prediction, picture quality significantly drops.
[0004]
Conventional techniques for solving such a drop in quality due to erroneous intra prediction include a constrained intra prediction scheme used in H.264. This scheme allows only intra-predicted samples to be used as reference samples for intra prediction, and prohibit specific intra prediction methods when reference samples are not intra-predicted (see Non Patent Literature (NPL) 1).

[Citation List]
[Non Patent Literature]
[0005]
[NPL 1] ISO/IEC 14496-10 "MPEG-4 Part 10 Advanced Video Coding"

[Summary of Invention]
[Technical Problem]
[0006]
Here, the next-generation HEVC moving picture coding scheme uses variable-length coding units of a plurality of sizes. With this scheme, whether to use intra prediction or inter prediction can be individually set for each coding unit. Accordingly, HEVC can improve coding efficiency.
[0007]
However, such cases in which variable-length coding units are used are not assumed with the constrained intra prediction scheme in conventional techniques, coding efficiency may be insufficient in such cases in which variable-length coding units are used.
[0008]
~~In view of this, an object~~ Embodiments of the present invention ~~is to~~ provide a moving picture coding method, a moving picture decoding method, a moving picture coding apparatus, a moving picture decoding apparatus, and a moving picture coding and decoding apparatus that enable improvement in coding efficiency.

[Solution to Problem]
[0008a]
According to a first aspect of the present invention, there is provided a method for reproducing a modulated multiplexed data including audio data and video data, the method comprising: receiving the modulated multiplexed data; demodulating the modulated multiplexed data; demultiplexing the multiplexed data to obtain a coded moving picture bitstream; analyzing the coded moving picture bitstream to obtain difference data of a target block among a plurality of blocks of two or more sizes; performing intra prediction on the target block to calculate values of predicted samples of the target block; and calculating reconstructed samples of the target block by adding the difference data and the values of the predicted samples, wherein in said performing of intra prediction includes: determining, for each of a plurality of

reference samples each located at bottom left, left, top left, top, or top right of the target block, a reference sample to be a valid reference sample if the reference sample is intra-predicted, and to be an invalid reference sample if the reference sample is inter-predicted; selecting, if the plurality of reference samples include both a valid reference sample and an invalid reference sample, the valid reference sample as a selected sample, and using a value of the selected sample as a complementary value of the invalid reference sample; and calculating the predicted sample of the target block, using a value of the valid reference sample and the complementary value of the invalid reference sample, and wherein in said selecting, a search starts from a location of a reference sample at bottom left of the target block among locations of all the plurality of reference samples, and is conducted in a search order of locations of reference samples at bottom left, left, top left, top, and top right of the target block in that order, and when a set of successive valid reference samples found first in the search is a first set of valid reference samples and when a set of successive valid reference samples found next in the search is a second set of valid reference samples, a value of a first reference sample located first in the search order in the first set of valid reference samples is used as the complementary value of the invalid reference sample when the invalid reference sample is located before the first reference sample in the search order, and a value of a second reference sample located last in the search order in the first set of valid reference samples is used as the complementary value of the invalid reference sample when the invalid reference sample is located between the first set of reference samples and the second set of reference samples.

[0008b]

According to a second aspect of the present invention, there is provided an apparatus for reproducing a modulated multiplexed data including audio data and video data, the apparatus comprising: a receiving unit configured to receive the modulated multiplexed data; a demodulating unit configured to demodulate the modulated multiplexed data; a demultiplexing unit configured to demultiplex the multiplexed data to obtain a coded moving picture bitstream; an analyzing unit configured to analyze the coded moving picture bitstream to obtain difference data of a target block among a plurality of blocks of two or more sizes; a intra predicting unit configured to perform intra prediction on the target block to calculate values of predicted samples of the target block; and a reconstructed sample calculating unit configured to calculate reconstructed samples of the target block by adding the difference data and the values of the predicted samples, wherein said intra predicting unit includes: a determining unit configured to determine, for each of a plurality of reference samples each located at bottom left, left, top left, top, or top right of the target block, a reference sample to be a valid reference sample if the reference sample is intra-predicted, and to be an invalid reference sample if the reference sample is inter-predicted; a sample selecting unit configured to select, if the plurality of reference samples include both a valid reference sample and an invalid reference sample, the valid reference sample as a selected sample, and use a value of the selected sample as a complementary value of the invalid

