

CLAIMS

[1] An image encoding device comprising:

a filter that carries out a filtering process on a local decoded image which is a result of addition of a difference image
5 decoded from compressed data about an inputted image and a prediction image; and

a variable length encoder that variable-length-encodes
10 said compressed data and a filter parameter used when the filtering process is carried out by said filter, and that generates a coded bitstream into which coded data about said compressed data and coded data about said filter parameter are multiplexed,

15 wherein said filter determines a classification method of carrying out a class classification on each coding block having a largest size, carries out a class classification on each pixel within each coding block having a largest size by using said classification method, calculates an offset value
20 for each class for each coding block having the largest size, and carries out a pixel adaptive offset process of adding said offset value to a pixel value of a pixel belonging to a corresponding class, and said variable length encoder variable-length-encodes an index indicating the classification method of carrying out a
25 class classification on each coding block having the largest size, the classification method being determined by said filter, and also variable-length-encodes a parameter about the offset value for each class determined for each coding block having the largest size on a basis of a binarization process using a truncated unary
30 code.

[2] The image encoding device according to claim 1, wherein a maximum of said offset value is determined by a bit depth of said decoded image.

[3] The image encoding device according to claim 2, wherein said image encoding device includes: a slice partitioner that partitions an inputted image into slices which are a plurality of part
5 images; a coding parameter determinator that determines the largest size of a coding block which is a unit to be processed at a time when an encoding process is carried out and also determines an upper limit on a number of hierarchies at a time when a coding block having the largest
10 size is partitioned hierarchically, and that assigns a coding mode to each of coding blocks which are partitioned hierarchically; a block partitioner that partitions a slice which is partitioned by said slice partitioner into coding blocks each having the largest size determined
by said coding parameter determinator, and that partitions each of said
15 coding blocks hierarchically into blocks until its number of hierarchies reaches the upper limit on the number of hierarchies which is determined by said coding parameter determinator; a predictor that carries out a prediction process according to the coding mode assigned by said coding
parameter determinator on each of the coding blocks which are partitioned
20 by said block partitioner so as to generate a prediction image; a difference image generator that generates a difference image between each of the coding blocks which are partitioned by said block partitioner and the prediction image generated by said predictor; an image
compressor that carries out a transformation process on the difference
25 image generated by said difference image generator and quantizes transform coefficients of said difference image, and that outputs the transform coefficients quantized thereby as compressed data; and a local decoded image generator that decodes the difference image from the compressed data outputted

from said image compressor, and adds the difference image decoded and the prediction image generated by said predictor so as to generate a local decoded image, wherein said variable length encoder variable-length-encodes header information of each slice including
5 information about the partitioning into the slices by said slice partitioner the compressed data outputted from said image compressor, the coding mode assigned by said coding parameter determinator, a quantization matrix parameter for generating a quantization matrix used when the transform coefficients are quantized by said image compressor,
10 and the filter parameter used when the filtering process is carried out by said filter

so as to generate a coded bitstream into which coded data about said header information, the coded data about said compressed data,
15 coded data about said coding mode, coded data about said quantization matrix parameter, and the coded data about said filter parameter

are multiplexed.

[4] The image encoding device according to claim 3, wherein when an intra coding mode is assigned, as the coding mode corresponding
20 to a coding block partitioned by the block partitioner, by the coding parameter determinator, the predictor carries out an intra-frame prediction process corresponding to said intra coding mode on each prediction block which is a unit for prediction process at a time of carrying out the prediction process on said coding block so as to generate
25 a prediction image.

[5] The image encoding device according to claim 4, wherein when an inter coding mode is assigned, as the coding mode corresponding to a coding block partitioned by the block partitioner, by the coding parameter determinator, the
30 ~~predictor carries out a motion-compensated prediction process~~

on each prediction block which is a unit for prediction process at a time of carrying out the prediction process on said coding block by using a reference image so as to generate a prediction image.

5 [6] The image encoding device according to claim 5, wherein the coding parameter determinator determines both a quantization parameter used when the difference image is compressed and a transformation block partitioning state for each of the coding blocks, and also determines an intra
10 prediction parameter or an inter prediction parameter used when the prediction process is carried out for each prediction block of said coding block, the predictor carries out an intra-frame prediction process by using said intra prediction parameter when an intra coding mode is assigned by said coding parameter
15 determinator and carries out a motion-compensated prediction process by using said inter prediction parameter when an inter coding mode is assigned by said coding parameter determinator, the image compressor carries out the transformation process on the difference image generated by the difference image
20 generator for each transformation block determined by said coding parameter determinator, and also quantizes the transform coefficients of said difference image by using the quantization parameter and the quantization matrix parameter which are determined by said coding parameter determinator and outputs
25 the transform coefficients quantized thereby as the compressed data about said difference image, and, when variable-length-encoding said compressed data, the coding mode, said quantization matrix parameter, the filter parameter, and the header information of each slice, the variable length
30 encoder variable-length-encodes the intra prediction

