

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
29 January 2004 (29.01.2004)

PCT

(10) International Publication Number
WO 2004/010708 A1

(51) International Patent Classification⁷: **H04N 7/34**

(21) International Application Number:
PCT/KR2003/000701

(22) International Filing Date: 8 April 2003 (08.04.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10-2002-0041986 18 July 2002 (18.07.2002) KR

(71) Applicant: **SAMSUNG ELECTRONICS CO., LTD.**
[KR/KR]; 416 Maetan-dong, Paldal-gu, Suwon-city,
Kyungki-do 442-373 (KR).

(72) Inventor: **SONG, Byung-Cheol**; 405-1104
Cheongmyung Maeul 4-danji, Jugong Apt.,
Youngtong-dong, Paldal-gu, Suwon-si, Gyeonggi-do
442-738 (KR).

(74) Agent: **LEE, Young-Pil**; The Cheonghwa Building,
1571-18, Seocho-dong, Seocho-gu, Seoul 137-874 (KR).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

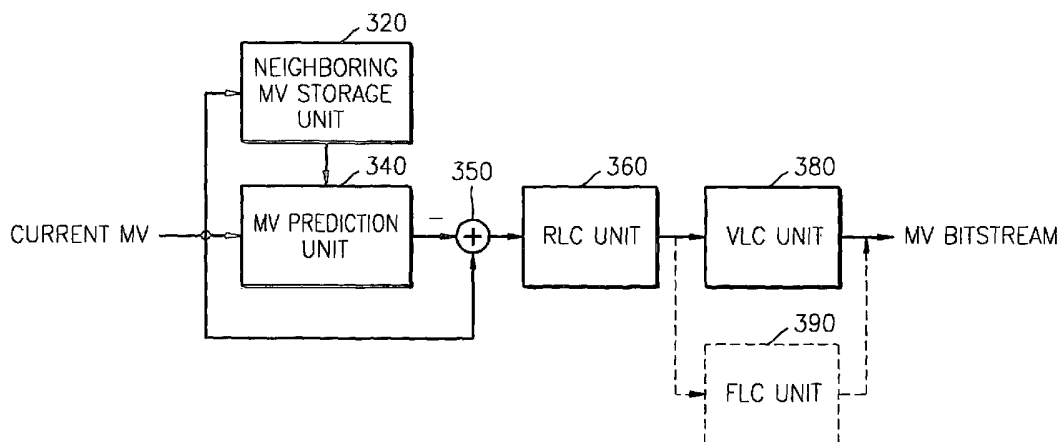
(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ADVANCED METHOD OF CODING AND DECODING MOTION VECTOR AND APPARATUS THEREFOR



(57) Abstract: A method of coding and decoding a motion vector and an apparatus therefor are provided. The method includes calculating a motion vector difference between a motion vector of a current block and a motion vector of a reference block; and performing run-length coding on the calculated motion vector difference in predetermined group units composed of at least one macro block.

WO 2004/010708 A1

ADVANCED METHOD OF CODING AND DECODING MOTION VECTOR AND APPARATUS THEREFOR

5 Technical Field

The present invention relates to a method and apparatus for coding a moving image, and more particularly, to a method and apparatus for efficiently coding and decoding a motion vector in a moving image compression technique based on motion compensation.

10

Background Art

Moving image compression standards, such as Moving Picture Experts Group (MPEG) and H.26x, employ a compression method based on motion compensation and conversion. In such a coding method based on motion compensation, motion vector information of each block must be coded before transmission. When Common Intermediate Format (CIF) or Quarter-CIF (QCIF) images are coded at a low transmission rate, the amount of motion vector information is usually greater than 30%, so compression efficiency largely depends on a method of compressing a motion vector.

20

FIG. 1 is a block diagram of a general encoder 100 for coding a moving image. For Video On Demand (VOD) services or moving image communication, the encoder 100 generates a bitstream coded using a compression technique and outputs the generated bitstream.

25

A Discrete Cosine Transform (DCT) section 110 performs a DCT operation on image data input in units of 8×8 pixel blocks, in order to remove spatial correlation. The quantization (Q) section 120 quantizes DCT coefficients obtained in the DCT section 110 to represent them with several representative values. Consequently, efficient loss compression can be accomplished.

30

An inverse quantization (IQ) section 130 inverse quantizes the quantized image data received from the Q section 120. An Inverse Discrete Cosine Transform (IDCT) section 140 performs IDCT on the inverse-quantized image data received from the IQ section 130. A
5 frame memory section 150 stores the image data subjected to IDCT in the IDCT section 140 in frame units.

A motion estimation (ME) section 160 calculates a motion vector (MV) in each macro block using image data of a currently input frame and image data of a previous frame stored in the frame memory section
10 150. A variable length coding (VLC) section 170 codes the MV received from the ME section 160 so that statistical redundancy can be removed.

When a current macro block is determined as being coded in an inter mode, an MV of the current macro block must be transmitted to a decoder. Here, as shown in FIGS. 2A through 2D, the horizontal and
15 vertical components of the MV of the current macro block are obtained by performing differential coding using one among the MVs of three neighboring macro blocks.

In addition, U.S. Patent No. 6,122,321 discloses an encoder similar to the general encoder 100 shown in FIG. 1.

20 FIGS. 2A through 2D are diagrams for explaining an MV prediction scheme defined in an MPEG-4 specification and a prediction scheme for the edge of a frame. The following description concerns an MV prediction scheme defined in the MPEG-4 specification.

In FIGS. 2A through 2D, MV is an MV of a current macro block,
25 and its three neighboring MVs, i.e., MV1, MV2, and MV3, are candidate predictors for differential coding. MV1 is an MV of a previous macro block, MV2 is an MV of an above macro block, and MV3 is an MV of an above right macro block. Dotted lines indicate a border of a frame, for example, a video object plane (VOP) defined in the MPEG-4, including
30 the current macro block. The following rules are applied to macro blocks at the edge of a current frame.

1. When a single macro block having a candidate predictor is positioned outside the current frame, the candidate predictor of the macro block is set to (0, 0).

2. When two macro blocks having a candidate predictor are positioned outside the current frame, the candidate predictors of the respective macro blocks are set to the same value as a candidate predictor of a macro block within the current frame.

3. When all macro blocks having a candidate predictor are positioned outside the current frame, the candidate predictors of the respective macro blocks are set to (0, 0).

When a single MV is transmitted per macro block, as shown in FIG. 2, a predictor for a current macro block is determined using MVs of neighboring macro blocks, i.e., candidate predictors, and then a difference between the determined predictor and the MV of the current macro block is transmitted.

Hereinafter, a method of calculating a predictor value will be described with reference to FIGS. 2A through 2D.

Referring to FIGS. 2A through 2D, a predictor value corresponding to the MV of a current macro block is a median of the neighboring MVs, i.e., MV1, MV2, and MV3. In addition, MV coding is independently performed on the horizontal and vertical components of the MV. Accordingly, medians for the respective horizontal and vertical components of the MV are separately calculated using Formulas (1) and (2).

$$P_x = \text{Median}(MV1_x, MV2_x, MV3_x) \quad \dots(1)$$

$$P_y = \text{Median}(MV1_y, MV2_y, MV3_y) \quad \dots(2)$$

For example, when $MV1 = (-2, 3)$, $MV2 = (1, 5)$, and $MV3 = (-1, 7)$,

$P_x = 1$ and $P_y = 5$ according to Formulas (1) and (2).

