predictor candidates. If no effective motion vector predictor candidates are determined by the processing up to step S1005, a zero motion vector is defined as a motion vector predictor candidate.

[0114] Next, in step S1006 the decoding unit 301 restores the motion vector predictor indication information on the basis of the number of motion vector predictor candidates. In step S1007, the motion vector predictor determination unit 303 then selects the optimum motion vector predictor from among the motion vector predictor candidates, based on the motion vector predictor indication information.

[0115] In the second example, the determination order of the motion vector predictor candidates PMVX, PMVY, and PMVZ may also be changed based on the mode of division of the target partition into sub-partitions and the positions of the sub- partitions, as described above in the first example.

[0116] The video encoding device 20 and video decoding device 30 described above are configured to narrow down candidates for a motion vector predictor and then detect the optimum motion vector predictor from the resulting motion vector predictor candidates. Therefore, it is possible to reduce the computational complexity necessary for the determination of the optimum motion vector predictor. Furthermore, the motion vector predictor indication information to specify the optimum motion vector predictor can be encoded in a smaller bit count.

[0117] The video encoding device 20 and the video decoding device 30 using the predictive encoding and predictive decoding of the second example are able to determine the motion vector predictor candidates with a smaller error from the motion vector of the target partition.

[0118] The below will describe a video encoding program 1000 for causing a computer to function as the video encoding device 20, and a video decoding program 1100 for causing a computer to function as the aforementioned video decoding device 30. Both of the above-mentioned programs are not part of the present invention, but useful for understanding the present invention.

[0119] Fig. 11 is a drawing showing a configuration of the video encoding program, not being part of the present invention. Fig. 12 is a drawing showing a configuration of the video decoding program , not being part of the present invention. Fig. 13 is a drawing showing a hardware configuration of a computer not being part of the present invention. Fig. 14 is a perspective view showing a computer, not being part of the present invention.

[0120] The video encoding program 1000 shown in Fig. 11 can be provided as stored in a recording medium SM. Furthermore, the video decoding program 1100 shown in Fig. 12 can also be provided as stored in a recording medium SM. Examples of such recording media SM applicable herein include recording media such as the floppy disk, CD-ROM, DVD, or ROM, semiconductor memories, or the like.

[0121] As shown in Fig. 13, a computer C10 can be provided with a reading device C12 such as a floppy disk drive unit, a CD-ROM drive unit, or a DVD drive unit, a working memory (RAM) C14 on which an operating system is resident, a memory C16 storing a program stored in a recording medium SM, a monitor unit C18 such as a display, a mouse C20 and a keyboard C22 as input devices, a communication device C24 for transmission/reception of data and others, and a CPU C26 to control execution of the program.

[0122] When the recording medium SM is put into the reading device C12, the computer C10 becomes accessible to the video encoding program 1000 stored in the recording medium SM, through the reading device C12 and becomes able to operate as the video encoding device 20, based on the program 1000.

[0123] When the recording medium SM is put into the reading device C12, the computer C10 becomes accessible to the video decoding program 1100 stored in the recording medium SM, through the reading device C12 and becomes able to operate as the video decoding device 30, based on the program 1100.

[0124] As shown in Fig. 11, the video encoding program 1000 is provided with a main module 1001 to generally control the processing, an input module 1002, a motion detection module 1003, a motion vector predictor candidate determination module 1004, a motion vector predictor determination module 1005, a motion vector difference module 1006, a motion compensation module 1007, a spatial prediction module 1008, a prediction method determination module 1009, a subtraction module 1010, an orthogonal transform module 1011, a quantization module 1012, an entropy encoding module 1013, an inverse quantization module 1014, an inverse orthogonal transform module 1015, and an addition module 1016. The functions that the input module 1002, the motion detection module 1003, the motion vector predictor candidate determination module 1004, the motion vector predictor determination module 1005, the motion vector difference module 1006, the motion compensation module 1007, the spatial prediction module 1008, the prediction method determination module 1009, the subtraction module 1010, the orthogonal transform module 1011, the quantization module 1012, the entropy encoding module 1013, the inverse quantization module 1014, the inverse orthogonal transform module 1015, and the addition module 1016 causes a computer to implement are the same as the functions of the aforementioned input unit 201, motion detection unit 202, motion vector predictor candidate determination unit 203, motion vector predictor determination unit 204, motion vector difference unit 205, motion compensation unit 206, spatial prediction unit 208, prediction method determination unit 209, subtraction unit 210, orthogonal transform unit 211, quantization unit 212, entropy encoding unit 213, inverse quantization unit 214, inverse orthogonal transform unit 215, and addition unit 216, respectively.

[0125] As shown in Fig. 12, the video decoding program 1100 is provided with a main module 1101 to generally control the processing, an entropy decoding module 1102, a motion vector predictor candidate determination module 1103, a motion vector predictor determination module 1104, a motion vector addition module 1105, a motion compensation module 1106, a spatial prediction module 1107, a prediction method determination module 1108, an inverse quantization module 1109, an inverse orthogonal transform module 1110, and an addition module 1111. The functions that the entropy decoding module 1102, motion vector predictor candidate determination module 1103, motion vector predictor determination module 1104, motion vector addition module 1105, motion compensation module 1106, spatial prediction module 1107, prediction method determination module 1108, inverse quantization module 1109, inverse orthogonal transform module 1110, and addition module 1111 causes a computer to implement are the same as the functions of the aforementioned entropy decoding unit 301, motion vector predictor candidate determination unit 302, motion vector predictor determination unit 303, motion vector addition unit 304, motion compensation unit 305, spatial prediction unit 307, prediction method determination unit 308, inverse quantization unit 309, inverse orthogonal transform unit 310, and addition unit 311, respectively.

[0126] The above describes various examples, but the present invention can be modified in many ways without being limited to the above examples. For example, in the above examples the encoded data of the motion vector difference being the difference between the motion vector of the target partition and the motion vector predictor (optimum motion vector predictor) is transmitted from the encoding device to the decoding device, but the optimum motion vector predictor may be adopted as the motion vector of the target partition, without transmitting the encoded data of the motion vector difference from the encoding device to the decoding device.

[0127] The motion vector predictor candidate PMVX may be determined as follows: predicted picture signals are created using the motion vector predictor candidates PMVa and PMVb and the motion vector predictor candidate PMVX to be adopted is a motion vector predictor candidate to make smaller the sum of absolute differences (SAD) between the predicted picture signal and the picture signal of the target partition, out of the motion vector predictor candidates PMVa and PMVb. The motion vector predictor candidate PMVY may be determined as follows: predicted picture signals are created using the motion vector predictor candidates PMVc and PMVd and the motion vector predictor candidate PMVY to be adopted is a motion vector predictor candidate to make smaller the sum of absolute differences (SAD) between the predicted picture signal and the picture signal of the target partition, out of the motion vector predictor candidates PMVc and PMCd. Furthermore, the sum of absolute transformed differences (SATD) or the sum of square differences (SSD) may be used instead of SAD.

