DESCRIPTION

Title of Invention

IMAGE PREDICTIVE ENCODING DEVICE, IMAGE PREDICTIVE ENCODING METHOD, IMAGE PREDICTIVE ENCODING PROGRAM, IMAGE PREDICTIVE DECODING DEVICE, IMAGE PREDICTIVE DECODING METHOD, AND IMAGE PREDICTIVE DECODING PROGRAM

Technical Field

[0001] The present invention relates to an image predictive encoding device, an image predictive encoding method, an image predictive encoding program, an image predictive decoding device, an image predictive decoding method, and an image predictive decoding program. More particularly, the present invention relates to an image predictive encoding device, an image predictive encoding method, an image predictive encoding program, an image predictive decoding device, an image predictive decoding method, and an image predictive decoding program that perform predictive encoding and predictive decoding by using region division.

Background Art

[0002] Compression encoding technology is used in order to efficiently transmit and store still image data and moving image data. The MPEG-1 to 4 and ITU (International Telecommunication Union) H.261 to H.264 systems are widely used for a compression encoding system for moving pictures.

[0003] In such encoding systems, encoding processing and decoding processing are performed after dividing an image serving as an

encoding target into a plurality of blocks. In intra-picture prediction encoding, a prediction signal of a target block is produced by using an adjacent reconstructed image signal within the same picture where the target block is included. The reconstructed image signal is generated by restoring compressed image data. Next, in the intra-picture prediction encoding, a differential signal is generated by subtracting the prediction signal from a signal of the target block, and the differential signal is encoded. In inter-picture prediction encoding, referring to the reconstructed image signal within a different picture from the picture where the target block is included, motion compensation is performed, and a prediction signal is thereby produced. Next, in the inter-picture prediction encoding, the prediction signal is subtracted from the signal of the target block so as to produce a differential signal, and the differential signal is encoded.

[0004] For example, intra-picture prediction encoding of H.264 adopts a method in which the prediction signal is produced by extrapolating, in a predetermined direction, reconstructed pixel values (reconstructed signals) of pixels located neighbouring a block serving as an encoding target. FIG. 20 is a schematic view describing the intra-picture prediction method used in ITU H.264. FIG. 20(A) shows the intra-picture prediction method in which extrapolation is performed in a vertical direction. In FIG. 20(A), a 4 x 4 pixel target block 802 is the target block serving as an encoding target. A pixel group 801 composed of pixels A to M located neighbouring a boundary of the target block 802 is a neighbouring region, and is an image signal that has been reconstructed in the past process. In prediction shown in

pixel values of the adjacent pixels A to D located directly above the target block 802 are extrapolated downwards so as to produce a prediction signal.

[0005] FIG. 20(B) shows an intra-picture prediction method in which extrapolation is performed in a horizontal direction. In prediction shown in FIG. 20(B), a prediction signal is produced by extrapolating pixel values of reconstructed pixels I to L located on the left of the target block 802 rightward.

[0006] In the intra-picture prediction method, the prediction signal having the lowest difference from the original signal of the target block is taken to be the optimal prediction signal, from among the nine prediction signals produced by the methods shown in (A) - (I) of FIG. 20. Specific methods for producing the prediction signal in this way are described, for example, in Patent Literature 1.

[0007] In typical inter-picture prediction encoding, a prediction signal is produced by searching for a signal resembling the original signal of the block serving as the encoding target, from reconstructed pictures. In the inter-picture prediction encoding, a motion vector and a residual signal between the original signal and the prediction signal of the target block are encoded. The motion vector is a vector indicating a spatial displacement amount between the target block and a region where the searched signal is located. The technique of searching for the motion vector for each block, in this way, is called block matching.

[0008] FIG. 21 is a schematic view describing block matching. In FIG. 21, a reconstructed picture 903 is shown in (a) and a picture 901 including a target block 902 is shown in (b). Here, a region 904 in the

picture 903 is a region that is in the same spatial position as the target block 902. In block matching, a search range 905 surrounding the region 904 is set, and a region 906 that has the lowest sum of absolute differences with respect to the original signal of the target block 902 is detected from the search range. The signal of the region 906 becomes a prediction signal, and a vector indicating the displacement amount from the region 904 to the region 906 is detected as a motion vector 907.

[0009] In block matching, there is also a method in which a plurality of reference pictures 903 are prepared, and the reference picture for performing the block matching is selected for each target block, and reference picture selection information is detected. In H.264, in order to accommodate local feature changes in images, a plurality of prediction types with different block sizes for encoding the motion vector are prepared. The prediction types of H.264 are described in Patent Literature 2, for example.

[0010] In compression encoding of moving image data, each picture (frame or field) can be encoded in any sequence. Therefore, there are three approaches for an encoding order in the inter-picture prediction that produces a prediction signal with reference to reconstructed pictures. The first approach is a forward prediction that produces a prediction signal with reference to reconstructed pictures in the past in a display order. The second approach is a backward prediction that produces a prediction signal with reference to reconstructed pictures in the future in a display order. The third approach is a bidirectional prediction that performs both the forward prediction and the backward

prediction so as to average the two prediction signals. These types of inter-picture prediction are described in Patent Literature 3, for example.

Citation List

Patent Literature

[0011] Patent Literature 1: United States Patent No. 6765964

Patent Literature 2: United States Patent No. 7003035

Patent Literature 3: United States Patent No. 6259739

Summary of Invention

Technical Problem

[0012] As described above, production of the prediction signal is performed for each block unit. However, since the location and movement of a moving object may be arbitrarily set in a video, when the picture is divided into blocks at equal intervals, there are cases that two or more regions with different movements and patterns are included in the block. In such a case, the prediction encoding of the movie causes a large prediction error near the edge of the object.

[0013] As described above, in H.264, in order to accommodate local feature changes in images and suppress an increase in the prediction error, a plurality of prediction types with different block sizes are prepared. As the block size becomes smaller, however, additional information required to produce the prediction signal (motion vector etc.) is necessary for each small block, resulting in an increase in code amount of the additional information. In addition, when many block sizes are prepared, mode information to select the block size is necessary, also resulting in an increase in code amount of the mode information.

[0014] In view of those problems, one aspect of the present invention aims to provide an image predictive encoding device, an image predictive encoding method, and an image predictive encoding program that can efficiently encode an image, while suppressing an increase in prediction information, such as additional information (motion vectors etc.) and mode information, and reducing the prediction error of the target block. Additionally, another aspect of the present invention aims to provide an image predictive decoding device, an image predictive decoding method, and an image predictive decoding program that correspond to such encoding aspect.

Solution to Problem

[0015] One aspect of the present invention relates to encoding an image. An image predictive encoding device according to one embodiment includes: (a) region division means for dividing an input image into a plurality of regions; (b) prediction information estimation means for producing a prediction signal of a target region among the plurality of regions from a reconstructed signal and obtaining prediction information that is used to produce the prediction signal, as prediction information associated with the target region; (c) prediction information encoding means for encoding the prediction information associated with the target region; (d) decision means for making a comparison of the prediction information associated with the target region and prediction information associated with a neighbouring region located neighbouring the target region and deciding, based on a result of the comparison, whether the prediction information associated with the neighbouring region can be used to produce the prediction signal of the

(e) region width determination means for, when it is decided by the decision means that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region, determining a region width of a partition that is included in the target region and where the prediction information associated with the neighbouring region is used to produce the prediction signal; (f) region width encoding means for encoding information identifying the region width associated with the target region; (g) prediction signal production means for producing the prediction signal of the target region from the reconstructed signal by using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width; (h) residual signal production means for producing a residual signal between the prediction signal of the target region and the original signal of the target region; (i) residual signal encoding means for encoding the residual signal; (j) residual signal restoration means for producing a decoded residual signal by decoding encoded data of the residual signal; (k) adding means for producing a reconstructed signal of the target region by adding the prediction signal to the decoded residual signal; and (l) storage means for storing the reconstructed signal of the target region as the reconstructed signal.

[0016] In addition, an image predictive encoding method according to one embodiment includes: (a) a region division step for dividing an input image into a plurality of regions; (b) a prediction information estimation step for producing a prediction signal of a target region among the plurality of regions from a reconstructed signal and obtaining

prediction information that is used to produce the prediction signal, as prediction information associated with the target region; (c) a prediction information encoding step for encoding the prediction information associated with the target region; (d) a decision step for making a comparison of the prediction information associated with the target region and prediction information associated with a neighbouring region located neighbouring the target region and deciding, based on a result of the comparison, whether the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region; (e) a region width determination step for, when it is decided in the decision step that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region, determining a region width of a partition that is included in the target region and where the prediction information associated with the neighbouring region is used to produce the prediction signal; (f) a region width encoding step for encoding information identifying the region width; (g) a prediction signal production step for producing the prediction signal of the target region from the reconstructed signal by using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width; (h) a residual signal production step for producing a residual signal between the prediction signal of the target region and the original signal of the target region; (i) a residual signal encoding step for encoding the residual signal; (j) a residual signal restoration step for producing a decoded residual signal by decoding encoded data of the residual signal; (k) a reconstructed

signal production step for producing a reconstructed signal of the target region by adding the prediction signal to the decoded residual signal; and (l) a storage step for storing the reconstructed signal of the target region as the reconstructed signal.