parameter or the inter prediction parameter, which is determined by said coding parameter determinator, and transformation block partitioning information so as to generate the coded bitstream into which the coded data about said compressed data, the coded data about said coding mode, the coded data about said quantization matrix parameter, the coded data about said filter parameter, the coded data about said header information, coded data about said intra prediction parameter or said inter prediction parameter, and coded data about said transformation block partitioning information are multiplexed.

[7] An image decoding device comprising:

a variable length decoder that variable-length-decodes compressed data and a filter parameter from coded data multiplexed into a coded bitstream; and

a filter that carries out a filtering process on a decoded image decoded from the compressed data variable-length-decoded by said variable length decoder by using the filter parameter variable-length-decoded by said variable length decoder,

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wherein said variable length decoder variable-length-decodes, as a filter parameter, an index indicating a classification method of carrying out a class classification on each coding block having a largest size from the coded data multiplexed into said coded bitstream, and also variable-length-decodes a parameter about an offset value for each class for each coding block having the largest size on a basis of a binarization process using a truncated unary code, and said filter specifies the classification method of carrying

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out a class classification on each coding block having the largest size by using the index indicating the classification method of carrying out a class classification on each coding block having the largest size, carries out a class classification on each pixel by using the classification method of carrying out a class classification, the classification method specified for each coding block having said largest size, calculates an offset value from the parameter about the offset value for each class for each coding block having the largest size, and carries out a pixel adaptive offset process of adding said offset value to a pixel value of a pixel belonging to a corresponding class.

[8] The image decoding device according to claim 7, wherein a maximum of said offset value is determined by a bit depth of said decoded image.

[9] The image decoding device according to claim 8, wherein said image decoding device includes: a variable length decoder that variable-length-decodes header information about each slice, a quantization matrix parameter, and a filter parameter from the coded data multiplexed into the coded bitstream, and that variable-length-decodes compressed data and a coding mode associated with each of coding blocks which are hierarchically partitioned from said coded data; a predictor that carries out a prediction process according to the coding mode variable-length-decoded by said variable length decoder and associated with the coding block so as to generate a prediction image; a difference image generator that inverse-quantizes transform coefficients which are compressed data variable-length-decoded by said variable length decoder and associated with the coding block by using a quantization parameter and said quantization matrix parameter which are variable-length-decoded by said variable length decoder, and that inverse-transforms the transform coefficients

inverse-quantized thereby so as to generate a difference image before compression; and a decoded image generator that adds the difference image generated by said difference image generator and the prediction image generated by said predictor so as to generate
5 a decoded image.

[10] The image decoding device according to claim 9, wherein when the coding mode variable-length-decoded by the variable length decoder and associated with the coding block is an intra coding mode, the predictor carries out an intra-frame
10 prediction process corresponding to said intra coding mode on each prediction block which is a unit for prediction process at a time of carrying out the prediction process on said coding block so as to generate a prediction image.

[11] The image decoding device according to claim 10, wherein when the coding mode variable-length-decoded by the variable length decoder and associated with the coding block is an inter coding mode, the predictor carries out a motion-compensated prediction process on each prediction block which is a unit for prediction process at a time of carrying out
20 the prediction process on the coding block by using a reference image so as to generate a prediction image.

[12] The image decoding device according to claim 11, wherein when variable-length-decoding the compressed data, the coding mode, and an adaptation parameter set from the coded data multiplexed into the coded bitstream, the variable length decoder
25 variable-length-decodes an intra prediction parameter or an inter prediction parameter, and transformation block partitioning information, when the coding mode variable-length-decoded by said variable length decoder and associated with the coding block is
30 an intra coding mode, the

predictor carries out the intra-frame prediction process by using said intra prediction parameter, and, when the coding mode variable-length-decoded by said variable length decoder and associated with the coding block is an inter coding mode, carries
5 out the motion-compensated prediction process by using said inter prediction parameter, and the difference image generator inverse-transforms the transform coefficients inverse-quantized thereby for each of transformation blocks acquired from the transformation block partitioning information
10 variable-length-decoded by said variable length decoder so as to generate a difference image before compression.

