CLAIMS

[1] An image encoding device comprising:

an intra prediction unit for, when a coding mode corresponding to one of coding blocks into which an inputted image is divided is an intra coding mode, carrying out an intra-frame prediction process on each block which is a unit for prediction of said coding block to generate a prediction image, wherein

when an intra prediction parameter shows an average prediction, said intra prediction unit carries out a filtering process using an intermediate prediction value generated by using the average prediction, and sets a value which said intra prediction unit has acquired through said filtering process as a final prediction value.

[2] The image encoding device according to claim 1, wherein when said intra prediction parameter shows an average prediction, the intra prediction unit changes a filter to be used according to a position of a pixel in each block which is a unit for prediction of said coding block at a time of carrying out the filtering process using the intermediate prediction value generated by using the average prediction.

[3] The image encoding device according to claim 2, wherein when said intra prediction parameter shows an average prediction, the intra prediction unit carries out the filtering process only on pixels each located at an upper end or a left end of each block which is a unit for prediction of said coding block at a time of carrying out the filtering process using the intermediate prediction value generated by using the average prediction.

[4] The image encoding device according to claim 3, wherein

when said intra prediction parameter shows an average prediction, at a time of carrying out the filtering process using the intermediate prediction value generated by using the average prediction, the intra prediction unit sets a coefficient associated with said intermediate prediction value for a pixel at an upper left corner of each block which is a unit for prediction of said coding block to 1/2, sets a coefficient associated with pixels each adjacent to an upper or left side of a target pixel to be filtered to 1/4, sets a coefficient associated with said intermediate prediction value for pixels at an upper end of said block, other than the pixel at said upper left corner, to 3/4, sets a coefficient associated with pixels adjacent to the upper side of said target pixel to be filtered to 1/4, sets a coefficient associated with said intermediate prediction value for pixels at a left end of said block, other than the pixel at said upper left corner, to 3/4, and sets a coefficient associated with pixels adjacent to the left side of said target pixel to be filtered to 1/4.

[5] The image encoding device according to claim 1, wherein when said intra prediction parameter does not show an average prediction, the intra prediction unit switches whether or not to carry out a smoothing process on reference pixels which are used for prediction according to a combination of a size of each block which is a unit for prediction of said coding block and an intra prediction parameter.

[6] The image encoding device according to claim 1, wherein said image encoding device includes:

a coding parameter determining unit for determining a maximum size of a coding block which is a unit to be processed at a time when an encoding process is carried out, and also

determining a maximum hierarchy depth at a time when a coding block having the maximum size is divided hierarchically, and for assigning a coding mode to each of coding blocks into which a coding block is divided hierarchically;

a block dividing unit for dividing an inputted image into coding blocks each having a maximum size, and also dividing each of said coding blocks hierarchically until its hierarchy number reaches the maximum hierarchy depth determined by said coding parameter determining unit;

a difference image generating unit for generating a difference image between the one of the coding blocks into which the inputted image is divided by said block dividing unit, and the prediction image generated by said intra prediction unit;

an image compression unit for compressing the difference image generated by said difference image generating unit, and outputting compressed data of said difference image; and

a variable length encoding unit for variable-length-encoding the compressed data outputted from said image compression unit and the coding mode assigned by said coding parameter determining unit to generate a bitstream into which encoded data of said compressed data and encoded data of said coding mode are multiplexed, wherein

when an intra coding mode is assigned by said coding parameter determining unit as a coding mode corresponding to one of the coding blocks into which the inputted image is divided by said block dividing unit, said intra prediction unit carries out an intra-frame prediction process to generate a prediction image by using an already-encoded image signal in a frame.

[7] The image encoding device according to claim 6, wherein said image encoding device includes a motion-compensated

prediction unit for, when an inter coding mode is assigned by said coding parameter determining unit as the coding mode corresponding to the one of the coding blocks into which the inputted image is divided by the block dividing unit, carrying out a motion-compensated prediction process on said coding block to generate a prediction image by using reference images, and said difference image generating unit generates a difference image between the one of the coding blocks into which the inputted image is divided by said block dividing unit, and the prediction image generated by the intra prediction unit or said motion-compensated prediction unit.