[0017] Furthermore, an image predictive encoding program according to one embodiment causes a computer to function as: (a) region division means for dividing an input image into a plurality of regions; (b) prediction information estimation means for producing a prediction signal of a target region among the plurality of regions from a reconstructed signal and obtaining prediction information that is used to produce the prediction signal, as prediction information associated with the target region; (c) prediction information encoding means for encoding the prediction information associated with the target region; (d) decision means for making a comparison of the prediction information associated with the target region and prediction information **associated with a neighbouring region located neighbouring** the target region and deciding, based on a result of the comparison, whether the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region; (e) region width determination means for, when it is decided by the decision means that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region, determining a region width of a partition that is included in the target region and where the prediction information associated with the neighbouring region is used to produce the prediction signal; (f) region width encoding means for encoding information identifying

width; (g) prediction signal production means for producing the prediction signal of the target region from the reconstructed signal by using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width; (h) residual signal production means for producing a residual signal between the prediction signal of the target region and the original signal of the target region; (i) residual signal encoding means for encoding the residual signal; (j) residual signal restoration means for producing a decoded residual signal by decoding encoded data of the residual signal; (k) adding means for producing a reconstructed signal of the target region by adding the prediction signal to the decoded residual signal; and (l) storage means for storing the reconstructed signal of the target region as the reconstructed signal.

[0018] According to an encoding aspect of the present invention, when the prediction information of the neighbouring region can be used, the prediction signal of the partition in the target region is produced by using the prediction information of the neighbouring region. Therefore, according to the encoding aspect of the present invention, prediction error of the target region where an edge exists can be reduced. In addition, since the prediction information of the neighbouring region is used to produce the prediction signal of the partition in the target region, it is possible to suppress an increase in an amount of prediction information.

[0019] In one embodiment, when it is decided that the prediction information associated with the target region and the prediction information associated with the neighbouring region are the same,

similar, equal, matching, or identical, it may be decided that the prediction information associated with the neighbouring region is not used to produce the prediction signal of the target region. This is because when the prediction information associated with the target region and the prediction information associated with the neighbouring region are the same, a reduction in the prediction error of the target region is not achieved.

[0020] In one embodiment, when it is decided that a combination of the prediction information associated with the target region and the prediction information associated with the neighbouring region fails to satisfy a predetermined condition, it may be decided that the prediction information associated with the neighbouring region is not used to produce the prediction signal of the target region.

[0021] In an encoding aspect of the present invention, when it is decided that the prediction information associated with the neighbouring region fails to be used to produce the prediction signal of the target region, encoded data of the region width associated with the target region may not be output. The code amount is thereby reduced.

[0022] In one embodiment, the neighbouring region may be two neighbouring regions one of which is on the left of and the other is on top of the target region. In such case, when it is decided that both of prediction information associated with the two neighbouring regions can be used to produce the prediction signal of the target region, identification information that identifies a neighbouring region having the prediction information to be used to produce the prediction signal of the target region from the two neighbouring regions, can be encoded.

According to such a feature, it is possible to produce the prediction signal of the partition from an optimal neighbouring region out of the two neighbouring regions, thereby the further reduction in the prediction error is achieved.

[0023] Another aspect of the present invention relates to decoding of an image. An image predictive decoding device according to one embodiment includes: (a) data analysis means for extracting, from compressed data which has been produced by dividing an image into a plurality of regions and encoding the regions, encoded data of prediction information that has been used to produce a prediction signal of a target region, encoded data of information identifying a region width of a partition in the target region where prediction information associated with a neighbouring region located neighbouring the target region has been used to produce the prediction signal, and encoded data of a residual signal; (b) prediction information decoding means for restoring the prediction information associated with the target region by decoding the encoded data of the prediction information; (c) decision means for making a comparison of the prediction information associated with the target region and the prediction information associated with the neighbouring region, and deciding, based on a result of the comparison, whether the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region; (d) region width decoding means for, when it is decided by the decision means that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region, restoring the region width by

decoding the encoded data of the information identifying the region width; (e) prediction signal production means for producing the prediction signal of the target region from a reconstructed signal by using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width; (f) residual signal restoration means for restoring a decoded residual signal of the target region from the encoded data of the residual signal; (g) adding means for producing a reconstructed signal of the target region by adding the prediction signal of the target region to the decoded residual signal; and (h) storage means for storing the reconstructed signal of the target region as the reconstructed signal.

[0024] In addition, an image predictive decoding method according to one embodiment includes: (a) a data analysis step for extracting, from compressed data which has been generated by dividing an image into a plurality of regions and encoding the regions, encoded data of prediction information that has been used to produce a prediction signal of a target region, encoded data of information identifying a region width of a partition in the target region where prediction information **associated with a neighbouring region located neighbouring** the target region has been used to produce the prediction signal, and encoded data of a residual signal; (b) a prediction information decoding step for restoring the prediction information associated with the target region by decoding the encoded data of the prediction information; (c) a decision step for making a comparison of the prediction information associated with the target region and the prediction information associated with the neighbouring region, and deciding; based on a result

of the comparison, whether the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region; (d) a region width decoding step for, when it is decided in the decision step that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region, restoring the region width by decoding the encoded data of the information identifying the region width; (e) a prediction signal production step for producing the prediction signal of the target region from a reconstructed signal by using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width; (f) a residual signal restoration step for restoring a decoded residual signal of the target region from the encoded data of the residual signal; (g) a reconstructed signal production step for producing a reconstructed signal of the target region by adding the prediction signal of the target region to the decoded residual signal; and (h) a storage step for storing the reconstructed signal of the target region as the reconstructed signal.

[0025] Furthermore, an image predictive decoding program according to one embodiment causes a computer to function as: (a) data analysis means for extracting, from compressed data which has been produced by dividing an image into a plurality of regions and encoding the regions, encoded data of prediction information that has been used to produce a prediction signal of a target region; encoded data of information identifying a region width of a partition in the target region where prediction information associated with a neighbouring region located neighbouring the target region has been used to

prediction signal; and encoded data of a residual signal; (b) prediction information decoding means for restoring the prediction information associated with the target region by decoding the encoded data of the prediction information; (c) decision means for making a comparison of the prediction information associated with the target region and the prediction information associated with the neighbouring region and deciding, based on a result of the comparison, whether the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region; (d) region width decoding means for, when it is decided by the decision means that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region, restoring the region width by decoding the encoded data of the information identifying the region width; (e) prediction signal production means for producing the prediction signal of the target region from a reconstructed signal by using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width; (f) residual signal restoration means for restoring a decoded residual signal of the target region from the encoded data of the residual signal; (g) adding means for producing a reconstructed signal of the target region by adding the prediction signal of the target region to the decoded residual signal; and (h) storage means for storing the reconstructed signal of the target region as the reconstructed signal.

[0026] The present invention according to such decoding enables to preferably reproduce an image from the compressed data produced by

encoding of the present invention described above.

[0027] In one embodiment, when it is decided that the prediction information associated with the target region and the prediction information associated with the neighbouring region are the same, it may be decided that the prediction information associated with the neighbouring region fails to be used to produce the prediction signal of the target region. In addition, when it is decided that a combination of the prediction information associated with the target region and the prediction information associated with the neighbouring region fails to satisfy a predetermined condition, it may be decided that the prediction information associated with the neighbouring region fails to be used to produce the prediction signal of the target region.

[0028] In one embodiment, when it is decided that the prediction information associated with the neighbouring region fails to be used to produce the prediction signal of the target region, the region width associated with the target region may be set to 0.

[0029] In one embodiment, the neighbouring region may be two neighbouring regions one of which is on the left of and the other is on top of the target region. In such case, when it is decided that both prediction information associated with the two neighbouring regions can be used to produce the prediction signal of the target region, the region width decoding means can decode identification information that identifies a neighbouring region having the prediction information to be used to produce the prediction signal of the target region from the two neighbouring regions.

Advantageous Effects of Invention

[0030] As described above, according to the present invention, an image predictive encoding device, an image predictive encoding method and an image predictive encoding program that can efficiently encode an image by suppressing an increase in prediction information and reducing prediction error of a target block, are provided. In addition, according to the present invention, an image predictive decoding device, an image predictive decoding method and an image predictive decoding program are correspondingly provided.

Brief Description of Drawings

[0031] FIG. 1 is a diagram showing an image predictive encoding device according to one embodiment;

FIG. 2 is a diagram illustrating a partition in a target block where a prediction signal is produced by using prediction information of a neighbouring block;

FIG. 3 is a flowchart showing procedures of an image predictive encoding method according to one embodiment;

FIG. 4 is a detailed flowchart of step S108 in FIG. 3;

FIG. 5 is a detailed flowchart of step S202 in FIG. 4;

FIG. 6 is a detailed flowchart of step S110 in FIG. 3;

FIG. 7 is a diagram showing an image predictive decoding device according to one embodiment;

FIG. 8 is a flowchart of an image predictive decoding method according to one embodiment;

FIG. 9 is a detailed flowchart of step S508 in FIG. 8;

FIG. 10 is a diagram illustrating another example of the neighbouring block;

FIG. 11 is a flowchart showing detailed procedures of another example of step S108 in FIG. 3;

FIG. 12 is a flowchart showing detailed procedures of another example of step S508 in FIG. 8;

FIG. 13 is a diagram illustrating another example of the partition in the target block where the prediction signal is produced by using the prediction information of the neighbouring block;

FIG. 14 is a diagram showing another example of the partition;

FIG. 15 is a diagram showing other examples of the target block and the neighbouring block;

FIG. 16 is a diagram showing an image predictive encoding program according to one embodiment;

FIG. 17 is a diagram showing an image predictive decoding program according to one embodiment;

FIG. 18 is diagram showing a hardware structure of a computer for executing a program stored in a record medium;

FIG.19 is a perspective view of the computer for executing the program stored in the record medium;

FIG. 20 is a schematic view describing an intra-picture prediction method used in ITU H.264p; and

FIG. 21 is a schematic view describing block matching.