In the meantime, when an error_resilient_disable_flag is not set in the MPEG-2 and the MPEG-4, prediction in one direction is performed using Formulas (3) and (4).

5

$$P_x = MV1_x \quad \dots(3)$$

$$P_y = MV1_y \quad \dots(4)$$

10

Here, if a resynchronization marker is generated, immediately the MV1 is set to (0, 0).

MV differences MVD_x and MVD_y for the respective components of the MV are calculated according to Formulas (5) and (6) using the medians, i.e. predictor values, P_x and P_y calculated according to Formulas (1) and (2) or the predictor values P_x and P_y calculated according to Formulas (3) and (4).

15

$$MVD_x = MV_x - P_x \quad \dots(5)$$

20

$$MVD_y = MV_y - P_y \quad \dots(6)$$

25

Each of the MV differences is converted into a bitstream not having statistical redundancy, using a variable length coder. Here, codes used for performing VLC on the MV differences MVD_x and MVD_y are a little different depending on standards.

30

However, in conventional technology, even though the MV differences MVD_x and MVD_y have a value of 0 in many images, one bit must be transmitted as information on each of the MV differences MVD_x and MVD_y because every process for MV coding is performed in units of macro blocks. Accordingly, the conventional technology has the

disadvantage of generating unnecessary MV information on a frame having no motion or having a uniform MV field.

Disclosure of the Invention

5 The present invention provides an advanced method of coding a motion vector and an apparatus therefor, by which motion vector coding efficiency can be increased.

 The present invention also provides an advanced method of decoding a motion vector and an apparatus therefor, by which motion
10 vector coding and decoding efficiency can be increased.

 According to an aspect of the present invention, there is provided a method of coding a motion vector. The method includes (a) calculating a motion vector difference between a motion vector of a current block and a motion vector of a reference block, and (b)
15 performing run-length coding on the calculated motion vector difference in predetermined group units composed of at least one macro block.

 Preferably, the predetermined group unit is one selected from the group consisting of a single macro block, a half slice, a single slice, a plurality of slices, and a single frame.

20 Preferably, the method further includes (c) performing variable length coding on a vector (run, length) indicating a run-length coded motion vector difference.

 Preferably, the method further includes (d) inserting coding unit information, which indicates the predetermined group unit for the
25 run-length coding, into the coded result.

 According to another aspect of the present invention, there is provided a method of coding a motion vector. The method includes (a) calculating a motion vector difference between a motion vector of a current block and a motion vector of a reference block, (b1) performing
30 run-length coding on the calculated motion vector difference in first group units composed of at least one macro block, and (b2) performing

run-length coding on the calculated motion vector difference in second group units composed of at least one macro block.

Preferably, the method further includes (c1) performing variable length coding on a vector (run, length) indicating a run-length coded motion vector difference obtained in step (b1) using a variable length coding table formed in first group units; and (c2) performing variable length coding on a vector (run, length) indicating a run-length coded motion vector difference obtained in step (b2) using a variable length coding table formed in second group units.

10 Preferably, the first and second group units are each a single macro block, a half slice, a single slice, a plurality of slices, or a single frame, and the first group unit is different from the second group unit.

Preferably, the method further includes (d) comparing the amount of data in a motion vector bitstream resulting from the first-group unit coding performed in step (c1) with the amount of data in a motion vector bitstream resulting from the second-group unit coding performed in step (c2) so as to select the motion vector bitstream having less data, and (e) inserting coding unit information indicating a coding unit used for the selected motion vector bitstream into the selected motion vector bitstream.

According to still another aspect of the present invention, there is provided a method of decoding a coded motion vector bitstream. The method includes (a) performing variable length decoding on an input motion vector bitstream in predetermined coding units, (b) performing run-length decoding on the variable length decoded motion vector bitstream in the predetermined coding units, (c) calculating a motion vector difference between a motion vector of a current block and a motion vector of a reference block from run-length decoded data obtained in step (b), and (d) calculating the motion vector of the current block using the calculated motion vector difference.

Preferably, the coding unit is a single macro block, a half slice, a

single slice, a plurality of slices, or a single frame.

Preferably, step (a) includes detecting the coding unit used for the input motion vector bitstream from coding unit information included in the input motion vector bitstream, and performing variable length decoding
5 on the input motion vector bitstream using a variable length decoding table formed in the detected coding units.

According to still another aspect of the present invention, there is provided an apparatus for coding a motion vector. The apparatus includes a motion vector difference calculation unit, which calculates a
10 motion vector difference between a motion vector of a current block and a motion vector of a reference block; and a run-length coding unit, which performs run-length coding on the motion vector difference calculated by the motion vector difference calculation unit in predetermined group units composed of at least one macro block.

According to still another aspect of the present invention, there is provided an apparatus for coding a motion vector. The apparatus includes a motion vector difference calculation unit, which calculates a motion vector difference between a motion vector of a current block and a motion vector of a reference block; a first run-length coding unit, which
20 performs run-length coding on the motion vector difference calculated by the motion vector difference calculation unit, in first group units composed of at least one macro block; and a second run-length coding unit, which performs run-length coding on the motion vector difference calculated by the motion vector difference calculation unit, in second
25 group units composed of at least one macro block.

According to still another aspect of the present invention, there is provided an apparatus for decoding a coded motion vector bitstream. The apparatus includes a variable length decoding unit, which performs variable length decoding on an input motion vector bitstream in
30 predetermined coding units; a run-length decoding unit, which performs run-length decoding on the variable length decoded motion vector

bitstream output from the variable length decoding unit in the predetermined coding units; and a motion vector difference calculation unit, which calculates a motion vector difference between a motion vector of a current block and a motion vector of a reference block from run-length decoded data output from the run-length decoding unit.

Brief Description of the Drawings

FIG. 1 is a block diagram of a general encoder for coding a moving image.

FIGS. 2A through 2D are diagrams for explaining a motion vector (MV) prediction method performed by an MV encoder.

FIG. 3 is a diagram of an apparatus for coding an MV according to a first embodiment of the present invention.

FIG. 4 is a diagram of an apparatus for coding an MV according to a second embodiment of the present invention.

FIG. 5 is a diagram of an apparatus for decoding an MV according to the first embodiment of the present invention.

FIG. 6 is a flowchart of a method of coding an MV according to the first embodiment of the present invention.

FIG. 7 is a flowchart of a method of coding an MV according to the second embodiment of the present invention.

FIG. 8 is a flowchart of a method of decoding a coded MV bitstream according to the first embodiment of the present invention.

Best mode for carrying out the Invention

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the attached drawings.