[8] The image encoding device according to claim 7, wherein said coding parameter determining unit determines a quantization parameter and a transform block size which are used when the difference image is compressed for each of the coding blocks, and also determines the intra prediction parameter, which is used when the intra-frame prediction process is carried out, when an intra coding mode is assigned by said coding parameter determining unit as the coding mode or determines inter prediction parameters which are used when the motion-compensated prediction process is carried out when an inter coding mode is assigned by said coding parameter determining unit as the coding mode, said image compression unit carries out a transformation process on the difference image generated by said difference image generating unit in units of a block having the transform block size determined by said coding parameter determining unit and also quantizes transform coefficients of said difference image by using the quantization parameter determined by said coding parameter determining unit to output the transform coefficients quantized thereby as the

compressed data of said difference image, and, when variable-length-encoding the compressed data outputted from said image compression unit and the coding mode assigned by said coding parameter determining unit, said variable length encoding unit variable-length-encodes the intra prediction parameter or the inter prediction parameters which are determined by said coding parameter determining unit, and the quantization parameter and the transform block size information to generate a bitstream into which the encoded data of said compressed data, the encoded data of said coding mode, encoded data of said intra prediction parameter or said inter prediction parameters, encoded data of said quantization parameter, and encoded data of said transform block size information are multiplexed.

[9] An image decoding device comprising:

an intra prediction unit for, when a coding mode associated with a coding block is an intra coding mode, carrying out an intra-frame prediction process on each block which is a unit for prediction of said coding block to generate a prediction image, wherein

when an intra prediction parameter shows an average prediction, said intra prediction unit carries out a filtering process using an intermediate prediction value generated by using the average prediction, and sets a value which said intra prediction unit has acquired through said filtering process as a final prediction value.

[10] The image decoding device according to claim 9, wherein when said intra prediction parameter shows an average prediction, the intra prediction unit changes a filter to be used according to a position of a pixel in each block which is

a unit for prediction of said coding block at a time of carrying out the filtering process using the intermediate prediction value generated by using the average prediction.

[11] The image decoding device according to claim 10, wherein when said intra prediction parameter shows an average prediction, the intra prediction unit carries out the filtering process only on pixels each located at an upper end or a left end of each block which is a unit for prediction of said coding block at a time of carrying out the filtering process using the intermediate prediction value generated by using the average prediction.

[12] The image decoding device according to claim 11, wherein when said intra prediction parameter shows an average prediction, at a time of carrying out the filtering process using the intermediate prediction value generated by using the average prediction, the intra prediction unit sets a coefficient associated with said intermediate prediction value for a pixel at an upper left corner of each block which is a unit for prediction of said coding block to 1/2, sets a coefficient associated with pixels each adjacent to an upper or left side of a target pixel to be filtered to 1/4, sets a coefficient associated with said intermediate prediction value for pixels at an upper end of said block, other than the pixel at said upper left corner, to 3/4, sets a coefficient associated with pixels adjacent to the upper side of said target pixel to be filtered to 1/4, sets a coefficient associated with said intermediate prediction value for pixels at a left end of said block, other than the pixel at said upper left corner, to 3/4, and sets a coefficient associated with pixels adjacent to the left side of said target pixel to be filtered to 1/4.

[13] The image decoding device according to claim 9, wherein when said intra prediction parameter does not show an average prediction, the intra prediction unit switches whether or not to carry out a smoothing process on reference pixels which are used for prediction according to a combination of a size of each block which is a unit for prediction of said coding block and an intra prediction parameter.

[14] The image decoding device according to claim 9, wherein said image decoding device includes: a variable length decoding unit for variable-length-decoding encoded data multiplexed into a bitstream to acquire compressed data and a coding mode which are associated with each of coding blocks into which an image is divided, and, when said coding mode is an intra coding mode, variable-length-decoding the encoded data to acquire an intra prediction parameter; an intra prediction unit for, when a coding mode associated with a coding block which is variable-length-decoded by said variable length decoding unit is an intra coding mode, carrying out an intra-frame prediction process to generate a prediction image by using an already-decoded image signal in a frame; a difference image generating unit for generating a pre-compressed difference image from the compressed data associated with the coding block variable-length-decoded by said variable length decoding unit; and a decoded image generating unit for adding the difference image generated by said difference image generating unit and the prediction image generated by said intra prediction unit to generate a decoded image.