[13] An image encoding method comprising:

a filtering process step of a filter carrying out a filtering process on a local decoded image which is a result of addition
15 of a difference image decoded from compressed data about an inputted image and a prediction image; and

a variable length encoding process step of a variable length
20 encoder variable-length-encoding said compressed data and a filter parameter used when the filtering process is carried out in said filtering process step, and generating a coded bitstream into which coded data about said compressed data and coded data about said filter parameter are multiplexed,

25 wherein said filtering process step includes the steps of determining a classification method of carrying out a class classification on each coding block having a largest size, carrying out a class classification on each pixel within

each coding block having the largest size by using
30 said classification method, calculating

an offset value for each class, and carrying out a pixel adaptive offset process of adding said offset value to a pixel value of a pixel belonging to a corresponding class, and said variable length encoding process step includes the steps of
5 variable-length-encoding an index indicating the classification method of carrying out a class classification on each coding block having the largest size, the classification method being determined in said filtering process step, and also variable-length-encoding a parameter about the offset value for
10 each class determined for each coding block having the largest size on a basis of a binarization process using a truncated unary code.

[14] An image encoding method comprising:

a filtering process step of a filter carrying out a
15 filtering process on a local decoded image which is a result of addition of a difference image decoded from compressed data about an inputted image and a prediction image; and

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a variable length encoding process step of a variable length encoder variable-length-encoding said compressed data and a filter parameter used when the filtering process is carried out in said filtering process step, and generating a
25 coded bitstream into which coded data about said compressed data and coded data about said filter parameter are multiplexed,

wherein said filtering process step includes the steps of determining a classification method of carrying out a class classification on each coding block having a largest size,
30 carrying out a class classification on each pixel within

each coding block having the largest size by using said classification method, determining a parameter for calculating an offset value for each class and also calculating an offset value for each class from said parameter, and carrying
5 out a pixel adaptive offset process of adding said offset value to a pixel value of a pixel belonging to a corresponding class, and said variable length coding process step includes the steps of variable-length-encoding an index indicating the classification method of carrying out a class classification on
10 each coding block having the largest size, the classification method being determined by said filtering process step, and also variable-length-encoding a parameter about the offset value for each class determined for each coding block having the largest size on a basis of a binarization process using a truncated unary
15 code.

[15] An image decoding method comprising:

a variable length decoding process step of a variable length decoder variable-length-decoding compressed data and a filter parameter from coded data multiplexed into a coded bitstream;

20 a filtering process step of a filter carrying out a filtering process on a decoded image decoded from the compressed data variable-length-decoded in said variable length decoding process step by using the filter parameter variable-length-decoded in said variable length decoding process step,

25 wherein said variable length decoding process step includes the steps of variable-length-decoding, as a filter parameter, an index indicating a classification method of carrying out a class
30 classification on each coding block having

a largest size from the coded data multiplexed into said coded bitstream, and also variable-length-decoding a parameter about an offset value for each class for each coding block having the largest size on a basis of a binarization process using a truncated unary code, and said filtering process step includes the steps of specifying the classification method of carrying out a class classification on each coding block having the largest size by using the index indicating the classification method of carrying out a class classification on each coding block having the largest size, carrying out a class classification on each pixel by using the classification method of carrying out a class classification, the classification method specified for each coding block having said largest size, calculating an offset value from the parameter for calculating the offset value for each class for each coding block having the largest size, and carrying out a pixel adaptive offset process of adding said offset value to a pixel value of a pixel belonging to a corresponding class.

CLAIMS

[1] An image encoding device comprising:

an image compressor that carries out a transformation process on a difference image between an inputted image and a prediction image and quantizes transform coefficients of the difference image and outputs the quantized transform coefficients as compressed data;

a filter that carries out a filtering process on a local decoded image which is a result of addition of the difference image decoded from the compressed data and the prediction image; and

a variable length encoder that variable-length-encodes the compressed data and a filter parameter used when the filtering process is carried out by the filter and generates a coded bitstream into which coded data of the compressed data and coded data of the filter parameter are multiplexed,

wherein the filter determines a classification method for each coding block having a largest size, carries out a classification on each pixel within each coding block having the largest size by using the classification method, calculates an offset value for each class for each coding block having the largest size, and carries out a pixel adaptive offset process by which the offset value is added to a pixel value of a pixel belonging to a corresponding class, and

the variable length encoder variable-length-encodes a quantization matrix parameter for generating a quantization matrix used when the transform coefficients are quantized by the image compressor and an index indicating the classification method for each coding block having the largest size, the classification method being determined by the filter, and variable-length-encodes a parameter of the offset value for each class on a basis of a binarization process using a truncated unary code.