Description of Embodiments

[0032] The preferable embodiments of the present invention are described in detail below with reference to the drawings. In each drawing, parts that are the same or equivalent are labeled with the same reference numerals.

[0033] FIG. 1 is a diagram showing an image predictive encoding device according to one embodiment. An image predictive encoding device 100 shown in FIG. 1 includes an input terminal 102, a block division unit 104, a prediction signal generator 106, a frame memory 108, a subtractor 110, a transformer 112, a quantizer 114, an inverse quantizer 116, an inverse transformer 118, an adder 120, a quantized transformed coefficient encoder 122, an output terminal 124, a prediction information estimator 126, a prediction information memory 128, a decision unit 130, a prediction information encoder 132, a region width determiner 134 and a region width encoder 136. The transformer 112, the quantizer 114, and the quantized transformed coefficient encoder 122 function as residual signal encoding means, while the inverse quantizer 116 and the inverse transformer 118 function as residual signal restoration means.

[0034] Each component of the image predictive encoding device 100 will be described below. The input terminal 102 is a terminal for inputting a signal of a moving picture. The signal of the moving picture is a signal that includes a plurality of images. The input terminal 102 is connected through a line L102 to the block division unit 104.

[0035] The block division unit 104 divides the image that is included in the signal of the moving picture into a plurality of regions. Specifically, the block division unit 104 sequentially selects the plurality of images that are included in the signal of the moving picture as an encoding target image. The block division unit 104 divides the selected image into a plurality of regions. In the present embodiment,

the region is a 8 × 8 pixel block. However, the block with different sizes and/or shapes may be used as the region. The block division unit 104 is connected through a line L104 to the prediction information estimator 126.

[0036] The prediction information estimator 126 detects prediction information required to produce a prediction signal of a target region (a target block) that is the target of encoding processing. As for a method for producing prediction information that is a prediction method, intra-picture prediction or inter-picture prediction that was described in the background art, is applicable. The present invention, however, is not limited to such prediction methods. The description below is given in the case where the block matching shown in FIG. 21 is performed in a prediction process. When the block matching is used, the prediction information includes motion vectors, reference picture selection information and the like. Hereinafter, prediction information that is detected to produce the prediction signal of the target block is referred to as "prediction information associated with a target block". The prediction information estimator 126 is connected through a line L126a and a line L126b to the prediction information memory 128 and the prediction information encoder 132, respectively.

[0037] The prediction information memory 128 receives the prediction information through the line L126a from the prediction information estimator 126 and stores the prediction information. The prediction information memory 128 is connected through a line L128 to the decision unit 130.

[0038] The prediction information encoder 132 receives the prediction

information through the line L126b from the prediction information estimator 126. The prediction information encoder 132 entropy-codes the received prediction information to produce encoded data and outputs the encoded data through a line L132 to the output terminal 124. Examples of entropy encoding include arithmetic coding, variable-length coding and the like, but the present invention is not limited to such entropy encoding methods.

[0039] The decision unit 130 receives the prediction information associated with the target block and the prediction information associated with a neighbouring block through the line L128 from the prediction information memory 128. The neighbouring block is a neighbouring region located neighbouring the target block and is an already encoded region. The decision unit 130 compares the prediction information associated with the target block against the prediction information associated with the neighbouring block, and decides whether the prediction information associated with the neighbouring block can be used to produce the prediction signal of the target block.

[0040] Specifically, the decision unit 130 compares the prediction information associated with the target block against the prediction information associated with the neighbouring block, and when the two pieces of prediction information coincide, it decides that the prediction information associated with the neighbouring block will not be used to produce the prediction signal of the target block. This is because, when the two pieces of prediction information coincide, the prediction signal of a partition of the target block produced by using the prediction

information associated with the neighbouring block may result in the same as the prediction signal produced by using the prediction information associated with the target block. That is, reduction in prediction error cannot be expected.

[0041] On the other hand, when the two pieces of prediction information are different, the decision unit 130 decides that the prediction information associated with the neighbouring block can be used to produce the prediction signal of the target block. The decision unit 130 is connected through a line L130 to the region width determiner 134 and the region width encoder 136, and a comparison (decision) result by the decision unit 130 is output through the line L130 to the region width determiner 134 and the region width encoder 136. Hereinafter, the decision result of a case when the prediction information associated with the neighbouring block will not be used to produce the prediction signal of the target block, is referred to as the decision result indicating "unusable", while the decision result of a case when the prediction information associated with the neighbouring block can be used to produce the prediction signal of the target block, is referred to as the decision result indicating "usable". Operations of the decision unit 130 are described in detail below.

[0042] The region width determiner 134 receives the decision result through the line L130 from the decision unit 130. When the decision result indicates "usable", the region width determiner 134 determines a region width of the partition of the target block where the prediction signal is produced by using the prediction information associated with the neighbouring block. Therefore, the region width determiner 134

receives the prediction information associated with the target block and the prediction information associated with the neighbouring block through a line L128a from the prediction information memory 128. Furthermore, the region width determiner 134 receives a reconstructed signal from the frame memory 108 and receives an original signal of the target block from the block division unit 104.

[0043] FIG. 2 is a diagram describing the partition of the target block where the prediction signal is produced by using the prediction information of the neighbouring block. FIG. 2 shows a case where a neighbouring block B1 on the left of a target block Bt serves as the neighbouring block, but the neighbouring block in the present invention may be a neighbouring block on the top of the target block or both neighbouring blocks on the left and on the top of the target block. There are cases that neighbouring blocks on the right and on the bottom of the target block can be used as the neighbouring block.

[0044] As shown in FIG. 2, the target block Bt and the neighbouring block B1 are a 8 × 8 pixel block. In FIG. 2, a top-left pixel position (horizontal position, vertical position) is represented by (0, 0), while a bottom-right pixel position (horizontal position, vertical position) is represented by (7, 7). A partition R2 shown in FIG. 2 is a region where the prediction information of the neighbouring block B1 is used to produce the prediction signal and a region width thereof is w in a horizontal direction. That is, the partition R2 is surrounded by four pixel positions of (0, 0), (w-1, 0), (0, 7) and (w-1, 7). A partition R1 is a region where the prediction information associated with the target block is used to produce the prediction signal.

[0045] In the present embodiment, the region width can be set from 0 to 8 pixels with one pixel increment. The region width determiner 134 of the present embodiment produces the prediction signal of the target block with respect to each of 9 settable region widths and selects the region width having the lowest absolute sum of the prediction error or the lowest square sum thereof. The process is performed by acquiring an original signal of the target block and the prediction information associated with the target block and the prediction information associated with the neighbouring block from the block division unit 104 and the prediction information memory 128, respectively and by producing the prediction signal of the target block, based on these pieces of prediction information and the region width, from the reconstructed signal that is stored in the frame memory 108. A method for determining the region width and candidates for the settable region width are not particularly limited. For example, the settable region widths may be pixel widths that are specified by multiples of 2, and can take any one or more width. Additionally, a plurality of settable region widths are prepared and selection information may be encoded for each sequence unit, each frame unit or each block unit.

[0046] The region width determiner 134 is connected through a line L134a and a line L134b to the region width encoder 136 and the prediction signal generator 106, respectively. The region width determiner 134 outputs the determined region width (information identifying the region width) through the line L134a and the line L134b to the region width encoder 136 and the prediction signal generator 106.

[0047] When the decision result received from the decision unit 130

indicates "usable", the region width encoder 136 entropy-codes the region width received through the line L134a to produce encoded data. The region width encoder 136 may use an entropy-coding method, such as arithmetic coding or variable-length coding, but the present invention is not limited to such encoding methods.

[0048] The region width encoder 136 is connected through a line L136 to the output terminal 124, and the encoded data produced by the region width encoder 136 is output through the line L136 to the output terminal 124.

[0049] The prediction signal generator 106 receives two pieces of prediction information associated with the target block and the neighbouring block through a line L128b from the prediction information memory 128. Additionally, the prediction signal generator 106 receives the region width through the line L134b from the region width determiner 134, and receives the reconstructed signal through a line L108 from the frame memory 108. The prediction signal generator 106 uses the two pieces of prediction information and the region width received to produce the prediction signal of the target block from the reconstructed signal. Examples of a method for producing the prediction signal are described below. The prediction signal generator 106 is connected through a line L106 to the subtractor 110. The prediction signal produced by the prediction signal generator 106 is output through the line L106 to the subtractor 110.