reference sample; and a predicted sample calculating unit configured to calculate the predicted sample of the target block, using a value of the valid reference sample and the complementary value of the invalid reference sample, and wherein said sample selecting unit is configured to start a search from a location of a reference sample at bottom left of the target block among locations of all the plurality of reference samples, and conduct the search in a search order of locations of reference samples at bottom left, left, top left, top, and top right of the target block in that order, and when a set of successive valid reference samples found first in the search is a first set of valid reference samples and when a set of successive valid reference samples found next in the search is a second set of valid reference samples, use a value of a first reference sample located first in the search order in the first set of valid reference samples as the complementary value of the invalid reference sample when the invalid reference sample is located before the first reference sample in the search order, and use a value of a second reference sample located last in the search order in the first set of valid reference samples as the complementary value of the invalid reference sample when the invalid reference sample is located between the first set of reference samples and the second set of reference samples.

[0009]

~~In order to achieve the above object,~~ Disclosed herein is a moving picture decoding method ~~according to an aspect of the present invention includes~~ including: analyzing a coded moving picture bitstream to obtain difference data of a target block among a plurality of blocks of two or more sizes; performing intra prediction on the target block to calculate values of predicted samples of the target block; and calculating reconstructed samples of the target block by adding the difference data and the values of the predicted samples, wherein in the performing of intra prediction, validity of each of reference samples that are located one of immediately above and immediately to the left of the target block is determined, and when the reference samples include both a valid reference sample and an invalid reference sample, the intra prediction is performed using the valid reference sample, and an intra-predicted reference sample is determined as a valid reference sample, and an inter-predicted reference sample is determined as an invalid reference sample.

[0010]

According to ~~this, with the moving picture decoding method according to the aspect of the present invention~~ the above disclosure, when reference samples that are located one of immediately above and immediately to the left of a target block include both a valid reference sample and an invalid reference sample, intra prediction can be performed using the valid reference sample. Accordingly, with the moving picture decoding method, more valid reference samples can be utilized, thereby enabling improvement in coding efficiency.

[0011]

In addition, in the analyzing, the coded moving picture bitstream may be further analyzed to determine an intra prediction method, and the performing of intra prediction further may include: calculating a complementary sample using one or more valid reference samples including the valid reference sample, the complementary sample being a reference sample at a location of the invalid reference sample; and calculating the predicted samples of the target block in accordance with the intra prediction method, using the valid reference sample and the complementary sample.

[0012]

According to ~~this, with the moving picture decoding method according to the aspect of the present invention~~ the above disclosure, a sample at an invalid reference sample location can be generated using valid reference samples. Accordingly, with the above disclosed moving picture decoding method, more valid reference samples can be utilized, thereby enabling improvement in coding efficiency.

[0013]

Further, the calculating of a complementary sample may include: selecting one of the valid reference samples as a selected sample; and determining a value of the selected sample as a value of the complementary sample.

[0014]

Further, the selecting may include: identifying, as a start reference sample location, a location of a valid reference sample found first in a search in a direction starting from a location of a bottom-left reference sample and ending at a location of a top-right reference sample among locations of all the reference samples; determining whether the invalid reference sample is located before or after the start reference sample location in a sample order that is the same as an order of samples in the search; selecting a sample at the start reference sample location as the selected sample when the invalid reference sample is located before the start sample location; and selecting, when the invalid reference sample is located after the start sample location, a valid reference sample as the selected sample in accordance with the sample order that is the same as the order of samples in the search, the valid reference sample being located before and closest to a location of the invalid reference sample.

[0015]

Further, the calculating of a complementary sample may include: selecting the valid reference samples as a plurality of selected samples; calculating a plurality of scaling values by multiplying a value of each of the selected samples by a predetermined scaling factor; calculating a first sum total value that is a sum total of the scaling values; calculating a second sum total value that is a sum of the first sum total value and a predetermined offset value; and calculating a value of the complementary sample by

down-shifting the second sum total value by a predetermined shift step value.

[0016]

Further, the intra prediction may be intra DC prediction.