Reference Signs List

[0128] 20 video encoding device; 30 video decoding device; 201 input unit; 202 detection unit; 203 motion vector predictor candidate determination unit; 204 motion vector predictor determination unit; 205 motion vector difference unit; 206 motion compensation unit; 207 memory; 208 spatial prediction unit; 209 prediction method determination unit; 210 subtraction unit; 211 transform unit; 212 quantization unit; 213 entropy encoding unit; 214 inverse quantization unit; 215 inverse transform unit; 216 addition unit; 301 entropy decoding unit; 302 motion vector predictor candidate determination unit; 303 motion vector predictor determination unit; 304 motion vector addition unit; 305 motion compensation unit; 306 frame memory; 307 spatial prediction unit; 308 prediction method determination unit; 309 inverse quantization unit; 310 inverse orthogonal transform unit; 311 addition unit.

REFERENCES CITED IN THE DESCRIPTION

Cited references

Patent documents cited in the description

- JP2010515399W [0005]

Non-patent literature cited in the description

- **WIEGAND T et al.**High Efficiency Video Coding (HEVC) text specification Working Draft 13. JCT-VC MEETING; 95. MPEG MEETING; 7-10-2010 - 15-10-2010; GUANGZHOU; (JOINT COLLABORATIVE TEAM ON VIDEO CODING OF ISO/IECJTC1/SC29/WG11 AND ITU-TSG16);, 2011, JCTVC-C4030000-0018. [0006]

Patentkrav

1. Fremgangsmåde til forudsigelsesafkodning af en bevægelsesvektor anvendt i bevægelseskompenseret forudsigelse for at gendanne en videosekvens bestående af en tidsmæssig sekvens af en flerhed af rammebilleder, omfattende:

et trin (S302) til bestemmelse af en første bevægelsesvektorforudsigelses-kandidat (PMV1) som opfylder et forudbestemt kriterie anvendt til bestemmelse af bevægelsesvektorforudsigelseskandidater, fra bevægelsesvektorer af inddelinger (BD, BL2, BL1, BL) som tilhører et venstre-tilgrænsende område placeret på venstre side af en målinddeling (BT) i et rammebillede af et afkodningsmål;

et trin (S303) til bestemmelse af en anden bevægelsesvektorforudsigelses-kandidat (PMV2) som opfylder et forudbestemt kriterie anvendt til bestemmelse af bevægelsesvektorforudsigelseskandidater, fra bevægelsesvektorer af inddelinger (BRA, BA2, BA1, BA, BE) som tilhører et øvre-tilgrænsende område placeret over målinddelingen (BT);

et trin (S806) til afkodning af kodet data og gendannelse af bevægelsesvektor-forudsigelsesindikationsinformation, som specificerer en optimal bevægelsesvektorforudsigelse af målinddelingen (BT); og

et trin (S807) til valg af den optimale bevægelsesvektorforudsigelse specificeret af bevægelsesvektorforudsigelsesindikationsinformationen, fra bevægelsesvektorforudsigelseskandidater som inkluderer mindst den første bevægelsesvektorforudsigelseskandidat (PMV1) og den anden bevægelsesvektorforudsigelseskandidat (PMV2);

kendetegnet ved, at

trinnet (S303) til bestemmelse af en anden bevægelsesvektorforudsigelses-kandidat (PMV2) bestemmer en bevægelsesvektor som opfylder det forudbestemte kriterie anvendt til bestemmelse af bevægelsesvektorforudsigelseskandidater som en anden bevægelsesvektorforudsigelseskandidat (PMV2), fra bevægelsesvektorer af inddelinger, med scanningsinddelinger (BRA, BA2, BA1, BA, BE) som tilhører det øvre-tilgrænsende område fra en højre retning til en venstre retning, og med decimering af antallet af inddelinger, som skal scannes, er inddelingerne scannet fra den højre retning mod den venstre retning et reduceret sæt af inddelinger.

DRAWINGS

Drawing

Fig.1A

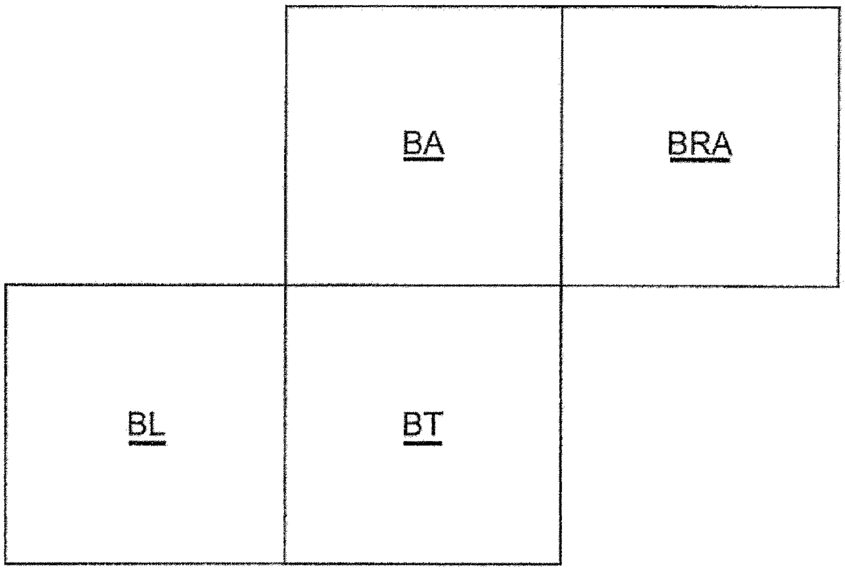
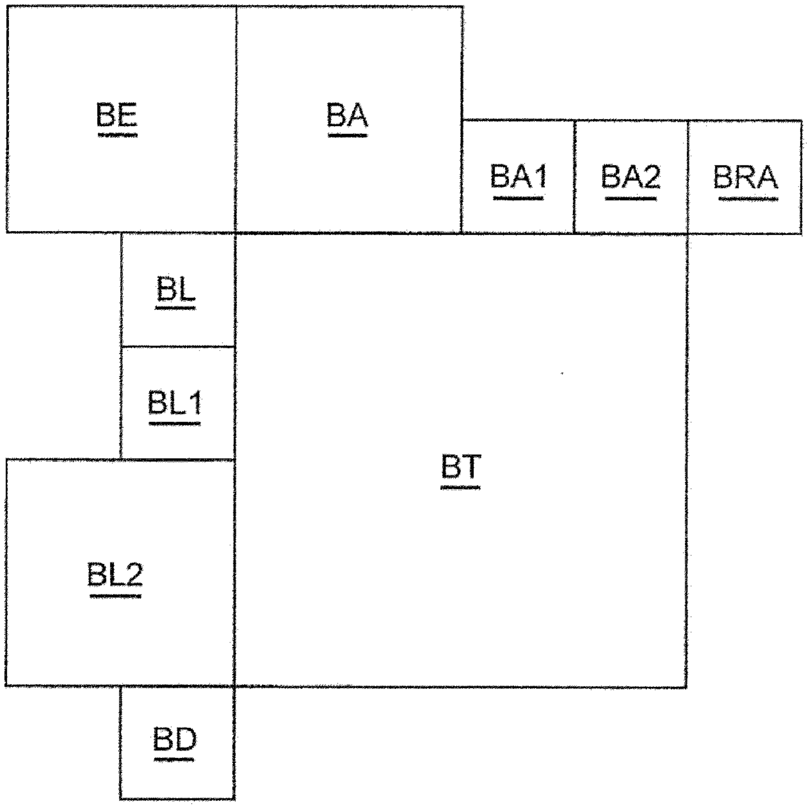


