

SPECIFICATION

TITLE OF THE INVENTION

VIDEOIMAGE ENCODING DEVICE, VIDEOIMAGE DECODING DEVICE, VIDEOIMAGE
ENCODING METHOD, AND VIDEOIMAGE DECODING METHOD

5 FIELD OF THE INVENTION

[0001]

The present invention relates to a videoan image encoding
device for and a videoan image encoding method of encoding a video
with a high degree of efficiency, and a videoan image decoding device
10 for and a videoan image decoding method of decoding a video which
is encoded with a high degree of efficiency.

BACKGROUND OF THE INVENTION

[0002]

Conventionally, in accordance with an international standard
15 video encoding method, such as MPEG or ITU-T H.26x, after an inputted
video frame is partitioned into macroblocks each of which consists
of blocks of 16x16 pixels and a motion-compensated prediction is
carried out on each of the macroblocks, information compression is
carried out on the inputted video frame by carrying out orthogonal
20 transformation and quantization on a prediction error signal on a
per block basis. A problem is, however, that as the compression ratio
becomes high, the compression efficiency is reduced because of
degradation in the quality of a prediction reference image used when
carrying out a motion-compensated prediction. To solve this problem,
25 in accordance with an encoding method such as MPEG-4 AVC/H.264 (refer
to nonpatent reference 1), by carrying out an in-loop deblocking
filtering process, a block distortion occurring in a prediction
reference image and caused by quantization of orthogonal transform
coefficients is

[0010]

Nonpatent reference 1: MPEG-4 AVC (ISO/IEC 14496-10)/H.ITU-T 264 standards

Nonpatent reference 2: "CE13: Sample Adaptive Offset with
5 LCU-Independent Decoding", JCT-VC Document JCTVC-E049, March 2011, Geneva, CH.

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0011]

10 Because the conventional video encoding device is constructed as above, this video encoding device needs to encode the offsets determined for several classes for each of the blocks into which the screen is partitioned. A problem is therefore that because a high-accuracy distortion compensation process is carried out during
15 the pixel adaptive offset process, the code amount required to encode the offsets increases and hence the coding efficiency drops with increase in the fineness of partitioning of the screen into the blocks.

[0012]

20 The present invention is made in order to solve the above-mentioned problem, and it is therefore an object of the present invention to provide ~~a video~~an image encoding device, ~~a video~~an image decoding device, ~~a video~~an image encoding method, and ~~a video~~an image decoding method capable of reducing the code amount required to encode
25 offsets and hence improving the coding efficiency.

MEANS FOR SOLVING THE PROBLEM

[0013]

In accordance with the present invention, there is provided
30 ~~a video~~an image encoding device in which a 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 ~~a block in question~~ each coding block having the largest size by using the above-mentioned 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 of adding the offset value to the pixel value of a pixel belonging to a corresponding class, and a variable length encoder variable-length-encodes 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 by the 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 the basis of a binarization process using a truncated unary code.

15 ADVANTAGES OF THE INVENTION

[0014]

Because the video encoding device according to the present invention is constructed in such a way that the filter determines a classification method of carrying out a class classification on each coding block having the largest size, carries out a class classification on each pixel within ~~a block in question~~ each coding block having the largest size by using the above-mentioned classification method, calculates the offset value for each class for each coding block having the largest size, and carries out the pixel adaptive offset process of adding the offset value to the pixel value of a pixel belonging to the corresponding class, and the variable length encoder variable-length-encodes the index indicating the classification method of carrying out a class classification on each coding block having the largest size, the classification method being determined by the filter, and also variable-length-encodes the parameter about the offset

Although the offset for each class is defined by using only one parameter for both the EO method and the BO method in the above-mentioned example, the offset itself for each class can be encoded as offset information for either one of the methods. At this time, according to an encoding method of encoding the above-mentioned offset value which the variable length encoding unit 13 uses, by setting up the range of values which the offset can have in advance and in common between the video encoding device and the video decoding device, high-efficiency encoding can be carried out by using a binarization method which takes into consideration the range of values which a symbol to be encoded, such as a truncated unary code shown in Fig. 25, has. In contrast, when the range of values which the offset can have is not set up in advance, a code which can be binarized without taking into consideration the range of values of a symbol to be encoded, such as a unary code shown in Fig. 26, is used. In general, while the EO method has an effect of smoothing noise occurring in an edge portion of the image, and has a high correlation between the offset values for classes on the basis of a relationship among pixels a, b, and c of each class shown in Fig. 14, the BO method does not have a clear correlation between classes which is substantially the same as that which the EO method has. Therefore, there is a case in which it is more appropriate to define an offset by using the parameter X only for the EO method, while encoding the offset value itself for each class as offset information for the BO method because a high image quality improvement effect is acquired while the code amount required to encode the offset information increases. A calculation expression for calculating an offset for each class can be prepared for each

CLAIMS

[1] ~~A video~~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 decoded from compressed data about an inputted image and a prediction image, ~~and that outputs the local decoded image on which the filtering process is carried out as a reference image used when generating said prediction image;~~ and

a variable length encoder that variable-length-encodes 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,

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 ~~a block in question~~ each coding block having a largest size by using said 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 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 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 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.

[23] The ~~videeimage~~ encoding device according to claim 12, wherein said ~~videeimage~~ encoding device includes: a slice partitioner that

5 partitions an inputted image into slices which are a plurality of part 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, ~~and header information of each slice including information about the partitioning into the slices by said slice partitioner~~ 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, ~~and coded data about said header information~~ are multiplexed.

[34] The ~~video~~image encoding device according to claim 23, 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.

[45] The ~~video~~image encoding device according to claim 34, 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 | [56] The ~~video~~image encoding device according to claim 45, 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.

[67] ~~A video~~ 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, ~~and that outputs the decoded image on which the filtering process is carried out as a reproduced image,~~

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

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 ~~corresponding to~~ 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.

[79] The ~~video~~image decoding device according to claim ~~68~~, wherein
 15 said ~~video~~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
 20 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
 25 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
 30 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.

[~~8~~10] The ~~video~~image decoding device according to claim ~~7~~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.

[~~9~~11] The ~~video~~image decoding device according to claim ~~8~~10,
 15 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.

[~~10~~12] The ~~video~~image decoding device according to claim ~~9~~11, wherein when variable-length-decoding the compressed data, the coding mode, and an adaptation parameter set from the coded data
 25 multiplexed into the coded bitstream, the variable length decoder 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 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 variable-length-decoded by said variable length decoder so as to generate a difference image before compression.

[1113] ~~A video~~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 of a difference image decoded from compressed data about an inputted image and a prediction image, ~~and outputting the local decoded image on which the filtering process is carried out as a reference image used when generating said prediction image;~~ and
 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 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, carrying out a class classification on each pixel within ~~a block in question~~each coding block having the largest size by using 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.

[1214] ~~A video~~ 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 outputting the local decoded image on which the filtering process is carried out as a reference image used when generating said~~

20 ~~prediction image; and~~

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 a block

~~in question~~ 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 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 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 code.

[1315] ~~A video~~ 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;

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, ~~and outputting the decoded image on which the filtering process is carried out as a reproduced image,~~

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 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 ~~corresponding to~~ 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.