FIG. 3 is a diagram of an apparatus for coding a motion vector (MV) according to a first embodiment of the present invention. The apparatus for coding an MV includes a neighboring MV storage unit 320 storing information on the MVs of blocks neighboring a current block; a

MV prediction unit 340, which detects a predictor for the MV of the current block using the neighboring MV information stored in the neighboring MV storage unit 320; an MV difference (MVD) calculation unit 350, which calculates an MVD, i.e., a difference between the predictor detected by the MV prediction unit 340 and the MV of the current block; a run-length coding (RLC) unit 360, which performs RLC on the calculated MVD in predetermined units, for example, in slice units or in frame units; and a variable length coding (VLC) unit 380, which performs VLC on the output of the RLC unit 360.

Hereinafter, operation of the apparatus for coding an MV according to the first embodiment of the present invention will be described with reference to FIG. 3.

Generally, MVs have strong correlation to their neighboring MVs and form a uniform MV field. Accordingly, in many cases, predictors calculated using Formulas (1) through (4) are the same as the MV of a current block, that is, $MVD_x = 0$ (or $MVD_y = 0$). In addition, MVDs consecutively have a value of 0 in many cases. The present invention is based on these characteristics.

According to the first embodiment of the present invention, the MV prediction unit 340 calculates predictors P_x and P_y using the neighboring MV information stored in the neighboring MV storage unit 320 and Formulas (1) and (2) based on a median filtering method. However, the predictors P_x and P_y can be calculated using Formulas (3) and (4).

The MVD calculation unit 350 calculates MVDs using current MV information and the predictors P_x and P_y obtained by the MV prediction unit 340.

The RLC unit 360 performs RLC on MVDs calculated by the MVD calculation unit 350 in selected group units, i.e., slice units or frame units, in the first embodiment. For example, when the size of a current frame is 352×288 and all macro blocks are processed in an inter mode, RLC

is performed on 396 MVDs at one time, i.e., in frame units, or 22 MVDs at one time, i.e., in slice units. Alternatively, RLC can be performed in units of other groups having a different size than the above-described units and including at least one macro block, for example, in 1/2 slice
5 units or in units of groups including at least one slice.

In the first embodiment of the present invention, the RLC unit 360 performs two-dimensional RLC, generates and outputs a set of (run, length). Here, the "run" indicates the number of zeros before a non-zero MVD, and the "length" indicates the size of the non-zero MVD.

10 Alternatively, the RLC unit 360 may use three-dimensional RLC. In this case, the RLC unit 360 generates and outputs a set of (last, run, length). The "last" is 1-bit information indicating whether a current MVD is the last non-zero MVD.

The VLC unit 380 performs VLC on the vector (run, length) output
15 from the RLC unit 360. In the first embodiment, VLC is performed on a vector (run, length). However, fixed length coding (FLC) may be performed on the "run" of the vector (run, length) using an FLC unit 390, and VLC may be performed on the "length" using the VLC unit 380.

Selectively, coding unit information indicating a coding unit can be
20 inserted into an output MV bitstream using a coding unit information insertion unit (not shown).

FIG. 4 is a diagram of an apparatus for coding an MV according to a second embodiment of the present invention. Referring to FIG. 4, the apparatus for coding an MV includes a neighboring MV storage unit 420
25 storing information on the MVs of blocks neighboring a current block; a MV prediction unit 440, which detects a predictor for the MV of the current block using the neighboring MV information stored in the neighboring MV storage unit 420; an MVD calculation unit 450, which calculates an MVD, i.e., a difference between the predictor detected by
30 the MV prediction unit 440 and the MV of the current block; a first RLC unit 460, which performs RLC on the calculated MVD in first group units;

a second RLC unit 470, which performs RLC on the calculated MVD in second group units; a first VLC unit 462, which performs VLC on the output of the first RLC unit 460 based on a first group unit VLC table; a second VLC unit 472, which performs VLC on the output of the second RLC unit 470 based on a second group unit VLC table; and a bitstream selection/coding unit information insertion unit 480, which selects a single MV bitstream from MV bitstreams received from the first and second VLC coding units 462 and 472 and inserts coding unit information of the selected MV bitstream into the selected MV bitstream.

10 The neighboring MV storage unit 420, the MV prediction unit 440, the MVD calculation unit 450, the first and second RLC units 460 and 470, and the first and second VLC units 462 and 472 of the apparatus for coding an MV shown in FIG. 4 perform the same functions as the corresponding functional units of the apparatus shown in FIG. 3, and thus detailed descriptions thereof will be omitted.

15 The bitstream selection/coding unit information insertion unit 480 compares the amount of bits in the MV bitstream received from the first VLC unit 462 with the amount of bits in the MV bitstream received from the second VLC unit 472 in units of frames, selects the MV bitstream having fewer bits, and inserts coding unit information, which indicates a coding unit during the RLC and VLC of the selected MV bitstream, into the selected MV bitstream.

25 For example, let's assume that the first group unit is a frame and the second group unit is a slice. When an MV bitstream output from the first VLC unit 462 is selected as a finally output MV bitstream as the result of comparing the amount of data of an MV bitstream output from the first VLC 462 with the amount of data of an MV bitstream output from the second VLC 472 with respect to a single frame, coding unit information indicating that the coding unit used in the first RLC unit 460 and the first VLC unit 462 was a frame is inserted into the selected MV bitstream.

In the second embodiment of the present invention, the coding unit information is set per frame and uses a flag of one bit. However, the coding unit information can be set per a different predetermined group and can use a flag having the different predetermined number of bits.

FIG. 5 is a diagram of an apparatus for decoding an MV according to the first embodiment of the present invention. The apparatus for decoding an MV includes a variable length decoding (VLD) unit 520 performing VLD on an input MV bitstream so as to generate a vector (run, length), and a run-length decoding (RLD) unit 540 performing RLD on the vector (run, length) generated from the VLD unit 520 so as to generate an MVD. This apparatus restores an MV in units of macro blocks using the MVD generated from the RLD 540 and MV information stored in a neighboring MV storage unit 560.

When necessary, for example, when FLC has been performed on the "run" of the vector (run, length) during encoding, a fixed length decoding (FLD) unit 530 can be used to perform FLD on the "run" of the vector (run, length).

FIG. 6 is a flowchart of a method of coding an MV according to the first embodiment of the present invention. The method of coding an MV according to the first embodiment will be described with reference to FIGS. 3 and 6.

A predictor for an MV of a current block is detected using MV information of blocks neighboring the current block in step 620. In the first embodiment of the present invention, the MV prediction unit 340 calculates predictors P_x and P_y using the MV information of blocks neighboring the current block stored in the neighboring MV storage unit 320 and Formulas (1) and (2) based on a median filtering method. However, the predictors P_x and P_x can be calculated using Formulas (3) and (4).

A difference, i.e., an MVD, between the detected predictor and

MV information of the current block is calculated in step 640. In the first embodiment of the present invention, the MVD calculation unit 350 calculates MVDs using the current MV information and the predictors P_x and P_y obtained by the MV prediction unit 340.

5 RLC is performed on the MVDs calculated in step 640 in predetermined group units, for example, in slice units, in step 660. In the first embodiment of the present invention, RLC is performed on the MVDs in slice units. However, RLC can be performed in frame units or in units of other groups having a predetermined size.