Fig.1B



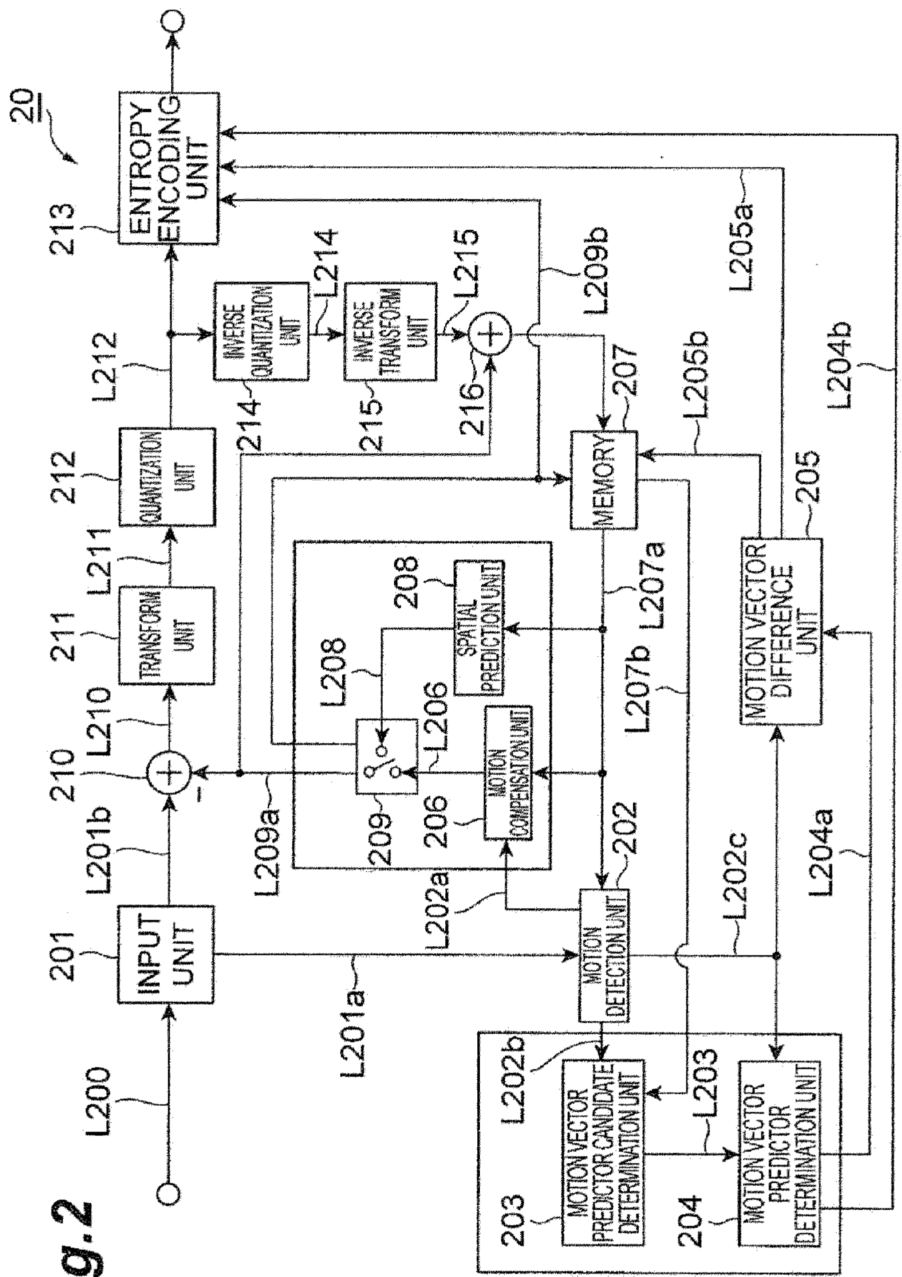
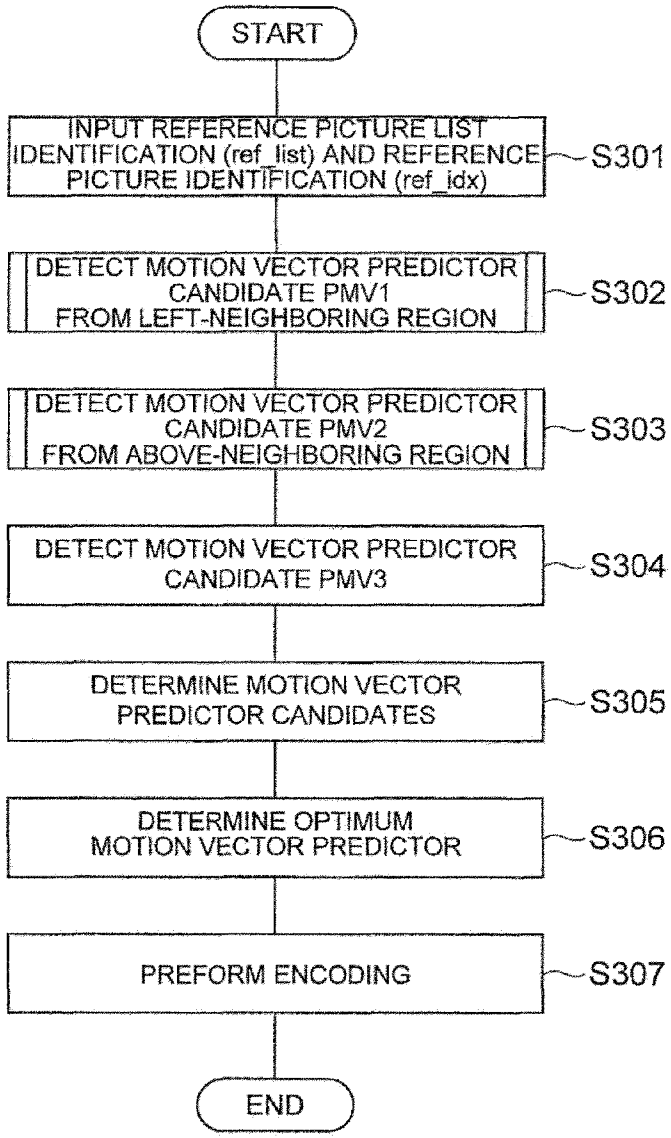

20
INPUT UNIT
TRANSFORM UNIT
QUANTIZATION UNIT
ENTROPY ENCODING UNIT
INVERSE QUANTIZATION UNIT
INVERSE TRANSFORM UNIT
MEMORY
SPATIAL PREDICTION UNIT
MOTION COMPENSATION UNIT
MOTION DETECTION UNIT
MOTION VECTOR DIFFERENCE UNIT
MOTION VECTOR PREDICTOR CANDIDATE DETERMINATION UNIT
MOTION VECTOR PREDICTOR DETERMINATION UNIT
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
L200
L201a
L201b
L202a
L202b
L202c
L203
L204a
L204b
L205a
L205b
L206
L207a
L207b
L208
L209a
L209b
L210
L211
L212
L214
L215

Fig.2

Fig.3


START
INPUT REFERENCE PICTURE LIST IDENTIFICATION (ref_list) AND REFERENCE PICTURE IDENTIFICATION (ref_idx)
S301
DETECT MOTION VECTOR PREDICTOR CANDIDATE PMV1 FROM LEFT-NEIGHBORING REGION
S302
DETECT MOTION VECTOR PREDICTOR CANDIDATE PMV2 FROM ABOVE-NEIGHBORING REGION
S303
DETECT MOTION VECTOR PREDICTOR CANDIDATE PMV3
S304
DETERMINE MOTION VECTOR PREDICTOR CANDIDATES
S305
DETERMINE OPTIMUM MOTION VECTOR PREDICTOR
S306
PREFORM ENCODING
S307
END