[0017]

According to ~~this, with the moving picture decoding method according to the aspect of the present invention~~ the above disclosure, in the intra DC prediction, more valid reference samples can be utilized, thereby enabling improvement in coding efficiency.

[0018]

Further, the performing of intra prediction may include: selecting each of one or more valid reference samples including the valid reference sample as a selected sample; specifying the number of the selected samples; selecting a scaling factor, an offset value, and a shift step value, using a look-up table, in accordance with the number of the selected samples; calculating a first sum total value that is a sum total of values of the selected samples; calculating a scaling value by multiplying the first sum total value by the selected scaling factor; calculating a second sum total value that is a sum of the selected offset value and the scaling value; and generating each value of all the predicted samples of the target block by down-shifting the second sum total value by the selected shift step value.

[0019]

In addition, the performing of intra prediction may further include performing of intra prediction in the case in which a predetermined value is determined as each value of all the predicted samples of the target block.

[0020]

In the analyzing, selection information coded in a header of the coded moving picture bitstream may be further obtained, the selection information may indicate one of (1) a constrained intra prediction scheme that is the intra prediction and (2) an unconstrained intra prediction scheme for performing intra prediction using all the reference samples without determining the validity of each of the reference samples, and in the performing of intra prediction, the intra prediction may be performed using one of the constrained intra prediction scheme and the unconstrained intra prediction scheme indicated by the selection information.

[0021]

According to ~~this, with the moving picture decoding method according to the aspect of the present invention~~ the above disclosure, it is possible to know, based on selection information, which of the constrained intra prediction scheme and the unconstrained intra prediction scheme is used.

[0022]

In the performing of intra prediction, a reference sample outside a target picture may be determined as an invalid reference

sample.

[0023]

Further, in the performing of intra prediction, a reference sample that is not included in the same unit of picture division as the target block may be determined as an invalid reference sample.

[0024]

The unit of picture division may be a slice.

[0025]

The unit of picture division may be a lightweight slice.

[0026]

The unit of picture division may be a tile.

[0027]

The unit of picture division may be a wavefront parallel processing unit (WPP).

[0028]

~~Further,~~ Disclosed herein is a moving picture coding method ~~according to an aspect of the present invention includes~~ including: dividing an original picture into a plurality of blocks of two or more sizes; performing intra prediction on a target block among the blocks to calculate values of predicted samples; calculating difference data that represents a difference between an original image in the target block and the values of the predicted samples; and coding the difference data to generate a coded moving picture bitstream, wherein in the performing of intra prediction, validity of each of reference samples that are located one of immediately above and immediately to the left of the target block is determined, and when the reference samples include both a valid reference sample and an invalid reference sample, the intra prediction is performed using the valid reference sample, and an intra-predicted reference sample is determined as a valid reference sample, and an inter-predicted reference sample is determined as an invalid reference sample.

[0029]

According to ~~this, with the moving picture coding method according to the aspect of the present invention~~ the above disclosure, when reference samples that are located one of immediately above and immediately to the left of a target block include both a valid reference sample and an invalid reference sample, intra prediction can be performed using the valid reference sample. Accordingly, with the moving picture decoding method, more valid reference samples can be utilized, thereby enabling improvement in coding efficiency.

[0030]

It should be noted that embodiments of the present invention can be realized not only as such a moving picture coding method and such a moving picture decoding method, but also as a moving picture coding apparatus or a moving picture decoding apparatus that uses, as means, characteristic steps included in the moving picture coding method or the moving picture decoding method. Further,

embodiments of the present invention can also be realized as a moving picture coding and decoding apparatus including such a moving picture coding apparatus and such a moving picture decoding apparatus.

[0031]

Furthermore, embodiments of the present invention can also be realized as a program for causing a computer to execute the characteristic steps included in the moving picture coding method or the moving picture decoding method. It goes without saying that such a program can be distributed via a recording medium such as CD-ROM and a transmission medium such as the Internet.

[0032]

Moreover, embodiments of the present invention can be realized as a semiconductor integrated circuit (LSI) that realizes a part or all of functions of such a moving picture coding apparatus or moving picture decoding apparatus, or various devices or a system including such a moving picture coding apparatus or moving picture decoding apparatus.