10 VLC is performed on a run-length coded MV bitstream obtained in step 660, in step 680.

FIG. 7 is a flowchart of a method of coding an MV according to the second embodiment of the present invention. The method of coding an MV according to the second embodiment will be described with reference to FIGS. 4 and 7.

15 A predictor for an MV of a current block is detected using MV information of blocks neighboring the current block in step 710. In the second embodiment of the present invention, the MV prediction unit 440 calculates predictors P_x and P_y using the MV information of blocks neighboring the current block stored in the neighboring MV storage unit 420 and Formulas (1) and (2) based on a median filtering method. However, the predictors P_x and P_x can be calculated using Formulas (3) and (4).

25 A difference, i.e., an MVD, between the detected predictor and MV information of the current block is calculated in step 720. In the second embodiment of the present invention, the MVD calculation unit 450 calculates MVDs using the current MV information and the predictors P_x and P_y obtained by the MV prediction unit 440.

30 RLC is performed on the MVDs calculated in step 720 in first group units in step 730. VLC is performed on a run-length coded MV bitstream obtained in step 730, using a VLC table formed in the second

group units, in step 732.

RLC is performed on the MVDs calculated in step 720 in second group units in step 740. VLC is performed on a run-length coded MV bitstream obtained in step 740, using a VLC table formed in the first
5 group units in step 742.

The amount of data in an MV bitstream obtained by performing VLC in the first group units in step 732 is compared with the amount of data in an MV bitstream obtained by performing VLC in the second group units in step 742, in step 750. If the amount of data in the first-group
10 unit coded MV bitstream is less than the amount of data in the second-group unit coded MV bitstream, the method progresses to step 760. If the amount of data in the second-group unit coded MV bitstream is less than the amount of data in the first-group unit coded MV bitstream, the method progresses to step 770.

15 The MV bitstream obtained in step 732 is selected in step 760. Then, coding unit information indicating that a coding unit is the first group unit is inserted into the selected MV bitstream in step 762.

The MV bitstream obtained in step 742 is selected in step 770. Then, coding unit information indicating that a coding unit is the second
20 group unit is inserted into the selected MV bitstream in step 772.

In the first embodiment of the present invention, the amounts of data in the respective MV bitstreams are compared with each other in frame units in step 750. However, the comparison can be performed in different predetermined group units, for example, in slice units or in units
25 of groups including at least two slices.

FIG. 8 is a flowchart of a method of decoding a coded MV bitstream according to the first embodiment of the present invention. Referring to FIG. 8, a coding unit is detected from coding unit information included in an input MV bitstream in step 810.

30 VLD is performed on the input MV bitstream using a VLD table formed in the detected coding units in step 820. In the first embodiment

of the present invention, the coding unit is a frame or slice. However, the coding unit may be a predetermined group composed of at least one macro block.

RLD is performed on the variable length decoded MV bitstream in step 830. MVDs between an MV of a current block and an MV of a reference block are calculated from the run-length decoded MV bitstream in the coding units in step 840. The MV of the current block is calculated using the calculated MVDs in step 850.

In the embodiments of the present invention, MV coding is performed in predetermined group units, for example, in frame or slice units. However, by adding a selection mode to a coded bitstream, coding can be adaptively performed in macro block units, considering the result of performing RLC and VLC on an image in frame or slice units, for example, considering the amount of bits generated in frame or slice units.

The present invention can be realized as a code which is recorded on a computer readable recording medium and can be read by a computer. The computer readable recording medium may be any type on which data which can be read by a computer system can be recorded, for example, a ROM, a RAM, a CD-ROM, a magnetic tape, a hard disc, a floppy disc, a flash memory, or an optical data storage device. The present invention can also be realized as carrier waves (for example, transmitted through the Internet). Alternatively, computer readable recording media can be distributed among computer systems connected through a network so that the present invention can be realized as a code which is stored in the recording media and can be read and executed in the computers.

The present invention is not limited to the above-described embodiments. It will be understood by those skilled in the art that various changes can be made in the embodiments without departing from the spirit and scope of the invention defined by the appended

claims.

Industrial Applicability

As described above, in the present invention, RLC is performed
5 on MVs in predetermined units using spatial correlation between MVs,
and then VLC is performed, so that MV coding efficiency can be
increased. As a result, a compression rate of a moving image coding
apparatus can be increased.

What is claimed is:

1. A method of coding a motion vector, comprising:
 - (a) calculating a motion vector difference between a motion vector of a current block and a motion vector of a reference block; and
 - 5 (b) performing run-length coding on the calculated motion vector difference in predetermined group units composed of at least one macro block.
2. The method of claim 1, wherein the predetermined group
10 unit is one selected from the group consisting of a single macro block, a half slice, a single slice, a plurality of slices, and a single frame.
3. The method of claim 1, further comprising (c) performing
15 variable length coding on a vector (run, length) indicating a run-length coded motion vector difference.
4. The method of claim 1, further comprising (c) performing
20 fixed length coding on a "run" of a vector (run, length) indicating a run-length coded motion vector difference and variable length coding on the "length".
5. The method of claim 1, further comprising (d) inserting
25 coding unit information, which indicates the predetermined group unit for the run-length coding, into the coded result.
6. A method of coding a motion vector, comprising:
 - (a) calculating a motion vector difference between a motion vector of a current block and a motion vector of a reference block;
 - (b1) performing run-length coding on the calculated motion vector
30 difference in first group units composed of at least one macro block; and
 - (b2) performing run-length coding on the calculated motion vector

difference in second group units composed of at least one macro block.

7. The method of claim 6, further comprising:

- (c1) performing variable length coding on a vector (run, length)
5 indicating a run-length coded motion vector difference obtained in step
(b1) using a variable length coding table formed in first group units; and
(c2) performing variable length coding on a vector (run, length)
indicating a run-length coded motion vector difference obtained in step
(b2) using a variable length coding table formed in second group units.

10

8. The method of claim 6, further comprising:

- (c1) performing fixed length coding on a "run" of a vector (run,
length) indicating a run-length coded motion vector difference obtained in
step (b1) and variable length coding on the "length" using a variable
15 length coding table formed in first group units; and
performing fixed length coding on a "run" of a vector (run, length)
indicating a run-length coded motion vector difference obtained in step
(b2) and variable length coding on the "length" using a variable length
coding table formed in second group units.

20

9. The method of claim 6, wherein the first and second group
units are each one selected from the group consisting of a single macro
block, a half slice, a single slice, a plurality of slices, and a single frame,
and the first group unit is different from the second group unit.

25

10. The method of claim 7, further comprising (d) comparing
the amount of data in a motion vector bitstream resulting from the
first-group unit coding performed in step (c1) with the amount of data in a
motion vector bitstream resulting from the second-group unit coding
30 performed in step (c2) so as to select the motion vector bitstream having
less data.

11. The method of claim 10, further comprising (e) inserting coding unit information indicating a coding unit used for the selected motion vector bitstream into the selected motion vector bitstream.