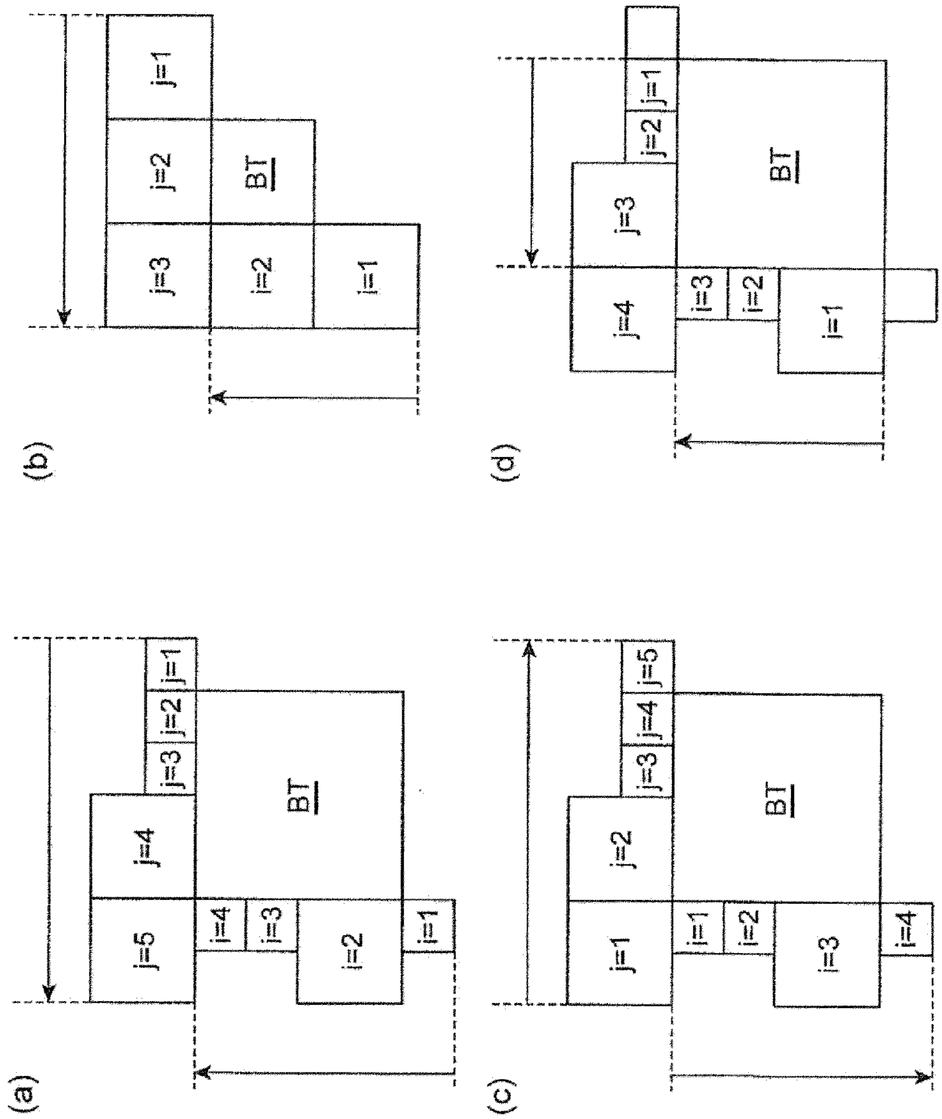

(a)
j=1
j=2
j=3
j=4
j=5
BT
i=1
i=2
i=3
i=4
(b)
j=1
j=2
j=3
BT
i=1
i=2
(c)
j=1
j=2
j=3
j=4
j=5
BT
i=1
i=2
i=3
i=4
(d)
j=1
j=2
j=3
j=4
BT
i=1
i=2
i=3

Fig.4

Fig.5

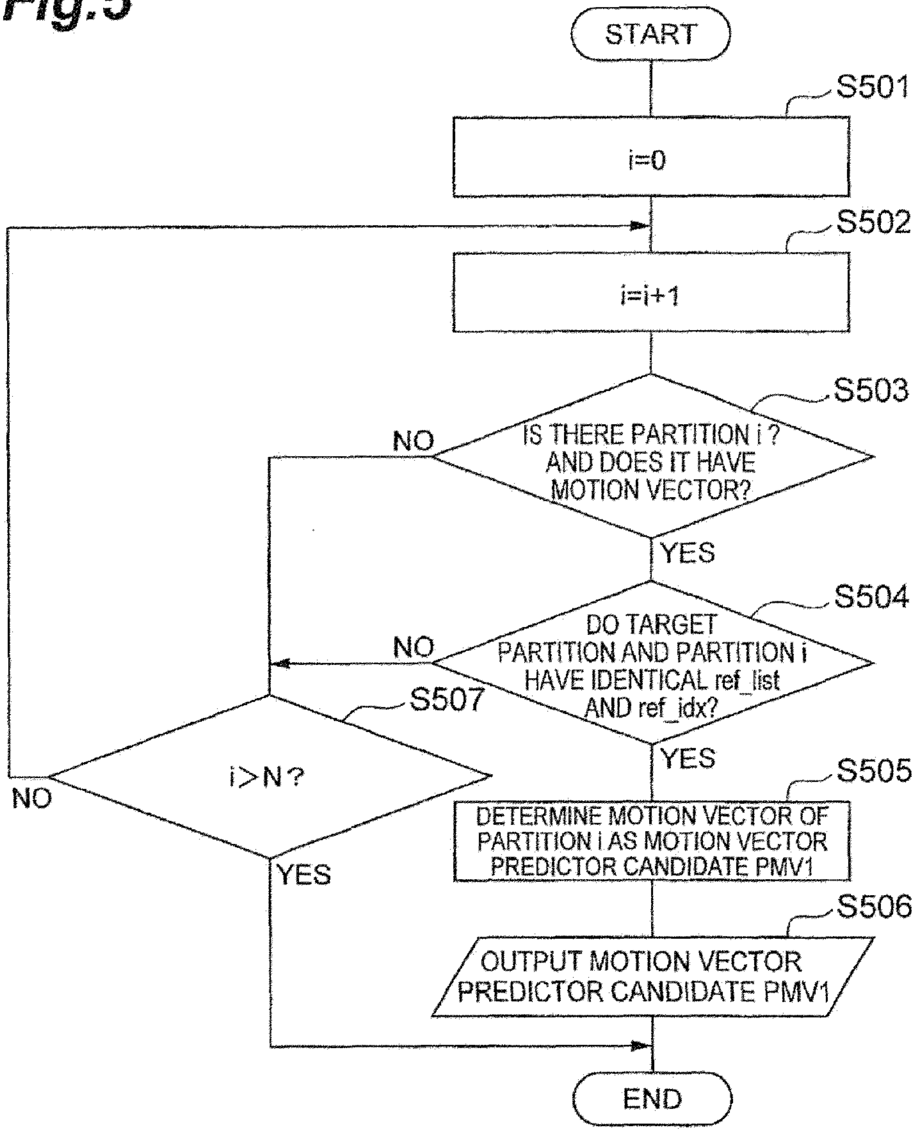

START
S501
i=0
S502
i=i+1
S503
IS THERE PARTITION i ? AND DOES IT HAVE MOTION VECTOR?
NO
YES
S504
DO TARGET PARTITION AND PARTITION i HAVE IDENTICAL ref_list AND ref_idx?
NO
YES
S507
i>N ?
NO
YES
S505
DETERMINE MOTION VECTOR OF PARTITION i AS MOTION VECTOR PREDICTOR CANDIDATE PMV1
S506
OUTPUT MOTION VECTOR PREDICTOR CANDIDATE PMV1
END