[15] The image decoding device according to claim 9, wherein the variable length decoding unit variable-length-decodes the encoded data multiplexed into the bitstream to acquire the

coding mode associated with each of coding blocks, and, when said coding mode is an inter coding mode, variable-length-decodes the encoded data to acquire inter prediction parameters, said image decoding device includes a motion-compensated prediction unit for, when the coding mode associated with the coding block, which is variable-length-decoded by said variable length decoding unit, is an inter coding mode, carrying out a motion-compensated prediction process on said coding block to generate a prediction image by using reference images and the inter prediction parameters variable-length-decoded by said variable length decoding unit, and the decoded image generating unit adds the difference image generated by the difference image generating unit and the prediction image generated by said intra prediction unit or said motion-compensated prediction unit to generate a decoded image.

[16] The image decoding device according to claim 9, wherein the variable length decoding unit variable-length-decodes the encoded data multiplexed into the bitstream to acquire a quantization parameter and transform block size information which are associated with each of the coding blocks, and the difference image generating unit inverse-quantizes the compressed data associated with the coding block which is variable-length-decoded by said variable length decoding unit by using the quantization parameter associated with said coding block and carries out an inverse transformation process on the compressed data inverse-quantized thereby in units of a block having said transform block size to generate a pre-compressed difference image.

[17] An image encoding method comprising:

an intra prediction processing step of, when a coding mode corresponding to one of coding blocks into which an inputted image is divided is an intra coding mode, carrying out an intra-frame prediction process on each block which is a unit for prediction of said coding block to generate a prediction image, wherein

when an intra prediction parameter shows an average prediction, a filtering process using an intermediate prediction value generated by using the average prediction is carried out and a value which has been acquired through said filtering process is set as a final prediction value in said intra prediction processing step.

[18] An image decoding method comprising:

an intra prediction processing step of, when a coding mode associated with a coding block is an intra coding mode, carrying out an intra-frame prediction process on each block which is a unit for prediction of said coding block to generate a prediction image, wherein

when an intra prediction parameter shows an average prediction, a filtering process using an intermediate prediction value generated by using the average prediction is carried out and a value which has been acquired through said filtering process is set as a final prediction value in said intra prediction processing step.

[19] An image prediction device comprising:

an intra prediction unit for carrying out an intra-frame prediction process to generate a prediction image, wherein

when an intra prediction parameter shows an average prediction, said intra prediction unit carries out a filtering process using an intermediate prediction value generated by

using the average prediction, and sets a value which said intra prediction unit has acquired through said filtering process as a final prediction value.

[20] An image decoding device comprising:

an intra prediction unit for carrying out an intra-frame prediction process to generate a prediction image.

CLAIMS

[1] A moving image encoding device comprising:

an encoding controlling unit for determining a maximum size of a coding block which is a unit to be processed at a time when a prediction process is carried out, and also determining a maximum hierarchy depth at a time when a coding block having the maximum size is divided hierarchically, and for selecting a coding mode which determines an encoding method of each coding block from one or more available coding modes;

a block dividing unit for dividing an inputted image into coding blocks each having a predetermined size, and also dividing each of said coding blocks hierarchically until its hierarchy number reaches the maximum hierarchy depth determined by said encoding controlling unit;

an intra prediction unit for, when an intra coding mode is selected by said encoding controlling unit as a coding mode corresponding to one of the coding blocks into which the inputted image is divided by said block dividing unit, carrying out an intra-frame prediction process to generate a prediction image by using an already-encoded image signal in a frame;

a difference image generating unit for generating a difference image between the one of the coding blocks into which the inputted image is divided by said block dividing unit, and the prediction image generated by said intra prediction unit;

an image compression unit for compressing the difference image generated by said difference image generating unit, and outputting compressed data of said difference image; and

a variable length encoding unit for variable-length-encoding the compressed data outputted from said image compression unit and the coding mode selected by said

encoding controlling unit to generate a bitstream into which encoded data of said compressed data and encoded data of said coding mode are multiplexed, wherein

when generating the prediction image, said intra prediction unit selects a predetermined filter from one more filters which are prepared in advance, carries out a filtering process on said prediction image by using said filter, and outputs the prediction image on which said intra prediction unit has carried out the filtering process to said difference image generating unit.