[0050] The subtractor 110 is connected through a line L104b to the block division unit 104. The subtractor 110 subtracts the prediction signal of the target block produced by the prediction signal generator

106 from the original signal of the target block, which is received through the line L104b from the block division unit 104. A residual signal is produced through such subtraction. The subtractor 110 is connected through a line L110 to the transformer 112 and the residual signal is output through the line L110 to the transformer 112.

[0051] The transformer 112 applies a discrete cosine transform to the input residual signal to produce transformed coefficients. The quantizer 114 receives the transformed coefficients through a line L112 from the transformer 112. The quantizer 114 quantizes the transformed coefficients to produce quantized transformed coefficients. The quantized transformed coefficient encoder 122 receives the quantized transformed coefficients through a line L114 from the quantizer 114 and entropy-codes the quantized transformed coefficients to produce encoded data. The quantized transformed coefficient encoder 122 outputs the encoded data produced through a line L122 to the output terminal 124. As an entropy-coding method for the quantized transformed coefficient encoder 122, arithmetic coding or variable-length coding may be used, but the present invention is not limited to such coding methods.

[0052] The output terminal 124 collectively outputs the encoded data received from the prediction information encoder 132, the region width encoder 136 and the quantized transformed coefficient encoder 122, outside.

[0053] The inverse quantizer 116 receives the quantized transformed coefficients through a line L114b from the quantizer 114. The inverse quantizer 116 inversely quantizes the received quantized transformed

coefficients to restore transformed coefficients. The inverse transformer 118 receives the transformed coefficients through a line L116 from the inverse quantizer 116 and applies an inverse discrete cosine transform to the transformed coefficients so as to restore a residual signal (decoded residual signal). The adder 120 receives the decoded residual signal through a line L118 from the inverse transformer 118 and receives the prediction signal through a line L106b from the prediction signal generator 106. The adder 120 adds the received decoded residual signal to the prediction signal to reproduce a signal of the target block (reconstructed signal). The reconstructed signal produced by the adder 120 is output through a line L120 to the frame memory 108 and stored in the frame memory 108 as the reconstructed signal.

[0054] The present embodiment uses the transformer 112 and the inverse transformer 118, but another transform process may be used as alternatives of these transformers. In addition, the transformer 112 and the inverse transformer 118 are not indispensable. In this way, in order to be used for producing the prediction signal of the subsequent target block, the reconstructed signal of the encoded target block is restored in an inverse process and stored in the frame memory 108.

[0055] Moreover, the structure of the encoder is not limited to the one shown in FIG. 1. For example, the decision unit 130 and the prediction information memory 128 may be included in the prediction signal generator 106. In addition, the region width determiner 134 may be included in the prediction information estimator 126.

[0056] With reference to operations of the image predictive encoding

device 100, an image predictive encoding method of one embodiment is described below. In addition, detailed operations of the decision unit 130, the region width determiner 134 and the prediction signal generator 106 are described.

[0057] FIG. 3 is a flowchart showing procedures of the image predictive encoding method according to one embodiment. As shown in FIG. 3, in the present image predictive encoding method, first in step S100, the block division unit 104 divides an encoding target image into a plurality of blocks. Then in step S102, one block is selected from the plurality of blocks as an encoding target block.

[0058] Then in step S104, the prediction information estimator 126 determines prediction information of the target block. The prediction information is encoded in the following step S106 by the prediction information encoder 132.

[0059] Next, the present image predictive encoding method proceeds to step S108. FIG. 4 is a detailed flowchart of step S108 in FIG. 3. In the process of step S108, first in step S200, two pieces of prediction information associated with the target block and the neighbouring block are input in the decision unit 130. Then in step S202, the decision unit 130 decides whether the prediction information of the neighbouring block can be used to produce the prediction signal of the target block.

[0060] FIG. 5 is a detailed flowchart of step S202 in FIG. 4. As shown in FIG. 5, in the process of step S202, first in step S300, the decision unit 130 decides whether the two pieces of prediction information associated with the target block and the neighbouring block coincide. When the decision in step S300 is true (Yes), that is when the two pieces

of prediction information associated with the target block and the neighbouring block coincide, the decision unit 130 outputs a decision result indicating "unusable" in step S302.

[0061] On the other hand, when the decision in step S300 is false (No), the process proceeds to step S304. In step S304, the decision unit 130 decides whether the prediction information associated with the neighbouring block is in an usable state to produce the prediction signal of the target block. When the decision in step S304 is true (Yes), the decision unit 130 outputs the decision result indicating "usable" in the following step S306. On the other hand, when the decision in step S304 is false (No), the decision unit 130 conducts the process of step S302 described above.

[0062] When it is decided that the prediction information associated with the neighbouring block is in an unusable state in step S304, there are cases where (1) the neighbouring block is outside a picture; (2) a combination of the prediction information of the target block and the prediction information of the neighbouring block is not approved; and the like.

[0063] In this way, the decision unit 130 decides, in accordance with a predetermined rule, whether to use the prediction information associated with the neighbouring block to produce the prediction signal of the partition of the target region. The rule is not required to be transmitted, if the encoder and the decoder share the information in advance, but it may be encoded and transmitted. For example, there is a method in which a plurality of such rules are prepared and which rule to be applied is transmitted for each frame unit, each sequence unit, or

each block unit.

[0064] Referring to FIG. 4 again, next, the present image predictive encoding method proceeds to step S204. In step S204, the region width determiner 134 refers to the decision result of the decision unit 130 and decides whether the decision result indicates "usable" or not. When the decision result of the decision unit 130 indicates "unusable", the process of step S108 ends.

[0065] On the other hand, when the decision result of the decision unit 130 indicates "usable", the region width determiner 134 selects, in the following step S206, the region width of the partition of the target region to be predicted by using the prediction information associated with the neighbouring block, from among candidates prepared in advance. Then in step S208, the region width encoder 136 encodes the determined region width.

[0066] Referring to FIG. 3 again, the process proceeds from step S108 to step S110. In step S110, the prediction signal generator 106 uses the two pieces of prediction information associated with the target block and the neighbouring block, and the region width determined by the region width determiner 134, to produce the prediction signal of the target block from the reconstructed signal stored in the frame memory 108.

[0067] One example of detailed operations of the prediction signal generator 106 in step S110 is described below. FIG. 6 is a detailed flowchart of step S110 in FIG. 3. FIG. 6 shows operations of the prediction signal generator 106, when, as shown in FIG. 2, the prediction signal of a partition R2 in a 8 × 8 pixel target block is

produced by using the prediction information associated with the neighbouring block on the left.

[0068] As shown in FIG. 6, first in step S400, the prediction signal generator 106 acquires prediction information Pt associated with the target block and prediction information Pn associated with the neighbouring block. Then in step S402, the prediction signal generator 106 acquires a region width w from the region width determiner 134.

[0069] Next in step S404, the prediction signal generator 106 uses the prediction information Pt and the region width w to produce the prediction signal of the partition R1 in the target block shown in FIG. 2 from the reconstructed signal. Next in step S406, the prediction signal generator 106 uses the prediction information Pn and the region width w to produce a prediction signal of the partition R2 in the target block from the reconstructed signal. In the example shown in FIG. 2, when the region width w is 0, step S406 can be omitted. In addition, when the region width is 8, step S404 can be omitted.

[0070] Referring to FIG. 3 again, the image predictive encoding method proceeds to step S112. In step S112, the subtractor 110 uses the original signal and the prediction signal of the target block to produce a residual signal. In the following step S114, the transformer 112, the quantizer 114 and the quantized transformed coefficient encoder 122 transform and encode the residual signal to produce encoded data.

[0071] Then in step S116, the inverse quantizer 116 and the inverse transformer 118 restore a decoded residual signal from quantized transformed coefficients. In the following step S118, the adder 120 adds the decoded residual signal to the prediction signal to produce a

reconstructed signal. Then in step S120, the reconstructed signal is stored in the frame memory 108 as the reconstructed signal.

[0072] Next in step S122, whether all blocks are processed as the target block is checked and when the process on all blocks is uncompleted, one of unprocessed blocks is selected as the target block and the process from step S102 is performed. On the other hand, when the process on all blocks is completed, the process of the present image predictive encoding method ends.

[0073] An image predictive decoding device according to one embodiment is described below. FIG. 7 is a diagram showing the image predictive decoding device according to one embodiment. An image predictive decoding device 200 shown in FIG. 7 is provided with an input terminal 202, a data analyzer 204, an inverse quantizer 206, an inverse transformer 208, an adder 210, an output terminal 212, a quantized transformed coefficient decoder 214, a prediction information decoder 216, a region width decoder 218, the frame memory 108, the prediction signal generator 106, the prediction information memory 128, and the decision unit 130. The inverse quantizer 206, the inverse transformer 208 and the quantized transformed coefficient decoder 214 function as residual signal restoration means. For decoding means including the inverse quantizer 206 and the inverse transformer 208, alternatives may be used. In addition, the inverse transformer 208 may be eliminated.