Fig.6

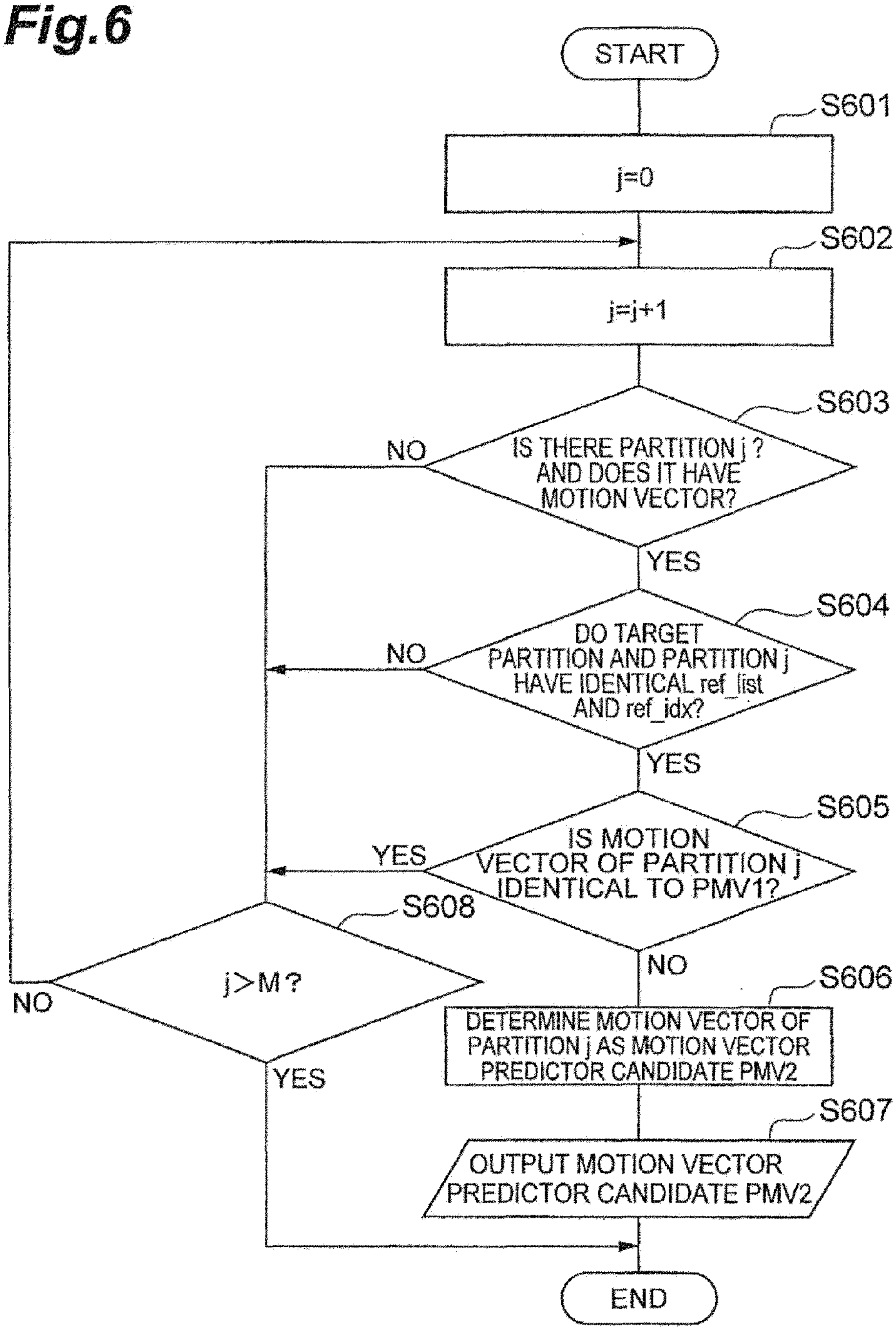

START
S601
j=0
S602
j=j+1
S603
IS THERE PARTITION j ? AND DOES IT HAVE MOTION VECTOR?
NO
YES
S604
DO TARGET PARTITION AND PARTITION j HAVE IDENTICAL ref_list AND ref_idx?
NO
YES
S605
IS MOTION VECTOR OF PARTITION j IDENTICAL TO PMV1?
YES
NO
S608
j>M?
NO
YES
S606
DETERMINE MOTION VECTOR OF PARTITION j AS MOTION VECTOR PREDICTOR CANDIDATE PMV2
S607
OUTPUT MOTION VECTOR PREDICTOR CANDIDATE PMV2
END