5

12. A method of decoding a coded motion vector bitstream, comprising:

(a) performing variable length decoding on an input motion vector bitstream in predetermined coding units;

10 (b) performing run-length decoding on the variable length decoded motion vector bitstream in the predetermined coding units;

(c) calculating a motion vector difference between a motion vector of a current block and a motion vector of a reference block from run-length decoded data obtained in step (b); and

15 (d) calculating the motion vector of the current block using the calculated motion vector difference.

13. The method of claim 12, wherein the coding unit is one selected from the group consisting of a single macro block, a half slice, a
20 single slice, a plurality of slices, and a single frame.

14. The method of claim 12, wherein step (a) comprises:

detecting the coding unit used for the input motion vector bitstream from coding unit information included in the input motion vector
25 bitstream; and

performing variable length decoding on the input motion vector bitstream using a variable length decoding table formed in the detected coding units.

30 15. An apparatus for coding a motion vector, comprising:
a motion vector difference calculation unit, which calculates a

motion vector difference between a motion vector of a current block and a motion vector of a reference block; and

5 a run-length coding unit, which performs run-length coding on the motion vector difference calculated by the motion vector difference calculation unit in predetermined group units composed of at least one macro block.

16. The apparatus of claim 15, wherein the predetermined group unit is one selected from the group consisting of a single macro
10 block, a half slice, a single slice, a plurality of slices, and a single frame.

17. The apparatus of claim 15, further comprising a variable length coding unit, which performs variable length coding on a vector (run, length) indicating a run-length coded motion vector difference
15 obtained by the run-length coding unit.

18. The apparatus of claim 15, further comprising a fixed length and variable length coding unit, which performs fixed length coding on a "run" of a vector (run, length) indicating a run-length coded motion vector
20 difference obtained by the run-length coding unit and variable length coding on the "length".

19. The apparatus of claim 17, wherein the apparatus inserts coding unit information, which indicates the predetermined group unit for
25 the run-length coding performed by the run-length coding unit, into the coded result.

20. An apparatus for coding a motion vector, comprising:
a motion vector difference calculation unit, which calculates a
30 motion vector difference between a motion vector of a current block and a motion vector of a reference block;

a first run-length coding unit, which performs run-length coding on the motion vector difference calculated by the motion vector difference calculation unit, in first group units composed of at least one macro block; and

5 a second run-length coding unit, which performs run-length coding on the motion vector difference calculated by the motion vector difference calculation unit, in second group units composed of at least one macro block.

10 21. The apparatus of claim 20, further comprising:

a first variable length coding unit, which performs variable length coding on a vector (run, length) indicating a run-length coded motion vector difference obtained by the first run-length coding unit, using a variable length coding table formed in first group units; and

15 a second variable length coding unit, which performs variable length coding on a vector (run, length) indicating a run-length coded motion vector difference obtained by the second run-length coding unit, using a variable length coding table formed in second group units.

20 22. The apparatus of claim 20, further comprising:

a first variable length coding unit, which performs fixed length coding on a "run" of a vector (run, length) indicating a first-group unit run-length coded motion vector difference obtained by the first run-length coding unit and variable length coding on the "length" using a variable
25 length coding table formed in first group units; and

a second variable length coding unit, which performs fixed length coding on a "run" of a vector (run, length) indicating a second-group unit run-length coded motion vector difference obtained by the second run-length coding unit and variable length coding on the "length" using a
30 variable length coding table formed in second group units.

23. The apparatus of claim 20, wherein the first and second group units are each one selected from the group consisting of a single macro block, a half slice, a single slice, a plurality of slices, and a single frame, and the first group unit is different from the second group unit.

5

24. The apparatus of claim 21, further comprising an optimal motion vector bitstream selection unit, which compares the amount of data in a motion vector bitstream resulting from the first-group unit coding performed by the first variable length coding unit with the amount
10 of data in a motion vector bitstream resulting from the second-group unit coding performed by the second variable length coding unit so as to select the motion vector bitstream having less data.

25. The apparatus of claim 24, wherein the optimal motion
15 vector bitstream selection unit inserts coding unit information indicating a coding unit used for the selected motion vector bitstream into the selected motion vector bitstream.

26. An apparatus for decoding a coded motion vector bitstream,
20 comprising:

a variable length decoding unit, which performs variable length decoding on an input motion vector bitstream in predetermined coding units;

a run-length decoding unit, which performs run-length decoding on
25 the variable length decoded motion vector bitstream output from the variable length decoding unit in the predetermined coding units; and

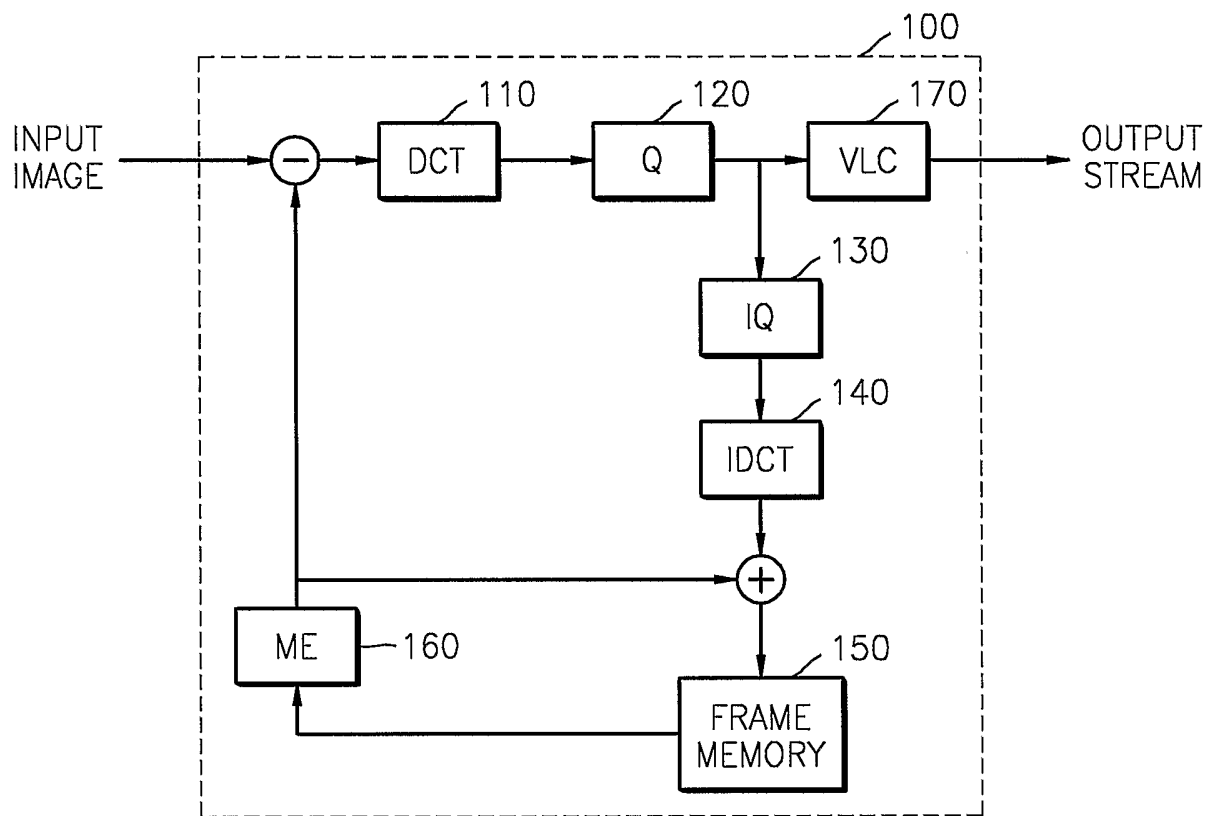
a motion vector difference calculation unit, which calculates a motion vector difference between a motion vector of a current block and a motion vector of a reference block from run-length decoded data
30 output from the run-length decoding unit.