[0074] Each component of the image predictive decoding device 200 is described in detail below. The input terminal 202 inputs compressed data that has been compression-encoded by the image predictive

encoding device 100 (or the image predictive encoding method) described above. The compressed data includes, with respect to each of a plurality of blocks in an image, encoded data of quantized transformed coefficients produced by transform-quantizing and entropy-coding a residual signal; encoded data of prediction information for producing a prediction signal; and encoded data of a region width of a partition in the block where the prediction signal is produced by using the prediction information associated with a neighbouring block located neighbouring a target block. In the present embodiment, the prediction information includes a motion vector and a reference picture number and the like. The input terminal 202 is connected via a line L202 to the data analyzer 204.

[0075] The data analyzer 204 receives the compressed data through the line L202 from the input terminal 202. The data analyzer 204 analyzes the received compressed data and separates the compressed data, with respect to a decoding target block, into the encoded data of the quantized transformed coefficients; the encoded data of the prediction information; and the encoded data of the region width. The data analyzer 204 outputs the encoded data of the region width through a line L204a to the region width decoder 218; outputs the encoded data of the prediction information through a line L204b to the prediction information decoder 216; and outputs the encoded data of the quantized transformed coefficients through a line L204c to the quantized transformed coefficient decoder 214.

[0076] The prediction information decoder 216 entropy-decodes the encoded data of the prediction information associated with the target

block to obtain prediction information. The prediction information decoder 216 is connected through a line L216 to the prediction information memory 128. The prediction information produced by the prediction information decoder 216 is stored through the line L216 in the prediction information memory 128. The prediction information memory 128 is connected through the line L128a and the line L128b to the decision unit 130 and the prediction signal generator 106, respectively.

[0077] The decision unit 130 has the same function as the decision unit 130 of the encoding device shown in FIG. 1. That is, the decision unit 130 compares the prediction information associated with the target block against the prediction information associated with the neighbouring block located neighbouring the target block, and decides whether the prediction information associated with the neighbouring block can be used when producing the prediction signal of the target block.

[0078] Specifically, the decision unit 130 compares the two pieces of prediction information associated with the target block and the neighbouring block located neighbouring each other, and when the two pieces of prediction information coincide, it decides that the prediction information associated with the neighbouring block will not be used to produce the prediction signal of the target block. That is, in such case, the decision unit 130 outputs a decision result indicating "unusable". On the other hand, when the two pieces of prediction information are different, the decision unit 130 outputs the decision result indicating "usable". The decision unit 130 is connected through

the region width decoder 218. The decision result by the decision unit 130 is output through the line L130 to the region width decoder 218. Since a detailed process flow of the process of the decision unit 130 is already described in FIG. 5, the detailed description is omitted here.

[0079] The region width decoder 218 entropy-decodes, based on the decision result received through the L130 from the decision unit 130, the input encoded data of the region width to restore the region width. That is, when the decision result indicates "usable", the region width decoder 218 decodes the encoded data of the region width to restore the region width. On the other hand, when the decision result is "unusable", restoration of the region width may not be conducted. The region width decoder 218 is connected through a line L218 to the prediction signal generator 106, and the region width produced by the region width decoder 218 is output through the line L218 to the prediction signal generator 106.

[0080] The prediction signal generator 106 has the same function as the prediction signal generator of the encoding device shown in FIG. 1. That is, the prediction signal generator 106 uses the prediction information associated with the target block and the prediction information associated with the neighbouring block (if necessary), as well as the region width received through the L218, so as to produce the prediction signal of the decoding target block from the reconstructed signal stored in the frame memory 108. Since detailed operations of the prediction signal generator 106 are described in FIG. 6, the detailed description is omitted here. The prediction signal generator 106 is connected through the line L106 to the adder 210. The prediction

signal generator 106 outputs the produced prediction signal through the line L106 to the adder 210.

[0081] The quantized transformed coefficient decoder 214 receives the encoded data of the quantized transformed coefficients through the line L204c from the data analyzer 204. The quantized transformed coefficient decoder 214 entropy-decodes the received encoded data to restore the quantized transformed coefficients of the residual signal of the target block. The quantized transformed coefficient decoder 214 outputs the restored quantized transformed coefficients through a line L214 to the inverse quantizer 206.

[0082] The inverse quantizer 206 inversely qunatizes the quantized transformed coefficients received through the line L214 to restore the transformed coefficients. The inverse transformer 208 receives the restored transformed coefficients through a line L206 from the inverse quantizer 206 and applies an inverse discrete cosine transform to the transformed coefficients to restore the residual signal (decoded residual signal) of the target block.

[0083] The adder 210 receives the decoded residual signal through a line L208 from the inverse transformer 208 and receives the prediction signal produced by the prediction signal generator 106 through the line L106. The adder 210 produces a reconstructed signal of the target block by adding the received decoded residual signal to the prediction signal. The reconstructed signal is output through a line L210 to the frame memory 108 and stored in the frame memory 108. In addition, the reconstructed signal is also output to the output terminal 212. The output terminal 212 outputs the reconstructed signal to the outside (to a

display, for example).

[0084] With reference to operations of the image predictive decoding device 200, an image predictive decoding method according to one embodiment is described below. FIG. 8 is a flowchart of the image predictive decoding method according to one embodiment. As shown in FIG. 8, in the present image predictive decoding method, first in step S500, compressed data is input through the input terminal 202. Then in step S502, a target block that is the target of the process is selected.

[0085] Then in step S504, the data analyzer 204 analyzes the compressed data and extracts encoded data of prediction information associated with the target block that is a decoding target; of a region width; and of quantized transformed coefficients. The prediction information is decoded by the prediction information decoder 216 in step S506.

[0086] Next, the process proceeds to step S508. FIG. 9 is a detailed flowchart of step S508 in FIG. 8. As shown in FIG. 9, in the process of step S508, first in step S600, two pieces of prediction information associated with the target block and a neighbouring block are input in the decision unit 130.

[0087] Next in step S202, the decision unit 130 decides usability of the prediction information associated with the neighbouring block and outputs a decision result. The operations of the decision unit 130 in step S202 is the same as the operations described in FIG. 5, so detailed description is omitted here.

[0088] Then in step S602, it is decided whether the decision result of the decision unit 130 indicates "usable" or not. When the decision

result in step S602 is true (Yes), that is, when the prediction information of the neighbouring block is usable, the region width decoder 218 decodes the encoded data of the region width to restore the region width of a partition (R2) of the target block in step S604. On the other hand, when the decision in step S602 is false (No), the region width decoder 218 sets the region width of the partition (R2) of the target block to 0 in step S606.

[0089] Referring to FIG. 8 again, after step S508 ends, the process proceeds to step S510. In step S510, the prediction signal generator 106 produces a prediction signal of the decoding target block from the reconstructed signal by using the two pieces of prediction information associated with the target block and the neighbouring block (prediction information associated with the neighbouring block is used only when it is necessary), and the region width. Here, step S510 is the same as step S110 described in FIG. 6.

[0090] In the following step S512, the quantized transformed coefficient decoder 214 restores quantized transformed coefficients from the encoded data; the inverse quantizer 206 restores transformed coefficients from the quantized transformed coefficients; and the inverse transformer 208 produces a decoded residual signal from the transformed coefficients.

[0091] Then in step S514, the adder 210 produces a reconstructed signal of the target block by adding the prediction signal of the target block to the decoded residual signal. In step S516, the reconstructed signal is stored in the frame memory 108 as the reconstructed signal for reproducing the next target block.

[0092] Then in step S518, when it is decided that the process on all blocks is incomplete, that is when the next compressed data exists, an unprocessed block is selected as the target block in step S502 and the steps thereafter are repeated. On the other hand, when the process on all blocks is completed in step S518, the process ends.

[0093] The image predictive encoding device and method as well as the image predictive decoding device and method, according to one embodiment, have been described above, but the present invention is not limited to the embodiment mentioned above. For example, the neighbouring block in the above embodiment is the neighbouring block on the left of the target block, but it may be the neighbouring block on top of the target block.

[0094] FIG. 10 is a diagram describing another example of the neighbouring block. In the example shown in FIG. 10, the target block Bt and the neighbouring block B2 are a 8 × 8 pixel block, and similarly a top-left pixel position (horizontal position, vertical position) is set to (0, 0), while a bottom-right pixel position is set to (7, 7). The partition R2 is a region surrounded by pixel positions (0, 0), (7, 0), (0, w-1) and (7, w-1) and the region where the prediction information of the neighbouring block B2 is likely to be used to produce the prediction signal. The region width of the partition R2 is w.

[0095] When the prediction information associated with the neighbouring block B2 shown in FIG. 10 is used to produce the prediction signal of the partition R2, a range of x in step S404 of FIG. 6 is 0 to 7, while a range of y is w to 7. In addition, the range of x in step S406 of FIG. 6 is 0 to 7, while the range of y is 0 to w-1.

[0096] In addition, the neighbouring block may be two neighbouring blocks one of which is on the left of and the other is on the top of the target block, and it is possible to select either of the two neighbouring blocks with respect to each target block. In such case, the prediction signal generator 106 has a function of performing the prediction process described with reference to FIG. 4 and FIG. 10, and the region width determiner 134 includes a function of selecting the neighbouring block having the prediction information that is used to predict the partition of the target block, that is, either the neighbouring block on the left or on top of the target block. In addition, the region width encoder 136 includes a function of encoding identification information that identifies the neighbouring block having the prediction information to be used to produce the prediction signal of the target region, from the two pieces of prediction information associated with the two neighbouring blocks, while the region width decoder 218 includes a function of decoding the identification information.