Fig.7

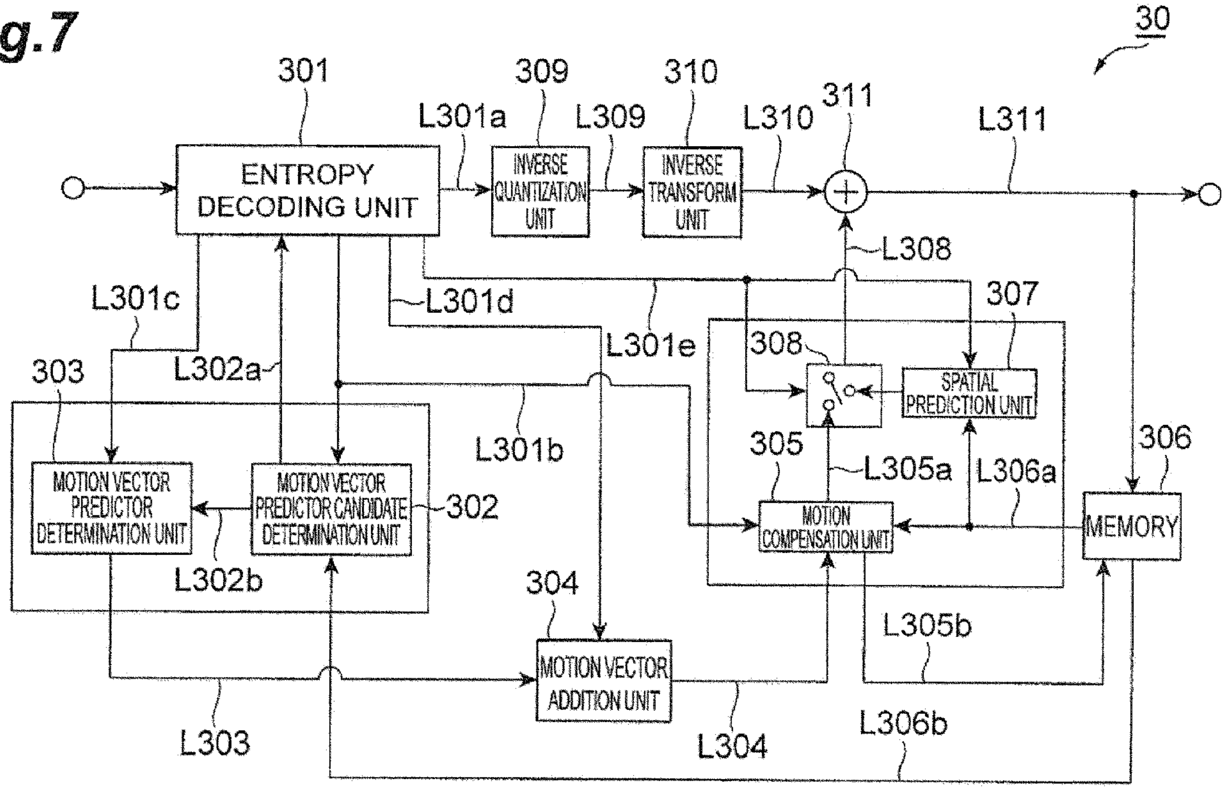

30
301
ENTROPY DECODING UNIT
309
INVERSE QUANTIZATION UNIT
310
INVERSE TRANSFORM UNIT
311
L301a
L309
L310
L311
L308
L301c
L301d
L301e
L302a
L301b
307
308
SPATIAL PREDICTION UNIT
303
MOTION VECTOR PREDICTOR DETERMINATION UNIT
MOTION VECTOR PREDICTOR CANDIDATE DETERMINATION UNIT
302
305
L305a
L306a
306
MEMORY
MOTION COMPENSATION UNIT
L302b
304
MOTION VECTOR ADDITION UNIT
L305b
L303
L304
L306b

Fig.8

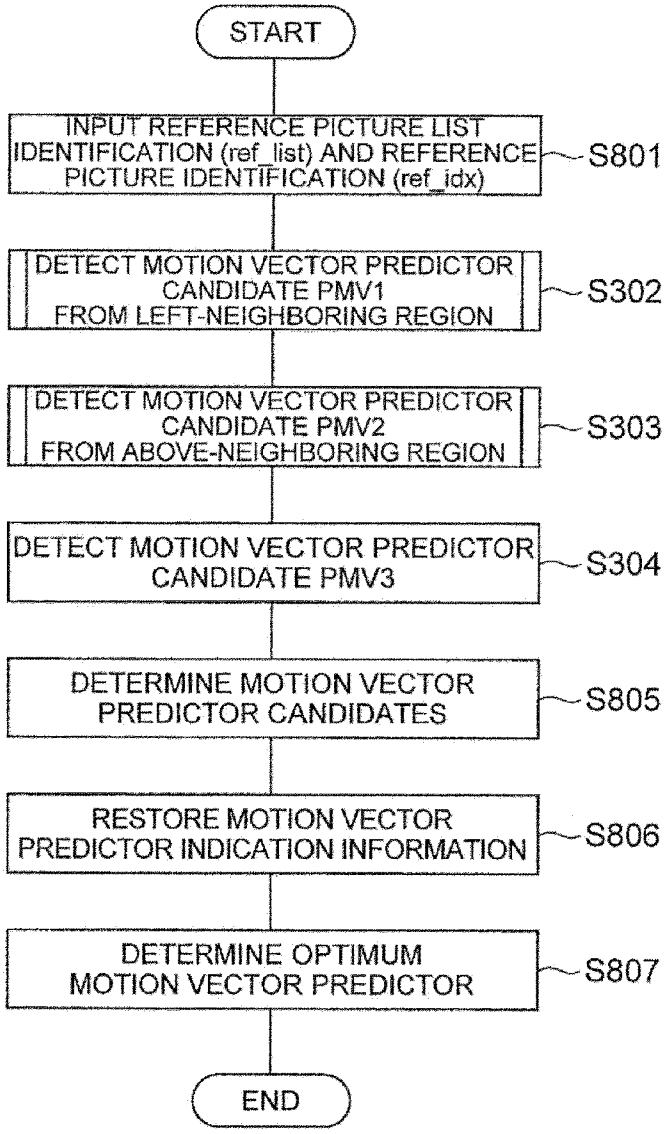

START
INPUT REFERENCE PICTURE LIST IDENTIFICATION (ref_list) AND REFERENCE PICTURE IDENTIFICATION (ref_idx)
S801
DETECT MOTION VECTOR PREDICTOR CANDIDATE PMV1 FROM LEFT-NEIGHBORING REGION
S302
DETECT MOTION VECTOR PREDICTOR CANDIDATE PMV2 FROM ABOVE-NEIGHBORING REGION
S303
DETECT MOTION VECTOR PREDICTOR CANDIDATE PMV3
S304
DETERMINE MOTION VECTOR PREDICTOR CANDIDATES
S805
RESTORE MOTION VECTOR PREDICTOR INDICATION INFORMATION
S806
DETERMINE OPTIMUM MOTION VECTOR PREDICTOR
S807
END