[Advantageous Effects of Invention]

[0033]

As described above, embodiments of the present invention can provide a moving picture coding method, a moving picture decoding method, a moving picture coding apparatus, a moving picture decoding apparatus, and a moving picture coding and decoding apparatus that enable improvement in coding efficiency.

[Brief Description of Drawings]

[0034]

[FIG. 1] FIG. 1 shows an example of intra prediction from neighboring reference samples when blocks have the same size.

[FIG. 2] FIG. 2 shows an example of intra prediction from neighboring reference samples when blocks have different sizes.

[FIG. 3] FIG. 3 is a flowchart showing moving picture coding processing in Embodiment 1 of the present invention.

[FIG. 4A] FIG. 4A shows an example of the location of a signal that indicates a result of selection between an unconstrained intra prediction scheme and a constrained intra prediction scheme in a compressed moving picture stream in Embodiment 1 of the present invention.

[FIG. 4B] FIG. 4B shows an example of the location of a signal that indicates a result of selection between the unconstrained intra prediction scheme and the constrained intra prediction scheme in a

Claims:

1. A method for reproducing a modulated multiplexed data including audio data and video data, the method comprising:

receiving the modulated multiplexed data;

demodulating the modulated multiplexed data;

demultiplexing the multiplexed data to obtain a coded moving picture bitstream;

analyzing the coded moving picture bitstream to obtain difference data of a target block among a plurality of blocks of two or more sizes;

performing intra prediction on the target block to calculate values of predicted samples of the target block; and

calculating reconstructed samples of the target block by adding the difference data and the values of the predicted samples,

wherein in said performing of intra prediction includes:

determining, for each of a plurality of reference samples each located at bottom left, left, top left, top, or top right of the target block, a reference sample to be a valid reference sample if the reference sample is intra-predicted, and to be an invalid reference sample if the reference sample is inter-predicted;

selecting, if the plurality of reference samples include both a valid reference sample and an invalid reference sample, the valid reference sample as a selected sample, and using a value of the selected sample as a complementary value of the invalid reference sample; and

calculating the predicted sample of the target block, using a value of the valid reference sample and the complementary value of the invalid reference sample, and

wherein in said selecting,

a search starts from a location of a reference sample at bottom left of the target block among locations of all the plurality of reference samples, and is conducted in a search order of locations of reference samples at bottom left, left, top left, top, and top right of the target block in that order, and

when a set of successive valid reference samples found first in the search is a first set of valid reference samples and when a set of successive valid reference samples found next in the search is a second set of valid reference samples, a value of a first reference sample located first in the search order in the first set of valid reference samples is used as the complementary value of the invalid reference sample when the invalid reference sample is located before the first reference sample in the search order, and a value of a second reference sample located last in the search order in the first set of valid reference samples is used as the complementary value of the invalid reference sample when the invalid reference sample is located between the first set of reference samples and the second set of reference samples.

2. An apparatus for reproducing a modulated multiplexed data including audio data and video data, the apparatus comprising:

a receiving unit configured to receive the modulated multiplexed data;

a demodulating unit configured to demodulate the modulated multiplexed data;

a demultiplexing unit configured to demultiplex the multiplexed data to obtain a coded moving picture bitstream;

an analyzing unit configured to analyze the coded moving picture bitstream to obtain difference data of a target block among a plurality of blocks of two or more sizes;

a intra predicting unit configured to perform intra prediction on the target block to calculate values of predicted samples of the target block; and

a reconstructed sample calculating unit configured to calculate reconstructed samples of the target block by adding the difference data and the values of the predicted samples,

wherein said intra predicting unit includes:

a determining unit configured to determine, for each of a plurality of reference samples each located at bottom left, left, top

left, top, or top right of the target block, a reference sample to be a valid reference sample if the reference sample is intra-predicted, and to be an invalid reference sample if the reference sample is inter-predicted;

a sample selecting unit configured to select, if the plurality of reference samples include both a valid reference sample and an invalid reference sample, the valid reference sample as a selected sample, and use a value of the selected sample as a complementary value of the invalid reference sample; and

a predicted sample calculating unit configured to calculate the predicted sample of the target block, using a value of the valid reference sample and the complementary value of the invalid reference sample, and