[2] An image decoding device comprising:

a variable length decoder that variable-length-decodes compressed data, a filter parameter and a quantization matrix parameter from coded data multiplexed into a coded bitstream;

a difference image generator that inverse-quantizes transform coefficients of a block obtained from the compressed data by using the quantization matrix parameter which is variable-length-decoded by the variable length decoder and inverse-transforms the inverse-quantized transform coefficients to generate a difference image;

5 a decoded image generator that adds the difference image and a prediction image to generate a decoded image; and

a filter that carries out a filtering process on the decoded image decoded from the compressed data by using the filter parameter,

10 wherein the variable length decoder variable-length-decodes, as a filter parameter, an index indicating a classification method for each coding block having a largest size from the coded data, and variable-length-decodes a parameter of an offset value for each class on which a binarization process using a truncated unary code is performed, and

15 the filter specifies the classification method for each coding block having the largest size by using the index, carries out a classification on each pixel by using the classification method specified for each coding block having the largest size, and carries out a pixel adaptive offset process by which the offset value is added to a pixel value of a pixel belonging to a corresponding class.

20 [3] An image encoding method comprising:

an image compression step of an image compressor carrying out a transformation process on a difference image between an inputted image and a prediction image and quantizing transform coefficients of the difference image and outputting the quantized transform coefficients as compressed data;

25 a filtering process step of a filter carrying out a filtering process on a local decoded image which is a result of addition of the difference image decoded from compressed data and the prediction image; and

30 a variable length encoding process step of a variable length encoder variable-length-encoding the compressed data and a filter parameter used when the filtering process is carried out in the filtering process step, and generating a coded bitstream

into which coded data of the compressed data and coded data of the filter parameter are multiplexed,

wherein the filtering process step includes the steps of determining a classification method for each coding block having a largest size, carrying out a classification on each pixel within each coding block having the largest size by using the classification method, calculating an offset value for each class, and carrying out a pixel adaptive offset process by which the offset value is added to a pixel value of a pixel belonging to a corresponding class, and

the variable length encoding process step includes the steps of variable-length-encoding a quantization matrix parameter for generating a quantization matrix used when the transform coefficients are quantized in the image compression step and an index indicating the classification method for each coding block having the largest size, the classification method being determined in the filtering process step, and variable-length-encoding a parameter of the offset value for each class on a basis of a binarization process using a truncated unary code.

[4] An image decoding method comprising:

a variable length decoding process step of a variable length decoder variable-length-decoding compressed data, a filter parameter and a quantization matrix parameter from coded data multiplexed into a coded bitstream;

a difference image generation step of a difference image generator inverse-quantizing transform coefficients of a block obtained from the compressed data by using the quantization matrix parameter which is variable-length-decoded in the variable length decoding process step and inverse-transforming the inverse-quantized transform coefficients to generate a difference image;

a decoded image generation step of a decoded image generator adding the difference image and a prediction image to generate a decoded image; and

a filtering process step of a filter carrying out a filtering process on the decoded image decoded from the compressed data by using the filter parameter,

wherein the variable length decoding process step includes the steps of variable-length-decoding, as a filter parameter, an index indicating a classification method for each coding block having a largest size from the coded data, and variable-length-decoding a parameter of an offset value for each class on which a binarization
 5 process using a truncated unary code is performed, and

the filtering process step includes the steps of specifying the classification method for each coding block having the largest size by using the index, carrying out a classification on each pixel by using the classification method specified for each coding block having the largest size, and carrying out a pixel adaptive offset process by which
 10 the offset value is added to a pixel value of a pixel belonging to a corresponding class.

[5] A medium storing a bitstream having coded data, the coded data comprising:
 variable-length-encoded data obtained by carrying out a transformation process on a difference image data between an inputted image and a prediction image,
 15 quantizing transform coefficients of the difference image and variable-length-encoding the quantized transform coefficients as compressed data; and

variable-length-encoded data of a filter parameter used when a filtering process is carried out on a local decoded image which is a result of addition of the difference image decoded from the compressed data and the prediction image,

20 wherein the filtering process includes
 determining a classification method for each coding block having a largest size,
 carrying out a classification on each pixel within each coding block having the largest size by using the classification method,

calculating an offset value for each class, and
 25 carrying out a pixel adaptive offset process by which the offset value is added to a pixel value of a pixel belonging to a corresponding class,

wherein the variable-length-encoded data include
 variable-length-encoded data of a quantization matrix parameter for generating a quantization matrix used when the transform coefficients of the difference image are
 30 quantized,

variable-length-encoded data of an index indicating the classification method for each coding block having the largest size, and

variable-length-encoded data of a parameter of the offset value for each class on a basis of a binarization process using a truncated unary code.