Fig.9

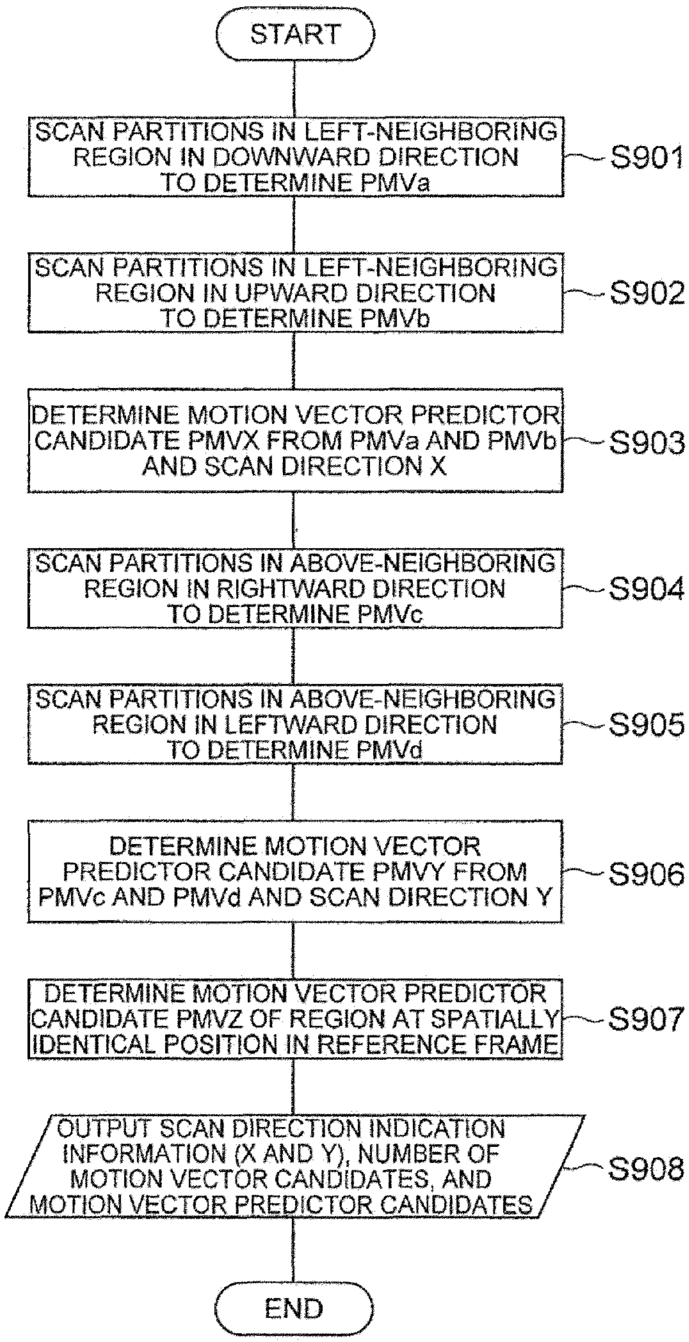

START
SCAN PARTITIONS IN LEFT-NEIGHBORING REGION IN DOWNWARD DIRECTION TO DETERMINE PMVa
S901
SCAN PARTITIONS IN LEFT-NEIGHBORING REGION IN UPWARD DIRECTION TO DETERMINE PMVb
S902
DETERMINE MOTION VECTOR PREDICTOR CANDIDATE PMVX FROM PMVa AND PMVb AND SCAN DIRECTION X
S903
SCAN PARTITIONS IN ABOVE-NEIGHBORING REGION IN RIGHTWARD DIRECTION TO DETERMINE PMVc
S904
SCAN PARTITIONS IN ABOVE-NEIGHBORING REGION IN LEFTWARD DIRECTION TO DETERMINE PMVd
S905
DETERMINE MOTION VECTOR PREDICTOR CANDIDATE PMVY FROM PMVc AND PMVd AND SCAN DIRECTION Y
S906
DETERMINE MOTION VECTOR PREDICTOR CANDIDATE PMVZ OF REGION AT SPATIALLY IDENTICAL POSITION IN REFERENCE FRAME
S907
OUTPUT SCAN DIRECTION INDICATION INFORMATION (X AND Y), NUMBER OF MOTION VECTOR CANDIDATES, AND MOTION VECTOR PREDICTOR CANDIDATES
S908
END

Fig.10

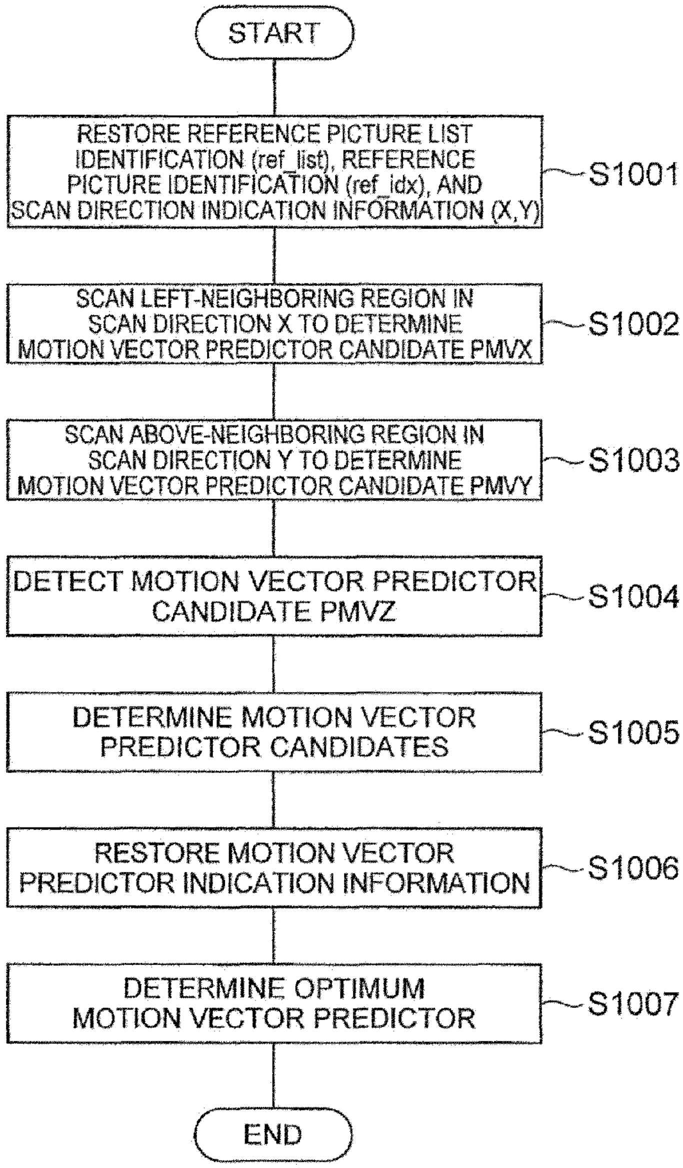

START
RESTORE REFERENCE PICTURE LIST IDENTIFICATION (ref_list), REFERENCE PICTURE IDENTIFICATION (ref_idx), AND SCAN DIRECTION INDICATION INFORMATION (X,Y)
S1001
SCAN LEFT-NEIGHBORING REGION IN SCAN DIRECTION X TO DETERMINE MOTION VECTOR PREDICTOR CANDIDATE PMVX
S1002
SCAN ABOVE-NEIGHBORING REGION IN SCAN DIRECTION Y TO DETERMINE MOTION VECTOR PREDICTOR CANDIDATE PMVY
S1003
DETECT MOTION VECTOR PREDICTOR CANDIDATE PMVZ
S1004
DETERMINE MOTION VECTOR PREDICTOR CANDIDATES
S1005
RESTORE MOTION VECTOR PREDICTOR INDICATION INFORMATION
S1006
DETERMINE OPTIMUM MOTION VECTOR PREDICTOR
S1007
END