27. The apparatus of claim 26, wherein the coding unit is one selected from the group consisting of a single macro block, a half slice, a single slice, a plurality of slices, and a single frame.

5 28. The apparatus of claim 26, wherein the variable length decoding unit detects the coding unit used for the input motion vector bitstream from coding unit information included in the input motion vector bitstream, and performs variable length decoding on the input motion vector bitstream using a variable length decoding table formed in the
10 detected coding units.

1/7

FIG. 1



2/7

FIG. 2A

	MV2	MV3
MV1	MV	

FIG. 2B

	MV2	MV3
(0,0)	MV	

FIG. 2C

	MV1	MV1
MV1	MV	

FIG. 2D

	MV2	(0,0)
MV1	MV	

FIG. 3

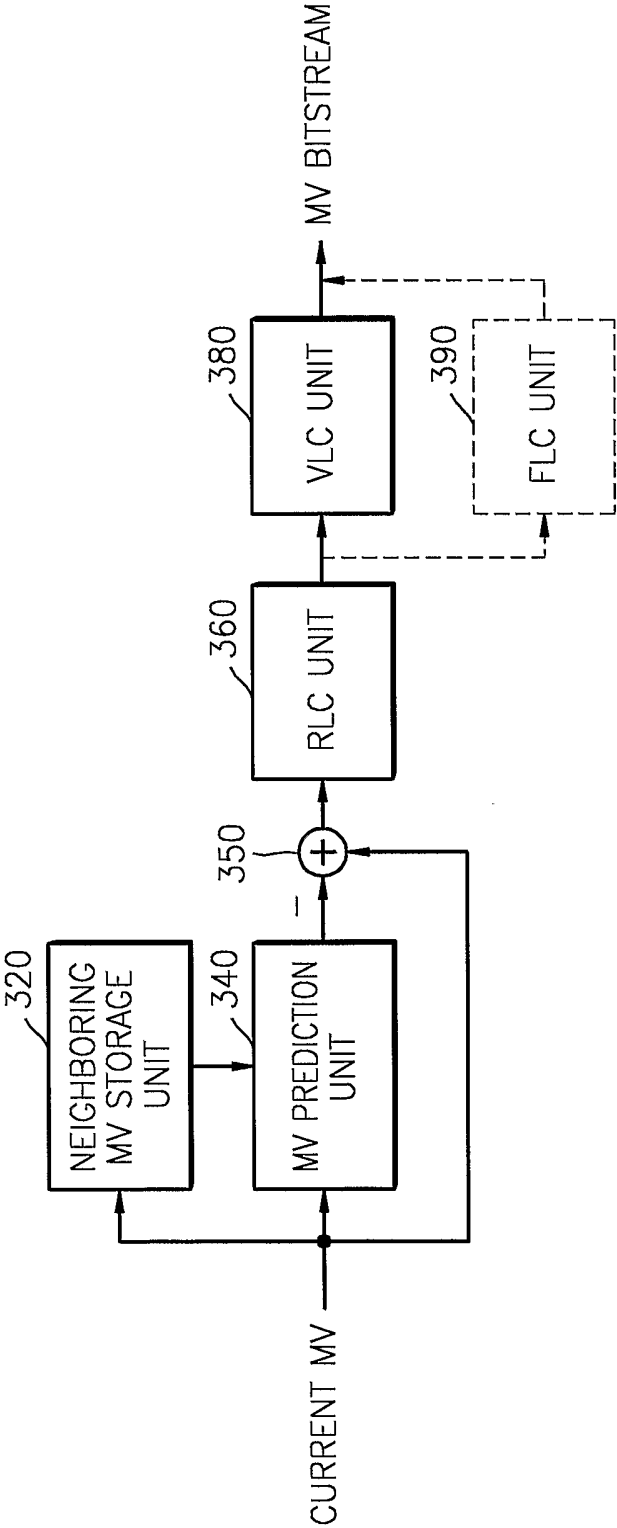
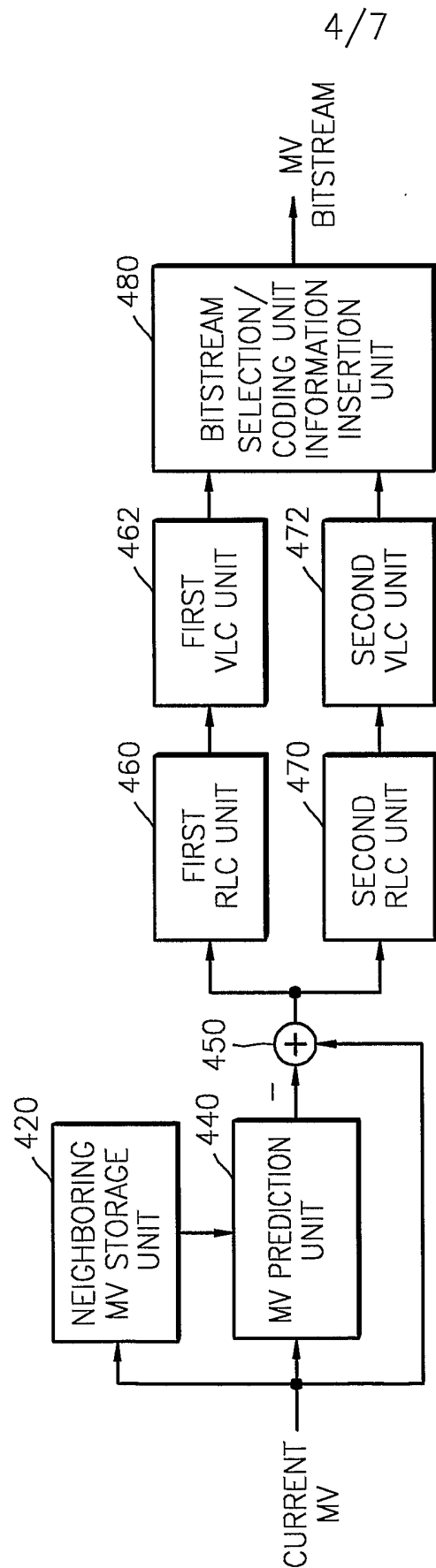