wherein said sample selecting unit is configured to

start a search from a location of a reference sample at bottom left of the target block among locations of all the plurality of reference samples, and conduct the search in a search order of locations of reference samples at bottom left, left, top left, top, and top right of the target block in that order, and

when a set of successive valid reference samples found first in the search is a first set of valid reference samples and when a set of successive valid reference samples found next in the search is a second set of valid reference samples, use a value of a first reference sample located first in the search order in the first set of valid reference samples as the complementary value of the invalid reference sample when the invalid reference sample is located before the first reference sample in the search order, and use a value of a second reference sample located last in the search order in the first set of valid reference samples as the complementary value of the invalid reference sample when the invalid reference sample is located between the first set of reference samples and the second set of reference samples.

Claims:

1. A method for reproducing a modulated multiplexed data including audio data and video data, the method comprising:

receiving the modulated multiplexed data;

demodulating the modulated multiplexed data;

demultiplexing the multiplexed data to obtain a coded moving picture bitstream;

analyzing the coded moving picture bitstream to obtain difference data of a target block among a plurality of blocks of two or more sizes;

performing intra prediction on the target block to calculate values of predicted samples of the target block; and

calculating reconstructed samples of the target block by adding the difference data and the values of the predicted samples,

wherein in said performing of intra prediction includes:

determining, for each of a plurality of reference samples each located at bottom left, left, top left, top, or top right of the target block, a reference sample to be a valid reference sample if the reference sample is intra-predicted, and to be an invalid reference sample if the reference sample is inter-predicted;

selecting, if the plurality of reference samples include both a valid reference sample and an invalid reference sample, the valid reference sample as a selected sample, and using a value of the selected sample as a complementary value of the invalid reference sample; and

calculating the predicted sample of the target block, using a value of the valid reference sample and the complementary value of the invalid reference sample, and

wherein in said selecting,

a search starts from a location of a reference sample at bottom left of the target block among locations of all the plurality of reference samples, and is conducted in a search order of locations of reference samples at bottom left, left, top left, top, and top right of the target block in that order, and

when a set of successive valid reference samples found first in the search is a first set of valid reference samples and when a set of successive valid reference samples found next in the search is a second set of valid reference samples, a value of a first reference sample located first in the search order in the first set of valid reference samples is used as the

complementary value of the invalid reference sample when the invalid reference sample is located before the first reference sample in the search order, and a value of a second reference sample located last in the search order in the first set of valid reference samples is used as the complementary value of the invalid reference sample when the invalid reference sample is located between the first set of reference samples and the second set of reference samples.

2. A method for generating a modulated multiplexed data comprising:

dividing an original picture into a plurality blocks each having a size selected from two or more sizes;

performing intra prediction on a target block among the blocks to calculate values of predicted samples;

calculating difference data that represents a difference between value of original pixels in the target block and the values of the predicted samples;

coding the difference data to generate a coded moving picture bitstream;

multiplexing the coded moving picture bitstream and an audio stream to obtain multiplex data;

modulating the multiplexed data; and

outputting the modulated multiplexed data,

wherein in said performing of intra prediction,

determining, for each of a plurality of reference samples each located at bottom left, left, top left, top, or top right of the target block, a reference sample to be a valid reference sample if the reference sample is intra-predicted, and to be an invalid reference sample if the reference sample is inter-predicted;

selecting, if the plurality of reference samples include both a valid reference sample and an invalid reference sample, the valid reference sample as a selected sample, and using a value of the selected sample as a complementary value of the invalid reference sample; and

calculating the predicted sample of the target block, using a value of the valid reference sample and the complementary value of the invalid reference sample, and

wherein in said selecting,

a search starts from a location of a reference sample at bottom left of the target block among locations of all the plurality of reference samples,

and is conducted in a search order of locations of reference samples at bottom left, left, top left, top, and top right of the target block in that order, and

when a set of successive valid reference samples found first in the search is a first set of valid reference samples and when a set of successive valid reference samples found next in the search is a second set of valid reference samples, a value of a first reference sample located first in the search order in the first set of valid reference samples is used as the complementary value of the invalid reference sample when the invalid reference sample is located before the first reference sample in the search order, and a value of a second reference sample located last in the search order in the first set of valid reference samples is used as the complementary value of the invalid reference sample when the invalid reference sample is located between the first set of reference samples and the second set of reference samples.