Fig.11

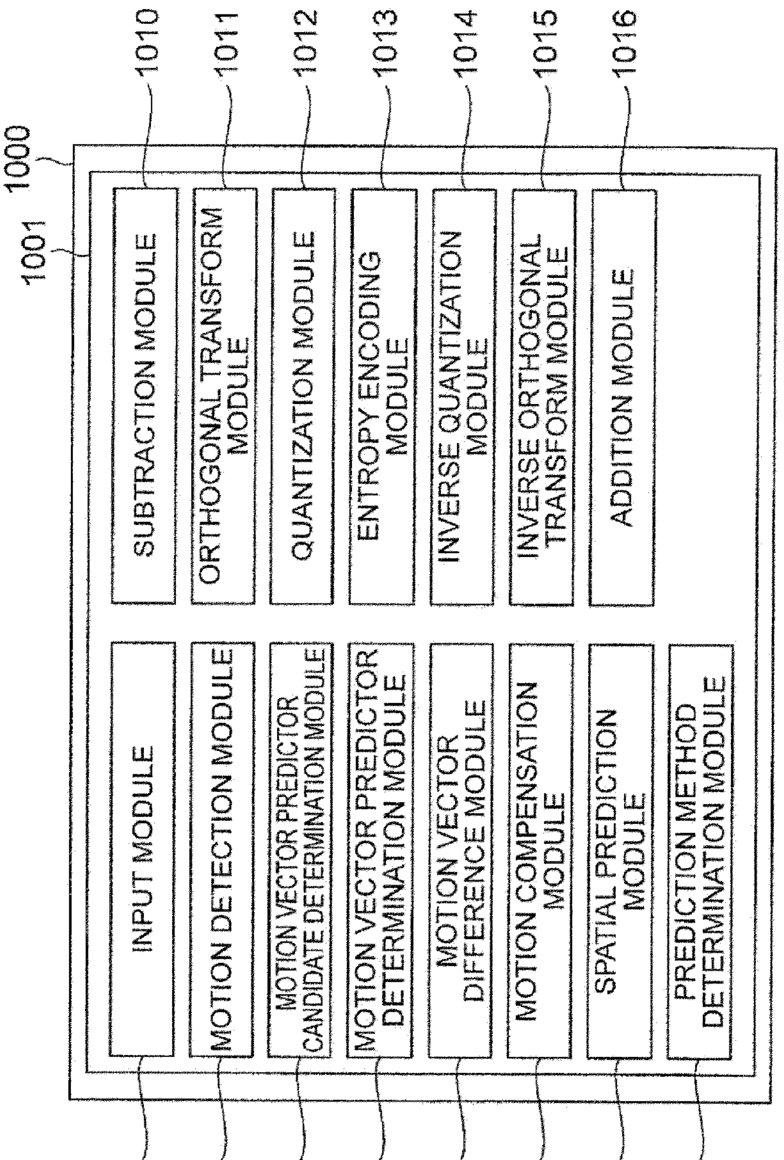

1000
1001
INPUT MODULE
1002
MOTION DETECTION MODULE
1003
MOTION VECTOR PREDICTOR CANDIDATE DETERMINATION MODULE
1004
MOTION VECTOR PREDICTOR DETERMINATION MODULE
1005
MOTION VECTOR DIFFERENCE MODULE
1006
MOTION COMPENSATION MODULE
1007
SPATIAL PREDICTION MODULE
1008
PREDICTION METHOD DETERMINATION MODULE
1009
SUBTRACTION MODULE
1010
ORTHOGONAL TRANSFORM MODULE
1011
QUANTIZATION MODULE
1012
ENTROPY ENCODING MODULE
1013
INVERSE QUANTIZATION MODULE
1014
INVERSE ORTHOGONAL TRANSFORM MODULE
1015
ADDITION MODULE
1016

Fig.12

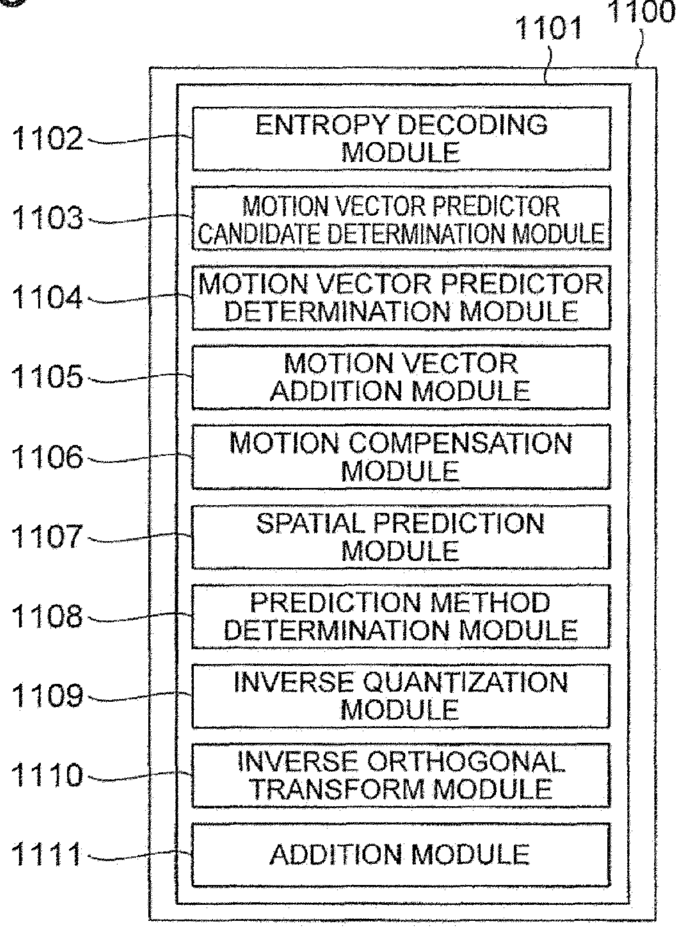

1100
1101
1102
ENTROPY DECODING MODULE
1103
MOTION VECTOR PREDICTOR CANDIDATE DETERMINATION MODULE
1104
MOTION VECTOR PREDICTOR DETERMINATION MODULE
1105
MOTION VECTOR ADDITION MODULE
1106
MOTION COMPENSATION MODULE
1107
SPATIAL PREDICTION MODULE
1108
PREDICTION METHOD DETERMINATION MODULE
1109
INVERSE QUANTIZATION MODULE
1110
INVERSE ORTHOGONAL TRANSFORM MODULE
1111
ADDITION MODULE

Fig.13

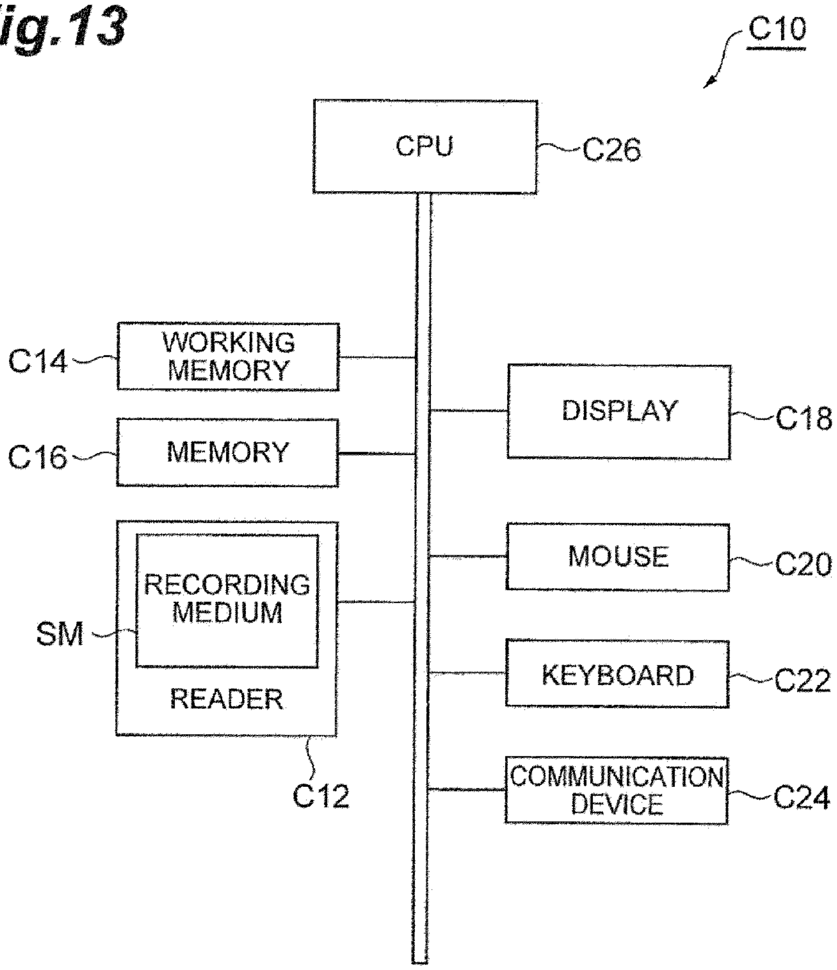

C10
CPU
C26
C14
WORKING MEMORY
C16
MEMORY
SM
RECORDING MEDIUM
READER
C12
DISPLAY
C18
MOUSE
C20
KEYBOARD
C22
COMMUNICATION DEVICE
C24

Fig.14