FIG. 4



5/7

FIG. 5

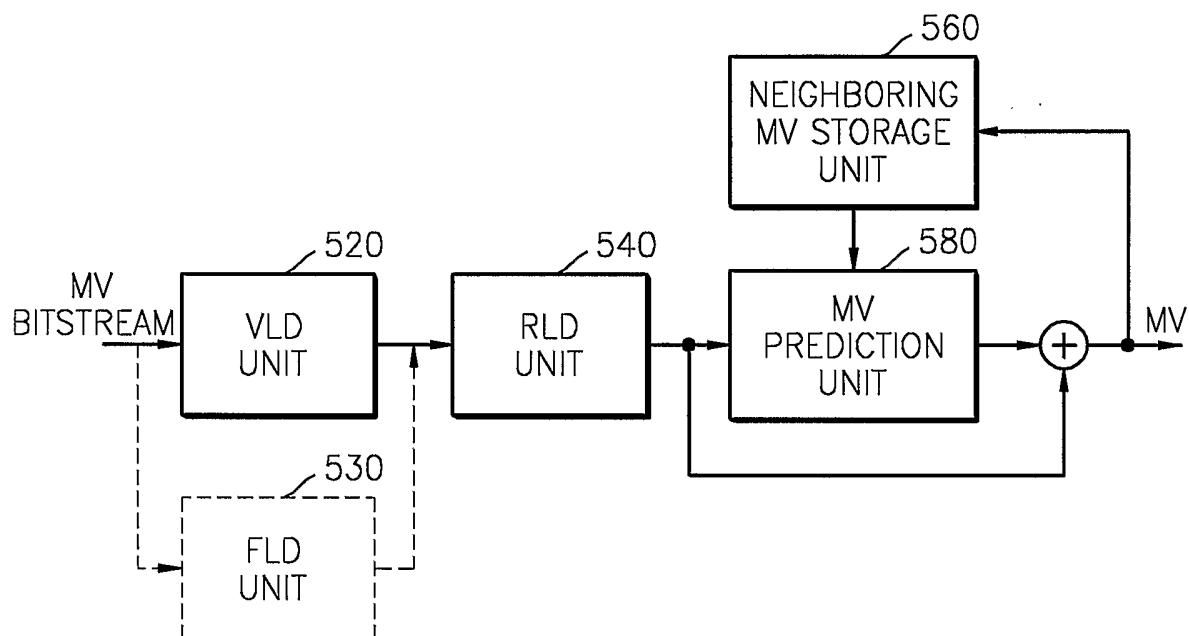
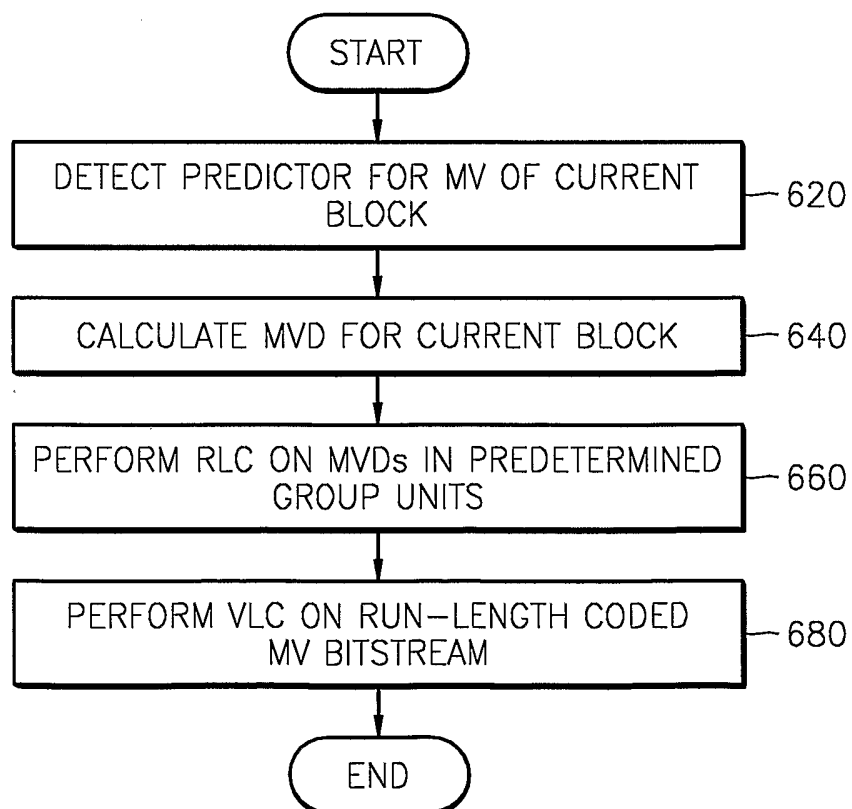
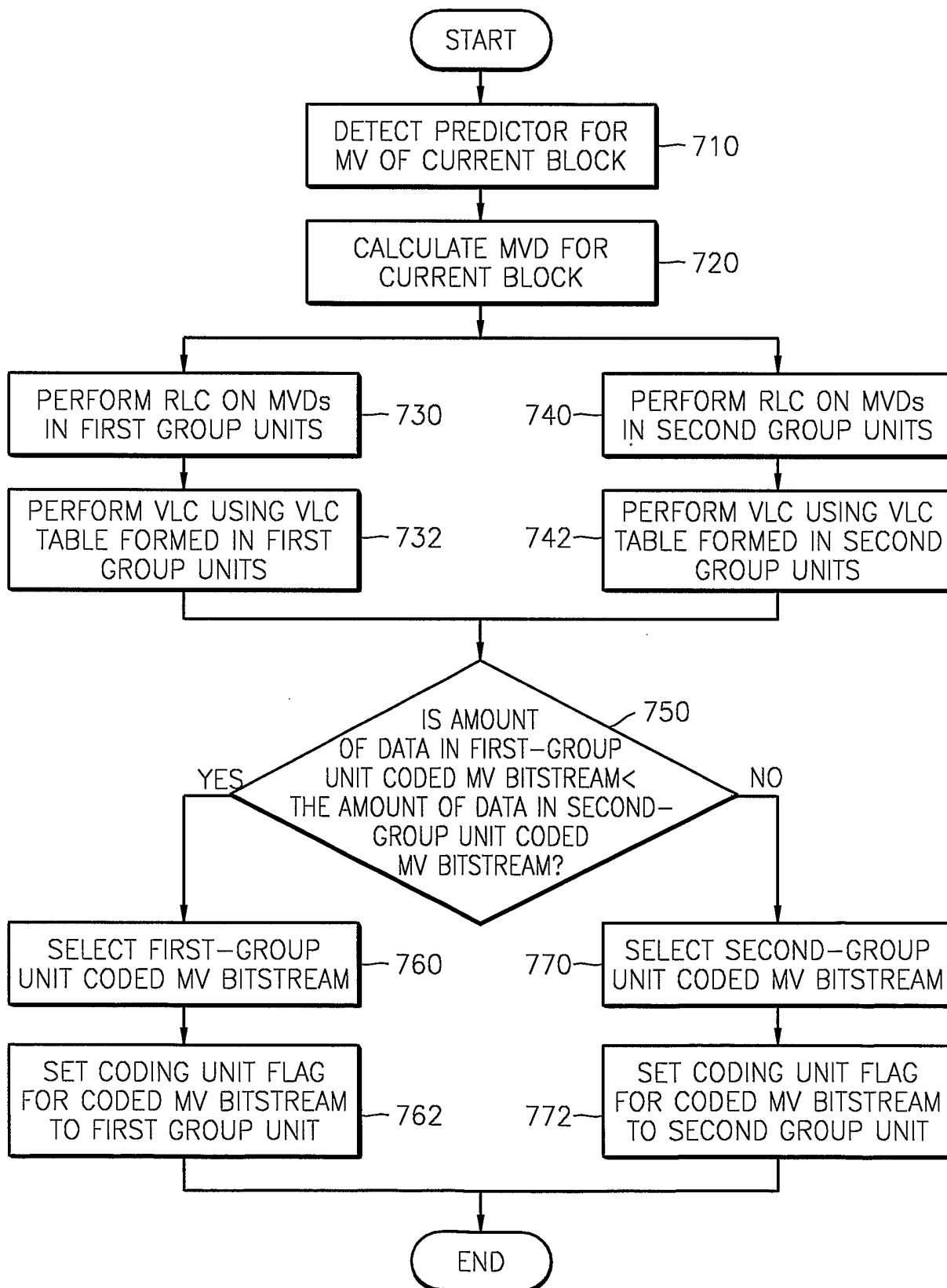
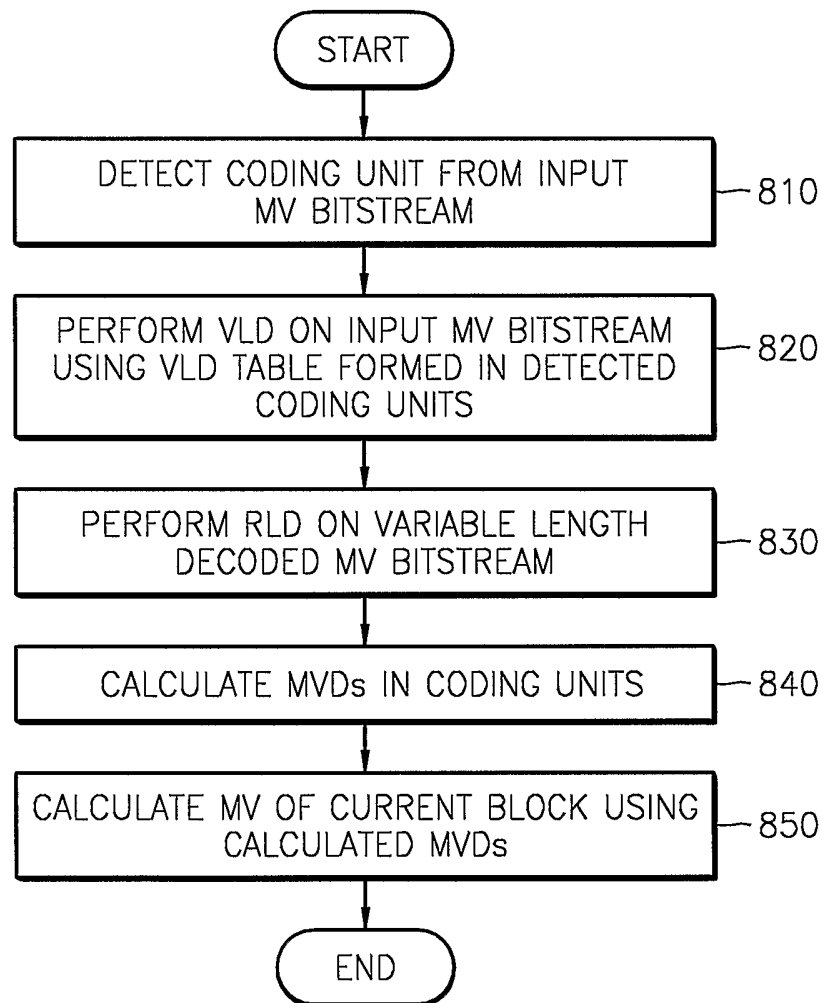