3. An apparatus for reproducing a modulated multiplexed data including audio data and video data, the apparatus comprising:

a receiving unit configured to receive the modulated multiplexed data;

a demodulating unit configured to demodulate the modulated multiplexed data;

a demultiplexing unit configured to demultiplex the multiplexed data to obtain a coded moving picture bitstream;

an analyzing unit configured to analyze the coded moving picture bitstream to obtain difference data of a target block among a plurality of blocks of two or more sizes;

a intra predicting unit configured to perform intra prediction on the target block to calculate values of predicted samples of the target block; and

a reconstructed sample calculating unit configured to calculate reconstructed samples of the target block by adding the difference data and the values of the predicted samples,

wherein said intra predicting unit is further configured to perform:

determining, for each of a plurality of reference samples each located at bottom left, left, top left, top, or top right of the target block, a reference sample to be a valid reference sample if the reference sample is intra-predicted, and to be an invalid reference sample if the reference sample is inter-predicted;

selecting, if the plurality of reference samples include both a valid reference sample and an invalid reference sample, the valid reference sample as a selected sample, and using a value of the selected sample as a complementary value of the invalid reference sample; and

calculating the predicted sample of the target block, using a value of the valid reference sample and the complementary value of the invalid reference sample, and

wherein in said selecting,

a search starts from a location of a reference sample at bottom left of the target block among locations of all the plurality of reference samples, and is conducted in a search order of locations of reference samples at bottom left, left, top left, top, and top right of the target block in that order, and

when a set of successive valid reference samples found first in the search is a first set of valid reference samples and when a set of successive valid reference samples found next in the search is a second set of valid reference samples, a value of a first reference sample located first in the search order in the first set of valid reference samples is used as the complementary value of the invalid reference sample when the invalid reference sample is located before the first reference sample in the search order, and a value of a second reference sample located last in the search order in the first set of valid reference samples is used as the complementary value of the invalid reference sample when the invalid reference sample is located between the first set of reference samples and the second set of reference samples.

4. An apparatus for generating a modulated multiplexed data comprising:

a dividing unit configured to divide an original picture into a plurality of blocks of two each having a size selected from more sizes;

an intra predicting unit configured to perform intra prediction on a target block among the blocks to calculate values of predicted samples;

a difference data calculating unit configured to calculate difference data that represents a difference between values of original pixels in the target block and the values of the predicted samples;

a coding unit configured to code the difference data to generate a coded moving picture bitstream;

a multiplexing unit configured to multiplex the coded moving picture bitstream and an audio stream to obtain multiplex data;

a modulating unit configured to modulate the multiplexed data; and

an outputting unit configured to output the modulated multiplexed data,

wherein said intra prediction unit further configured to perform,

determining, for each of a plurality of reference samples each located at bottom left, left, top left, top, or top right of the target block, a reference sample to be a valid reference sample if the reference sample is intra-predicted, and to be an invalid reference sample if the reference sample is inter-predicted;

selecting, if the plurality of reference samples include both a valid reference sample and an invalid reference sample, the valid reference sample as a selected sample, and using a value of the selected sample as a complementary value of the invalid reference sample; and

calculating the predicted sample of the target block, using a value of the valid reference sample and the complementary value of the invalid reference sample, and

wherein in said selecting,

a search starts from a location of a reference sample at bottom left of the target block among locations of all the plurality of reference samples, and is conducted in a search order of locations of reference samples at bottom left, left, top left, top, and top right of the target block in that order, and

when a set of successive valid reference samples found first in the search is a first set of valid reference samples and when a set of successive valid reference samples found next in the search is a second set of valid reference samples, a value of a first reference sample located first in the search order in the first set of valid reference samples is used as the complementary value of the invalid reference sample when the invalid reference sample is located before the first reference sample in the search order, and a value of a second reference sample located last in the search order in the first set of valid reference samples is used as the complementary value of the invalid reference sample when the invalid reference sample is located between the first set of reference samples and the second set of reference samples.