[0097] Detailed description is given below for step S108 when using two neighbouring blocks on the left and on the top. FIG. 11 is a flowchart showing detailed procedures of another example of step S108 in FIG. 3. As shown in FIG. 11, in the process of step S108 of the present example, two pieces of prediction information associated with neighbouring blocks on the top of and on the left of the target block are input in the decision unit 130 in step S700.

[0098] Next, the decision unit 130 decides, in accordance with the procedures shown in step S202 of FIG. 5, whether the prediction information associated with the neighbouring block on the left of the

target block can be used to produce the prediction signal of the partition of the target block, and outputs a decision result. Then in step S704, when it is decided that the decision result of the decision unit 130 indicates "unusable" (in the case of No), that is, when the decision result shows that the prediction information associated with the neighbouring block on the left will not be used to produce the prediction signal of the partition of the target block; the procedure proceeds to the following step S202. The decision unit 130 decides, in accordance with the procedures shown in step S202 of FIG. 5, whether the prediction information associated with the neighbouring block on the top of the target block can be used to produce the prediction signal of the partition of the target block and outputs a decision result.

[0099] Then, in step S706, when it is decided that the decision result of the decision unit 130 indicates "unusable" (in the case of No), that is, when the decision result shows that the prediction information associated with the neighbouring block on the top will not be used to produce the prediction signal of the partition of the target block; the process of step S108 ends.

[0100] On the other hand, in step S706, when it is decided that the decision result of the decision unit 130 indicates "usable" (in the case of Yes), the region width determiner 134 determines, in step S708, the region width w of the partition R2 (refer to FIG. 10) of the target block, where the prediction signal is produced by using the prediction information of the neighbouring block on the top. Then, in the following step S208, the region width w is encoded by the region width encoder 136.

[0101] On the other hand, back in step S704, when it is decided that the decision result of the decision unit 130 indicates "usable" (in the case of Yes), the decision unit 130 decides in the following step S202, in accordance with the procedures shown in step S202 of FIG. 5, whether the prediction information associated with the neighbouring block on the top of the target block can be used to produce the prediction signal of the partition of the target block and outputs a decision result.

[0102] Then in step S710, when it is decided that the decision result of the decision unit 130 indicates "unusable" (in the case of No), the region width determiner 134 determines, in the following step S712, the region width w of the partition R2 (refer to FIG. 2) of the target block, where the prediction signal is produced by using the prediction information of the neighbouring block on the left. Then, the region width w is encoded by the region width encoder 136 in the following step S208.

[0103] On the other hand, in step S710, when it is decided that the decision result of decision unit 130 indicates "usable" (in the case of Yes), the neighbouring block having the prediction information to be used to produce the prediction signal is selected in the following step S714 from the neighbouring block on the left and the neighbouring block on the top.

[0104] Specifically, in step S714, the region width determiner 134 selects which of the prediction information of the neighbouring block on the top and the prediction information of the neighbouring block on the left is to be used to produce the prediction signal of the partition of the target block. The method for selection is not limited, but for example, the region width determiner 134 sets the widths of the neighbouring

block and of the partition R2, as shown in FIG. 2 and FIG. 10; produces the prediction signal of the target block by using the prediction information of the neighbouring block and the prediction information of the target block; and selects a group of the neighbouring block and the region width that makes prediction errors of the target block the smallest. Then in the following step S716, the region width encoder 136 encodes identification information identifying the neighbouring block having the selected prediction information. Next, in step S718, when it is decided that the neighbouring block on the left is selected, the process proceeds to step S712. On the other hand, in step S718, when it is decided that the neighbouring block on the left is not selected, that is, when it is decided that the neighbouring block on the top is selected, the process proceeds to step S708.

[0105] FIG. 12 is a flowchart showing detailed procedures of another example in step S508 of FIG. 8, which shows procedures used in decoding corresponding to encoding where the process of FIG. 11 is used. As shown in FIG. 12, in this example, first in step S800, the prediction information associated with the neighbouring block on the left of the target block and the prediction information associated with the neighbouring block on the top are input in the decision unit 130.

[0106] In the following two steps, the decision unit 130 decides, in accordance with the procedures shown in step S202 of FIG. 5, usability of the prediction information associated with the neighbouring block on the left and usability of the prediction information associated with the neighbouring block on the top, and outputs a decision result.

[0107] Next, in step S802, the region width decoder 218 decides, based

on the decision result of the decision unit 130, whether the prediction information associated with either one of the two neighbouring blocks is usable or not. When the prediction information associated with any of the neighbouring blocks is unusable, the region width decoder 218 sets, in step S804, the region width of the partition R2 in the decoding target block to 0 and ends the process.

[0108] On the other hand, in step S802, when it is decided that the prediction information associated with either one of the two neighbouring blocks is usable, the region width decoder 218 decides, based on the decision result of the decision unit 130, in the following step S806, whether both of the prediction information associated with the two neighbouring blocks are usable or not. When both of the prediction information of the two neighbouring blocks are usable, the region width decoder 218 decodes, in the following step S808, identification information to identify one of the neighbouring block from the encoded data and proceeds to step S812.

[0109] On the other hand, in step S806, when it is decided that the prediction information associated with either one of the two neighbouring blocks is usable, the region width decoder 218 selects, based on the decision result of the decision unit 130, in the following step S810, one of the prediction information associated with the two neighbouring blocks and proceeds to step S812. In step S812, the region width decoder 218 decodes a value of the region width.

[0110] The prediction signal may be produced by using both of the prediction information associated with the neighbouring block on the left of the target block and the prediction information associated with

the neighbouring block on the top. In that case, the region width encoder 136 has a function of encoding both groups of the two pieces of prediction information associated with the two neighbouring blocks and two region widths, while the region width decoder 218 has a function of decoding both groups of the two pieces of prediction information and the two region widths. In addition, in that case, as shown in FIG. 13, prediction signals of four partitions R1 to R4 in the target block Bt are produced individually.

[0111] Accordingly, the prediction signal generator 106 produces the prediction signal of the partition R2 by using the prediction information associated with the neighbouring block B1 on the left, and produces the prediction signal of the partition R3 by using the prediction information associated with the neighbouring block B2 on the top. In addition, the prediction signal generator 106 needs to have a function of producing the prediction signal of the partition R4. The method for predicting the partition R4, which may be given as a rule in advance, is not limited in the present invention. Examples of the method include a method for averaging the prediction signal of the partition R4 that is produced based on the prediction information associated with the neighbouring block on the left, and the prediction signal of the partition R4 that is produced based on the prediction information associated with the neighbouring block on the top, with respect to a pixel unit; and a method for producing the prediction signal of the partition R4 based on the prediction information associated with the neighbouring block on the top-left. In addition, there may be adopted a method in which selection is automatically made, by using surrounding already decoded

data including the prediction information associated with the neighbouring blocks on the left and on the top, from the prediction information that belong to the neighbouring blocks on the top and on the left; or a method of transmitting selection information.

[0112] Furthermore, the following modifications can be made in the present invention.

[0113] (Block shape)

In the description above, the partition of the target block is always rectangular, but as shown in the partitions R1 and R2 of the target block Bt in FIG. 14(a), or as shown in the partitions R1 and R2 of the target block Bt in of FIG. 14(b), the partition in any shape may be used. In such case, shape information is transmitted in addition to a region width.

[0114] (Block size)

In the description above, the block size is a fixed size, but as shown in (a) - (c) of FIG. 15, the target block Bt and the neighbouring block B1 may differ in size. In such case, as shown in (a) - (c) of FIG. 15, various shapes can be used as the shape of the partitions R1 to R3 in the target block Bt. The partitions to be constituted may be determined according to circumstances or the information indicating the neighbouring block may be selected from a plurality of candidates and may be explicitly encoded. In addition, a predetermined rule may be given in advance (for example, a unit for selecting the region width is aligned with the smaller one in block size).

[0115] (Region width encoder and decoder)

In the region width encoder, not a region width value itself, but

information identifying the region width may be encoded. In addition, in the region width decoder, not the region width value itself, but the information identifying the region width may be decoded from the encoded data, and the region width value may be restored, based on the information identifying the region width. For example, the region width encoder prepares a plurality of candidates for the region width values of the partition in the target block and may encode the identification information of the selected candidate. The region width decoder may restore the region width value based on the decoded identification information. The candidates for the region widths may be determined in advance by the encoder and the decoder, or may be transmitted for each sequence unit or for each frame unit. In addition, the region width encoder may encode a differential value between the region width value of the partition in the target block and the region width of the neighbouring block. In such case, the region width decoder can restore the region width value of the partition in the target block by adding the already decoded region width value of the neighbouring block to the differential value decoded from the encoded data. Alternatively, the region width encoder may encode information indicating that the region width of the partition in the target block is the same as the region width of the neighbouring block. When the information indicating that the region width of the partition in the target block is the same as the region width of the neighbouring block, is decoded, the region width decoder can use the region width of the neighbouring block as the region width of the partition in the target block. In this case, information indicating that the region width of the

partition in the target block is different from the region width of the neighbouring block, as well as, information identifying the region width value or the region width, may be transmitted. When the information indicating that the region width of the partition in the target block is different from the region width of the neighbouring block, is decoded, the region width decoder further decodes the information identifying the region width value or the region width from the encoded data and may restore the region width value, based on the information identifying the region width. In addition, the region width encoder may encode one or more information items for identifying the region width. That is, one or more information items that are capable of uniquely identifying the region width (for example, one or more bits) may be encoded. In such case, the region width decoder decodes one or more information items from the encoded data and can restore the region width, in accordance with the one or more information items.