FIG. 6



6/7
FIG. 7

7/7

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR03/00701

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 H04N 7/34

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC H04N, H04B, G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Patents and Applications for Inventions since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NPS: "image, coding, run, length, variable, motion, vector, estimation, detection, prediction, group, picture, block"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5978048 A (Daewoo Electronics Co., Inc.) 2 November 1999 See the whole document	1-28
A	US 5905535 A (Thomson multimedia S.A.) 18 May 1999 See the whole document	1-28
A	JP 11112994 A2 (LG Electronics Inc.) 23 April 1999 See the whole document	1-28
A	US 5428403 A (U.S. Philips Corporation) 27 June 1995 See the whole document	1-28
A	US 6141448 A (Hewlett-Packard) 31 October 2000 See the whole document	1-28

☐ 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 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

12 JULY 2003 (12.07.2003)

Date of mailing of the international search report

15 JULY 2003 (15.07.2003)

Name and mailing address of the ISA/KR



Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701,
Republic of Korea

Facsimile No. 82-42-472-7140

Authorized officer

JEONG, Seong Jung

Telephone No. 82-42-481-5768



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR03/00701

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5978048 A	02-11-1999	JP 11112989 A2	23-04-1999
		GB 9720556 A	26-11-1997
		GB 2329783 B	20-03-2002
		GB 2329783 A1	31-03-1999
		GB 2329783 A	31-03-1999
		FR 2769162 B1	04-05-2001
		FR 2769162 A1	02-04-1999
		DE 19743202 A1	01-04-1999
		CN 1213253 A	07-04-1999
US 5905535 A	18-05-1999	JP 8251601 A2	27-09-1996
		FR 2725577 B1	29-11-1996
		FR 2725577 A1	12-04-1996
		ES 2171513 T3	16-09-2002
		EP 0707428 B1	16-01-2002
		EP 0707428 A1	17-04-1996
		DE 69525009 T2	31-10-2002
		DE 69525009 C0	21-02-2002
		CN 1132983 A	09-10-1996
JP 11112994 A2	23-04-1999	CA 2160087 AA	11-04-1996
		US 6498810 B1	24-12-2002
		KR 0249223 B1	15-03-2000
		GB 9815047 A0	09-09-1998
		GB 2329295 B2	03-04-2002
		GB 2329295 A1	17-03-1999
		DE 19825042 C2	04-07-2002
		DE 19825042 A1	18-03-1999
US 5428403 A	27-06-1995		
		JP 5219499 A2	27-08-1993
		GB 9217742 A0	30-09-1992
		GB 9120739 A0	13-11-1991
		EP 0535746 B1	29-01-1997
		EP 0535746 A3	23-06-1993
		EP 0535746 A2	07-04-1993
		DE 69217150 T2	17-07-1997
		DE 69217150 C0	13-03-1997
US 6141448 A	31-10-2000	AT 0148607 E	15-02-1997
		None	