[2] The moving image encoding device according to claim 1, wherein said moving image encoding device includes a motion-compensated prediction unit for, when an inter coding mode is selected by said encoding controlling unit as the coding mode corresponding to the one of the coding blocks into which the inputted image is divided by said block dividing unit, carrying out a motion-compensated prediction process on said coding block to generate a prediction image by using a reference image, and the difference image generating unit generates a difference image between the one of the coding blocks into which the inputted image is divided by said block dividing unit, and the prediction image generated by said intra prediction unit or said motion-compensated prediction unit.

[3] The moving image encoding device according to claim 2, wherein the encoding controlling unit determines a quantization parameter and a transform block size which are used when the difference image is compressed for each of the coding blocks, and also determines intra prediction parameters or inter prediction parameters which are used when the prediction process is carried out for each of the coding blocks, the image

compression unit carries out a transformation process on the difference image generated by the difference image generating unit in units of a block having the transform block size determined by said encoding controlling unit and also quantizes transform coefficients of said difference image by using the quantization parameter determined by said encoding controlling unit to output the transform coefficients quantized thereby as the compressed data of said difference image, and, when variable-length-encoding the compressed data outputted from said image compression unit and the coding mode selected by said encoding controlling unit, the variable length encoding unit variable-length-encodes the intra prediction parameters or the inter prediction parameters which are determined by said encoding controlling unit, and the quantization parameter and the transform block size to generate a bitstream into which the encoded data of said compressed data, the encoded data of said coding mode, encoded data of said intra prediction parameters or said inter prediction parameters, encoded data of said quantization parameter, and encoded data of said transform block size are multiplexed.

[4] The moving image encoding device according to claim 3, wherein the intra prediction unit selects a filter which is used for the filtering process in consideration of at least one of a size of the block on which the intra prediction unit carries out the intra prediction, the quantization parameter determined by the encoding controlling unit, a distance between the already-encoded image signal in the frame which is used when generating the prediction image and a target pixel to be filtered, and the intra prediction parameters determined by said encoding controlling unit.

[5] The moving image encoding device according to claim 4, wherein when the intra prediction parameters determined by the encoding controlling unit show an average prediction, the intra prediction unit carries out the filtering process on the prediction image generated thereby.

[6] The moving image encoding device according to claim 4, wherein a table for filter selection showing the filter which is used for the filtering process is prepared for each combination, which is taken into consideration when the intra prediction unit selects a filter, of two or more of the size of the block on which the intra prediction unit carries out the intra prediction, the quantization parameter determined by said encoding controlling unit, the distance between the already-encoded image signal in the frame which is used when generating the prediction image and the target pixel to be filtered, and the intra prediction parameters determined by said encoding controlling unit, and the intra prediction unit selects a filter which is used for the filtering process by referring to said table.

[7] The moving image encoding device according to claim 6, wherein when plural types of tables for filter selection are prepared, the encoding controlling unit outputs a filter selection table index showing a table to which the intra prediction unit refers when selecting a filter, and the variable length encoding unit includes the filter selection table index outputted thereto from said encoding controlling unit in a header of the bitstream.

[8] The moving image encoding device according to claim 1, wherein the intra prediction unit designs a Wiener filter which minimizes a sum of squared errors between the one of the coding

blocks into which the inputted image is divided by said block dividing unit, and the prediction image, and, when use of said Wiener filter increases a degree of reduction in prediction errors as compared with use of the filter selected from the one or more filters which are prepared in advance, carries out the filtering process on the prediction image by using said Wiener filter, instead of the filter which the intra prediction unit has selected, and outputs the prediction image on which said intra prediction unit has carried out the filtering process to the difference image generating unit, and the variable length encoding unit variable-length-encodes filter coefficients of the Wiener filter designed by said intra prediction unit and multiplexes encoded data of said filter coefficients into the bitstream.