[0116] (Transformer, Inverse-transformer)

A transform process of the residual signal may be performed in a fixed block size. The target region may be further divided into a size that matches with the partition, and with respect to each region produced by the further division, the transform process may be performed.

[0117] (Decision unit)

The neighbouring block, of which prediction information associated with the neighbouring block can be used, is not limited to the neighbouring block on the top of and the neighbouring block on the left of the target block. For example, when the prediction information is

encoded beforehand by one block line, all four blocks located neighbouring to the target block are to be the neighbouring block, and the pieces of prediction information associated therewith can be used to produce the prediction signal of the target block.

[0118] In addition, when the pieces of prediction information of all blocks in a picture is encoded beforehand, the prediction signal of each target block can be freely constituted by using a total of five (nine, when including left-top, left-bottom, right-top and right-bottom) pieces of prediction information associated with surrounding four blocks and the target block.

[0119] Furthermore, even if the partition is provided when the target block and the neighbouring block have the same prediction information, the encoding and decoding processing may never fail, so that a prediction signal production process of the present invention can be realized even in a structure where a decision unit is omitted.

[0120] (About decision of decision unit)

In the description above, according to the predetermined rule for the decision unit 130 to decide usability of the prediction information associated with the neighbouring block, it is decided that the prediction information associated with the neighbouring block is not to be used, when the prediction information associated with the neighbouring block coincides with the prediction information associated with the target block, or when it is decided that the prediction information of the neighbouring block is in a unusable state. In the latter case, when the neighbouring block is predicted by intra-picture prediction and the

target block is predicted by inter-picture prediction, and in the vice versa case; it may be decided that the prediction information associated with the neighbouring block in not to be used. In addition, when a difference between a motion vector of the neighbouring block and a motion vector of the target block exceeds a threshold value, it may be decided that the prediction information associated with the neighbouring block is not to be used. Furthermore, when the block sizes of the neighbouring block and the target block are different from each other, it may be decided that the prediction information associated with the neighbouring block is not to be used. In the description above, the prediction information associated with the neighbouring block and the target block are compared, but based on whether the prediction signals produced with the two pieces of prediction information are the same or not, usability of the prediction information associated with the neighbouring block may be decided.

[0121] (Prediction information)

In the description above, the inter-picture prediction (motion vector and reference picture information) is described as a method for producing the prediction signal, but the present invention is not limited to such prediction method. The prediction method including the intra-picture prediction, luminance compensation, bidirectional prediction, or backward prediction, may be applied to the prediction signal production process of the present invention. In such case, mode information, a luminance compensation parameter and the like are included in the prediction information.

[0122] (Color signal)

In the description above, a color format is not particularly mentioned, but as to a color signal or a color-difference signal, a production process of the prediction signal may be performed separately from a luminance signal. In addition, the production process of the prediction signal of the color signal or the color-difference signal may be performed in conjunction with the process of the luminance signal. In the latter case, when a resolution of the color signal is lower than the luminance signal (for example, the resolution is half in a horizontal direction and in a vertical direction), the region width in the luminance signal may be controlled (for example, to even values), or a transformation equation from the region width of the luminance signal to the region width of the color signal may be determined.

[0123] (Block denoising processing)

It is not mentioned above, but, when a block denoising process is performed with respect to a reconstructed image, a denoising process may be performed with respect to a boundary part of the partition.

[0124] In the following, an image predictive encoding program enabling a computer to operate as the image predictive encoding device 100, and an image predictive decoding program enabling a computer to operate as the image predictive decoding device 200 are described below.

[0125] FIG. 16 is a diagram showing an image predictive encoding program as well as a recordable medium according to one embodiment. Fig. 17 shows an image predictive decoding program as well as a recording medium according to one embodiment. FIG. 18 is a diagram showing a hardware configuration of a computer for executing a

program recorded in the recording medium. FIG. 19 is a perspective view of the computer for executing the program stored in the record medium.

[0126] As shown in FIG. 16, an image predictive encoding program P100 is provided by being stored in a record medium 10. As shown in FIG. 17, an image predictive decoding program P200 is also provided by being stored in the recording medium 10. Examples of the recording medium 10 include recording media, such as floppy disks, CD-ROMs, DVDs, and ROMs; and semiconductor memories.

[0127] As shown in FIG. 18, a computer 30 is provided with a reading device 12 such as a floppy disk drive, a CD-ROM drive device, and a DVD drive device; a working memory (RAM) 14 including a resident operating system; a memory 16 that stores a program stored in the record medium 10; a display device 18 such as a display; a mouse 20 and a keyboard 22 both of which are input devices; a communication device 24 that transmits and receives data and the like; and a CPU 26 that controls the execution of the program. Upon insertion of the recording medium 10 into the reading device 12, the computer 30 becomes accessible to the image predictive encoding program P100 stored in the record medium 10 from the reading device 12, and is enabled by the program P100 to operate as the image predictive encoding device 100. In addition, upon the insertion of the recording medium 10 into the reading device 12, the computer 30 becomes accessible to the image predictive decoding program P200 stored in the recording medium 10 from the reading out device 12, and is enabled by the program P200 to operate as the image predictive decoding device

200.

[0128] As shown in FIG. 19, the image predictive encoding program P100 and the image predictive decoding program P200 may be provided through a network as a computer data signal 40 superimposed on a carrier wave. In such case, the computer 30 stores in the memory 16 the image predictive encoding program P100 or the image predictive decoding program P200 that is received by the communication device 24, and can execute the program P100 or P200.

[0129] As shown in FIG. 16, the image predictive encoding program P100 is provided with a block division module P104, a prediction signal production module P106, a storage module P108, a subtraction module P110, a transformation module P112, a quantization module P114, an inverse quantization module P116, an inverse transformation module P118, an adding module P120, and a quantized transformed coefficient encoding module P122, a prediction information estimation module P126, a prediction information storage module P128, a decision module P130, a region width determination module P134, a prediction information encoding module P132, a region width determination module P134, and a region width encoding module P136.

[0130] Functions realized by executing each module described above are the same as the functions of the image predictive encoding device 100 described above. That is, the functions of each module of the image predictive encoding program P100 are the same as the functions of the block division unit 104, the prediction signal generator 106, the frame memory 108, the subtractor 110, the transformer 112, the quantizer 114, the inverse quantizer 116, the inverse transformer 118,

the adder 120, the quantized transformed coefficient encoder 122, the prediction information estimator 126, the prediction information memory 128, the decision unit 130, the prediction information encoder 132, the region width determiner 134, and the region width encoder 136.

[0131] The image predictive decoding program P200 is provided with a data analysis module P204, a quantized transformed coefficient decoding module P214, a prediction information decoding module P216, a region width decoding module P218, the prediction information storage module P128, the decision module P130, an inverse quantization module P206, an inverse transformation module P208, an adding module P210, the prediction signal production module P106, and the storage module P108.

[0132] Functions realized by executing each module described above are the same as those of each component of the image predictive decoding device 200. That is, the functions of each module of the image predictive decoding program P200 are the same as the functions of the data analyzer 204, the quantized transformed coefficient decoder 214, the prediction information decoder 216, the region width decoder 218, the prediction information memory 128, the decision unit 130, the inverse quantizer 206, the inverse transformer 208, the adder 210, the prediction signal generator 106, and the frame memory 108.

[0133] As described above, the present invention has been described in detail based on the embodiments. The present invention, however, is not limited to the above-described embodiments. Various modifications can be made without departing from the scope of the invention.

Reference Signs List

[0134]

100	image predictive encoding device
102	input terminal
104	block division unit
106	prediction signal generator
108	frame memory
110	subtractor
112	transformer
114	quantizer
116	inverse quantizer
118	inverse transformer
120	adder
122	quantized transformed coefficient encoder
124	output terminal
126	prediction information estimator
128	prediction information memory
130	decision unit
132	prediction information encoder
134	region width determiner
136	region width encoder
200	image predictive decoding device
202	input terminal
204	data analyzer
206	inverse quantizer
208	inverse transformer
210	adder

212 output terminal

214 quantized transformed coefficient decoder

216 prediction information decoder

218 region width decoder

CLAIMS

1. An image predictive encoding device comprising:

region division means for dividing an input image into a plurality of regions;

prediction information estimation means for producing a prediction signal of a target region, the target region included among the plurality of regions, and the prediction signal produced from a reconstructed signal, the prediction information estimation means also for obtaining prediction information that is used to produce the prediction signal, the prediction signal being prediction information associated with the target region;

prediction information encoding means for encoding the prediction information associated with the target region;

decision means for making a comparison of the prediction information associated with the target region and prediction information associated with a neighbouring region located neighbouring the target region, the decision means also for deciding, based on a result of the comparison, whether the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region;

region width determination means for determining a region width of a partition that is included in the target region, the region width determined by the region width determination means when it is decided by the decision means that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region;

region width encoding means for encoding information identifying the region width;

prediction signal production means for producing the prediction signal of the target region from the reconstructed signal using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width;

residual signal production means for producing a residual signal between the prediction signal of the target region and an original signal of the target region;

residual signal encoding means for encoding the residual signal;

residual signal restoration means for producing a decoded residual signal by decoding encoded data of the residual signal;

adding means for producing a reconstructed signal of the target region by adding the prediction signal to the decoded residual signal; and

storage means for storing the reconstructed signal of the target region as the reconstructed signal.