[9] A moving image decoding device comprising:

a variable length decoding unit for variable-length-decoding encoded data multiplexed into a bitstream to acquire compressed data and a coding mode which are associated with each of coding blocks into which an image is hierarchically divided;

an intra prediction unit for, when a coding mode associated with a coding block which is variable-length-decoded by said variable length decoding unit is an intra coding mode, carrying out an intra-frame prediction process to generate a prediction image by using an already-decoded image signal in a frame;

a difference image generating unit for generating a pre-compressed difference image from the compressed data associated with the coding block variable-length-decoded by said variable length decoding unit; and

a decoded image generating unit for adding the difference image generated by said difference image generating unit and the prediction image generated by said intra prediction unit to generate a decoded image, wherein

when generating the prediction image, said intra prediction unit selects a predetermined filter from one more filters which are prepared in advance, carries out a filtering process on said prediction image by using said filter, and outputs the prediction image on which said intra prediction unit has carried out the filtering process to said decoded image generating unit.

[10] The moving image decoding device according to claim 9, wherein said moving image encoding device includes a motion-compensated prediction unit for, when the coding mode associated with the coding block, which is variable-length-decoded by the variable length decoding unit, is an inter coding mode, carrying out a motion-compensated prediction process on said coding block to generate a prediction image by using a reference image, and the decoded image generating unit adds the difference image generated by the difference image generating unit and the prediction image generated by the intra prediction unit or said motion-compensated prediction unit to generate a decoded image.

[11] The moving image decoding device according to claim 10, wherein the variable length decoding unit variable-length-decodes the encoded data multiplexed into the bitstream to acquire compressed data, a coding mode, intra prediction parameters or inter prediction parameters, a quantization parameter, and a transform block size which are associated with each of the coding blocks, and the difference

image generating unit inverse-quantizes the compressed data associated with the coding block which is variable-length-decoded by said variable length decoding unit by using the quantization parameter associated with said coding block and carries out an inverse transformation process on the compressed data inverse-quantized thereby in units of a block having said transform block size to generate a pre-compressed difference image.

[12] The moving image decoding device according to claim 11, wherein the intra prediction unit selects a filter which is used for the filtering process in consideration of at least one of a size of the block on which the intra prediction unit carries out the intra prediction, the quantization parameter variable-length-decoded by the variable length decoding unit, a distance between the already-decoded image signal in the frame which is used when generating the prediction image and a target pixel to be filtered, and the intra prediction parameters variable-length-decoded by said variable length decoding unit.

[13] The moving image decoding device according to claim 12, wherein when the intra prediction parameters variable-length-decoded by the variable length decoding unit show an average prediction, the intra prediction unit carries out the filtering process on the prediction image generated thereby.

[14] The moving image decoding device according to claim 12, wherein a table for filter selection showing the filter which is used for the filtering process is prepared for each combination, which is taken into consideration when the intra prediction unit selects a filter, of two or more of the size of the block on which the intra prediction unit carries out the

intra prediction, the quantization parameter variable-length-decoded by the variable length decoding unit, the distance between the already-decoded image signal in the frame which is used when generating the prediction image and the target pixel to be filtered, and the intra prediction parameters variable-length-decoded by said variable length decoding unit, and the intra prediction unit selects a filter which is used for the filtering process by referring to said table.

[15] The moving image decoding device according to claim 14, wherein when plural types of tables for filter selection are prepared, the intra prediction unit selects a filter which is used for the filtering process by referring to a table for filter selection which is shown by a filter selection table index variable-length-decoded by the variable length decoding unit.

[16] The moving image decoding device according to claim 9, wherein when the variable length decoding unit variable-length-decodes the encoded data multiplexed into the bitstream to acquire filter coefficients of a Wiener filter, the intra prediction unit carries out the filtering process on the prediction image by using said Wiener filter instead of the filter which the intra prediction unit has selected from the one or more filters which are prepared in advance, and outputs the prediction image on which the intra prediction unit has carried out the filtering process to the decoded image generating unit.

[17] An moving image encoding method comprising:

an encoding control processing step of an encoding controlling unit determining a maximum size of a coding block which is a unit to be processed at a time when a prediction

process is carried out and also determining a maximum hierarchy depth at a time when a coding block having the maximum size is divided hierarchically, and selecting a coding mode which determines an encoding method of encoding each coding block from one or more available coding modes;

a block division processing step of a block dividing unit dividing an inputted image into coding blocks each having a predetermined size, and also dividing each of said coding blocks hierarchically until its hierarchy number reaches the maximum hierarchy depth determined in said encoding control processing step;

an intra prediction processing step of, when an intra coding mode is selected in said encoding control processing step as a coding mode corresponding to one of the coding blocks into which the inputted image is divided in said block division processing step, an intra prediction unit carrying out an intra-frame prediction process to generate a prediction image by using an already-encoded image signal in a frame;

a difference image generation processing step of a difference image generating unit generating a difference image between the one of the coding blocks into which the inputted image is divided in said block division processing step, and the prediction image generated in said intra prediction processing step;

an image compression processing step of an image compression unit compressing the difference image generated in said difference image generation processing step, and outputting compressed data of said difference image; and

a variable length encoding processing step of a variable length encoding unit variable-length-encoding the compressed

data outputted in said image compression processing step and the coding mode selected in said encoding control processing step to generate a bitstream into which encoded data of said compressed data and encoded data of said coding mode are multiplexed,

wherein when generating the prediction image in said intra prediction process step, a predetermined filter is selected from one or more filters which are prepared in advance, a filtering process is carried out on said prediction image by using said filter, and the prediction image on which the filtering process has been carried out is outputted to said difference image generating unit.

[18] The moving image encoding method according to claim 17, wherein in the intra prediction processing step, a filter which is used for the filtering process is selected in consideration of at least one of a size of the block on which the intra prediction unit carries out the intra prediction, the quantization parameter determined in the encoding control processing step, a distance between the already-encoded image signal in the frame which is used when generating the prediction image and a target pixel to be filtered, and the intra prediction parameters determined in said encoding control processing step.

[19] The moving image encoding method according to claim 18, wherein in the intra prediction processing step, the filtering process is carried out on the generated prediction image when the intra prediction parameters determined in the encoding control processing step show an average prediction.

[20] A moving image decoding method comprising:

a variable length decoding processing step of a variable length decoding unit variable-length-decoding encoded data

multiplexed into a bitstream to acquire compressed data and a coding mode which are associated with each of coding blocks into which an image is hierarchically divided;

an intra prediction processing step of, when a coding mode associated with a coding block which is variable-length-decoded in said variable length decoding processing step is an intra coding mode, an intra prediction unit carrying out an intra-frame prediction process to generate a prediction image by using an already-decoded image signal in a frame;

a difference image generation processing step of a difference image generating unit generating a pre-compressed difference image from the compressed data associated with the coding block variable-length-decoded in said variable length decoding processing step; and

a decoded image generation processing step of a decoded image generating unit adding the difference image generated in said difference image generation processing step and the prediction image generated in said intra prediction processing step to generate a decoded image, wherein

when generating the prediction image in said intra prediction processing step, a predetermined filter is selected from one or more filters which are prepared in advance, a filtering process is carried out on said prediction image by using said filter, and the prediction image on which the filtering process has been carried out is outputted to said decoded image generating unit.

[21] The moving image decoding method according to claim 20, wherein in the intra prediction processing step, a filter which is used for the filtering process is selected in consideration of at least one of a size of the block on which the intra

prediction unit carries out the intra prediction, the quantization parameter variable-length-decoded in the variable length decoding processing step, a distance between the already-decoded image signal in the frame which is used when generating the prediction image and a target pixel to be filtered, and intra prediction parameters variable-length-decoded in said variable length decoding processing step.

[22] The moving image decoding method according to claim 21, wherein in the intra prediction processing step, the filtering process is carried out on the generated prediction image when the intra prediction parameters variable-length-decoded in the variable length decoding processing step show an average prediction.