2. The image predictive encoding device according to Claim 1, wherein when deciding that the prediction information associated with the target region and the prediction information associated with the neighbouring region are identical, the decision means does not use the prediction information associated with the neighbouring region to produce the prediction signal of the target region.

3. The image predictive encoding device according to Claim 1, wherein when deciding that a combination of the prediction information associated with the target region and the prediction information associated with the neighbouring region fails to satisfy a predetermined condition, the decision means also decides not to use the prediction information associated with the neighbouring region to produce the prediction signal of the target region.

4. The image predictive encoding device according to Claim 1, wherein when the decision means decides not to use the prediction information associated with the neighbouring region to produce the prediction signal of the target region, the region width encoding means does not output encoded data of the region width.

5. The image predictive encoding device according to Claim 1, wherein the neighbouring region comprises two neighbouring regions, a first neighbouring region being positioned left of the target region and a second neighbouring region being positioned on top of the target region, and

when the decision means decides that prediction information associated with both of the two neighbouring regions can be used to produce the prediction signal of the target region, the region width encoding means encodes identification information that identifies the neighbouring region as being used to produce the prediction signal of the target region from the two neighbouring regions.

6. An image predictive decoding device comprising:

data analysis means for extracting, from compressed data which has been produced by dividing an image into a plurality of regions and encoding the regions, encoded data of prediction information associated with a target region that has been used to produce a prediction signal of the target region, encoded data of information identifying a region width of a partition in the target region where prediction information **associated with a neighbouring region located neighbouring** the target region has been used to produce the prediction signal, and encoded data of a residual signal;

prediction information decoding means for restoring the prediction information associated with the target region by decoding the encoded data of the prediction information associated with the target region;

decision means for making a comparison of the prediction information associated with the target region and the prediction information associated with the neighbouring region, and deciding, based on a result of the comparison, whether the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region;

region width decoding means for restoring the region width by decoding the encoded data of the information identifying the region width, the region width restored by the region width decoding means when it is decided by the decision means that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region;

prediction signal production means for producing the prediction signal of the target region from a reconstructed signal by using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width;

residual signal restoration means for restoring a decoded residual signal of the target region from the encoded data of the residual signal;

adding means for producing a reconstructed signal of the target region by adding the prediction signal of the target region to the decoded residual signal; and

storage means for storing the reconstructed signal of the target region as the reconstructed signal.

7. The image predictive decoding device according to Claim 6, wherein when deciding that the prediction information associated with the target region and the prediction information associated with the neighbouring region are identical, the decision means decides not to use the prediction information associated with the neighbouring region to produce the prediction signal of the target region.

8. The image predictive decoding device according to Claim 6, wherein when deciding that a combination of the prediction information associated with the target region and the prediction information associated with the neighbouring region fails to satisfy a predetermined condition, the decision means also decides not to use the prediction

information associated with the neighbouring region to produce the prediction signal of the target region.

9. The image predictive decoding device according to Claim 6, wherein when the decision means decides not to use the prediction information associated with the neighbouring region to produce the prediction signal of the target region, the region width decoding means sets the region width associated with the target region to zero.

10. The image predictive decoding device according to Claim 6, wherein the neighbouring region comprises two neighbouring regions, a first one of the neighbouring regions being left of the target region, and a second one of the neighbouring regions being on top of the target region, and

when the decision means decides that prediction information associated with both of the two neighbouring regions can be used to produce the prediction signal of the target region, the region width decoding means decodes identification information that identifies the neighbouring region used to produce the prediction signal of the target region from the two neighbouring regions.

11. An image predictive encoding method comprising:

a region division step for dividing an input image into a plurality of regions;

a prediction information estimation step for producing a prediction signal of a target region from a reconstructed signal, the

target region included among the plurality of regions, the prediction information estimation step also for obtaining prediction information associated with the target region, the prediction information associated with the target region used to produce the prediction signal;

a prediction information encoding step for encoding the prediction information associated with the target region;

a decision step for making a comparison of the prediction information associated with the target region and prediction information associated with a neighbouring region located neighbouring the target region and deciding, based on a result of the comparison, whether the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region;

a region width determination step for determining a region width of a partition that is included in the target region when it is decided in the decision step that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region;

a region width encoding step for encoding information identifying the region width;

a prediction signal production step for producing the prediction signal of the target region from the reconstructed signal by using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width;

a residual signal production step for producing a residual signal between the prediction signal of the target region and an original signal

of the target region;

a residual signal encoding step for encoding the residual signal;

a residual signal restoration step for producing a decoded residual signal by decoding encoded data of the residual signal;

a reconstructed signal production step for producing a reconstructed signal of the target region by adding the prediction signal to the decoded residual signal; and

a storage step for storing the reconstructed signal of the target region as the reconstructed signal.

12. An image predictive encoding program causing a computer to function as:

region division means for dividing an input image into a plurality of regions;

prediction information estimation means for producing a prediction signal of a target region from a reconstructed signal, the target region included among the plurality of regions, the prediction information estimation means also for obtaining prediction information that is used to produce the prediction signal, the prediction information associated with the target region;

prediction information encoding means for encoding the prediction information associated with the target region;

decision means for making a comparison of the prediction information associated with the target region and prediction information **associated with a neighbouring region located neighbouring** the target region and deciding, based on a result of the comparison,

prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region;

region width determination means for determining a region width of a partition that is included in the target region, the region width determined with the region width determination means when it is decided by the decision means that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region, and where the prediction information associated with the neighbouring region is used to produce the prediction signal;

region width encoding means for encoding information identifying the region width;

prediction signal production means for producing the prediction signal of the target region from the reconstructed signal by using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width;

residual signal production means for producing a residual signal between the prediction signal of the target region and an original signal of the target region;

residual signal encoding means for encoding the residual signal;

residual signal restoration means for producing a decoded residual signal by decoding encoded data of the residual signal;

adding means for producing a reconstructed signal of the target region by adding the prediction signal to the decoded residual signal; and

storage means for storing the reconstructed signal of the target region as the reconstructed signal.

13. An image predictive decoding method comprising:

a data analysis step for extracting, from compressed data which has been produced by dividing an image into a plurality of regions and encoding the regions, encoded data of prediction information that has been used to produce a prediction signal of a target region and is associated with the target region, encoded data of information identifying a region width of a partition in the target region, and encoded data of a residual signal, where prediction information associated with a neighbouring region located neighbouring the target region has been used to produce the prediction signal;

a prediction information decoding step for restoring the prediction information associated with the target region by decoding the encoded data of the prediction information associated with the target region;

a decision step for making a comparison of the prediction information associated with the target region and the prediction information associated with the neighbouring region, and deciding, based on a result of the comparison, whether the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region;

a region width decoding step for restoring the region width by decoding the encoded data of the information identifying the region width, the region width restored when it is decided in the decision step

that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region;

a prediction signal production step for producing the prediction signal of the target region from a reconstructed signal by using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width;

a residual signal restoration step for restoring a decoded residual signal of the target region from the encoded data of the residual signal;

a reconstructed signal production step for producing a reconstructed signal of the target region by adding the prediction signal of the target region to the decoded residual signal; and

a storage step for storing the reconstructed signal of the target region as the reconstructed signal.

14. An image predictive decoding program causing a computer to function as:

data analysis means for extracting, from compressed data which has been produced by dividing an image into a plurality of regions and encoding the regions, encoded data of prediction information associated with a target region and used to produce a prediction signal of the target region; encoded data of information identifying a region width of a partition in the target region, and encoded data of a residual signal, where prediction information associated with a neighbouring region located neighbouring the target region has been used to produce the prediction signal;

prediction information decoding means for restoring the prediction information associated with the target region by decoding the encoded data of the prediction information;

decision means for making a comparison of the prediction information associated with the target region and the prediction information associated with the neighbouring region and deciding, based on a result of the comparison, whether the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region;

region width decoding means for restoring the region width by decoding the encoded data of the information identifying the region width, the region width restored with the region width decoding means when it is decided by the decision means that the prediction information associated with the neighbouring region can be used to produce the prediction signal of the target region;

prediction signal production means for producing the prediction signal of the target region from a reconstructed signal by using the prediction information associated with the target region, the prediction information associated with the neighbouring region, and the region width;

residual signal restoration means for restoring a decoded residual signal of the target region from the encoded data of the residual signal;

adding means for producing a reconstructed signal of the target region by adding the prediction signal of the target region to the decoded residual signal; and

storage means for storing the reconstructed signal of the target region as the reconstructed signal.