[DESCRIPTION]

[Title of Invention]

IMAGE CODING METHOD, IMAGE DECODING METHOD, IMAGE CODING APPARATUS, IMAGE DECODING APPARATUS, AND IMAGE CODING AND DECODING APPARATUS

[Technical Field]

[0001]

The present invention relates to image coding methods, image decoding methods, image coding apparatuses, image decoding apparatuses, and image coding and decoding apparatuses, and particularly to an image coding method and an image decoding method each of which uses a buffer description for specifying a picture to be held in a buffer and a reference list description for specifying a picture to be referred to.

[Background Art]

[0002]

State-of-the-art video coding schemes, such as MPEG-4 AVC / H.264 (see Non Patent Literature 1) and the upcoming HEVC (High-Efficiency Video Coding), perform coding of image or video content using inter-picture prediction from previously coded or decoded reference pictures. In other words, the video coding schemes exploit the information redundancy across consecutive pictures in time. In MPEG-4 AVC video coding scheme, reference pictures in the decoded picture buffer (DPB) are managed either using a predefined sliding-window scheme for removing earlier pictures in coding order from the DPB, or explicitly using a number of buffer management signals in the coded bitstream to manage and remove unused reference pictures.

[Citation List]

[Non Patent Literature]

[0003]

[Non Patent Literature 1] ISO/IEC 14496-10 "MPEG-4 Part10 Advanced Video Coding"

[Summary of Invention]

[Technical Problem]

[0004]

In the image coding method and the image decoding method which adopt such video coding schemes, there is a demand for a further improvement in coding efficiency.

[0005]

Thus, embodiments of the present invention provide an image coding method or an image decoding method in which the coding efficiency can improve.

[Solution to Problem]

[0006]

According to a first aspect of the present invention, there is provided an image coding method for generating a coded bitstream by coding an image using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, the image coding method comprising: writing, into a sequence parameter set, buffer description defining information for defining a plurality of buffer descriptions; writing, into the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions; selecting, for each processing unit that is a picture or a slice, one of the buffer descriptions, and writing, into a first header of the processing unit, buffer description selecting information for specifying the selected buffer description, the first header being included in the coded bitstream; and coding the processing unit using the selected buffer description and one of the reference list descriptions which corresponds to the selected buffer description.

According to a second aspect, there is provided an image decoding method for decoding a coded bitstream using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, the image decoding method comprising: obtaining, from a sequence parameter set corresponding to the coded bitstream,

buffer description defining information for defining a plurality of buffer descriptions; obtaining, from the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions; obtaining, from a first header of a processing unit that is a picture or a slice, buffer description selecting information for specifying one of the buffer descriptions, the first header being included in the coded bitstream; and decoding the processing unit using (i) a buffer description specified in the buffer description selecting information and (ii) one of the reference list descriptions which corresponds to the specified buffer description.

According to a third aspect, there is provided an image coding apparatus for generating a coded bitstream by coding an image using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, the image coding apparatus comprising a frame memory control unit configured to perform the following: writing, into a sequence parameter set, buffer description defining information for defining a plurality of buffer descriptions; writing, into the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions; and selecting, for each processing unit that is a picture or a slice, one of the buffer descriptions, and writing, into a first header of the processing unit, buffer description selecting information for specifying the selected buffer description, the first header being included in the coded bitstream, wherein the image coding apparatus codes the processing unit using the selected buffer description and one of the reference list descriptions which corresponds to the selected buffer description.

According to a fourth aspect, there is provided an image decoding apparatus for decoding a coded bitstream using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, the image decoding apparatus comprising a frame memory control unit configured to perform the following: obtaining, from a sequence parameter set corresponding to the coded bitstream, buffer description defining information for defining a plurality of buffer descriptions; obtaining, from the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions; and obtaining, from a first header of a processing unit that is a picture or a slice, buffer description selecting information for specifying one of the buffer descriptions, the first header being included in the coded bitstream, wherein the image decoding apparatus decodes the processing unit using (i) a buffer description specified in the buffer description selecting information and (ii) one of the reference list descriptions which corresponds to the specified buffer description.

According to a fifth aspect, there is provided an image coding and decoding apparatus comprising the image coding apparatus according to the third aspect and an image decoding apparatus according to the fourth aspect.

[0007]

These general and specific aspects may be implemented using a system, a method, an integrated circuit, a computer program, or a computer-readable recording medium such as a CD-ROM, or any combination of systems, methods, integrated circuits, computer programs, or computer-readable recording media.

[Advantageous Effects of Invention]

[0008]

Embodiments of the present invention provide an image coding method or an image decoding method in which the coding efficiency can improve.

[Brief Description of Drawings]

[0009]

[FIG. 1] FIG. 1 shows an example of a picture referencing structure.

[FIG. 2] FIG. 2 shows a structure of a coded bitstream.

[FIG. 3] FIG. 3 is a block diagram of an image coding apparatus according to the first embodiment of the present invention.

[FIG. 4] FIG. 4 is a flowchart of an image coding method according to the first embodiment of the present invention.

[FIG. 5] FIG. 5 is a flowchart of a writing process of reference list description defining information according to the first embodiment of the present invention.

[FIG. 6] FIG. 6 is a flowchart of the first example of a coding process according to the first embodiment of the present invention.

[FIG. 7] FIG. 7 is a flowchart of the second example of the coding process according to the first embodiment of the present invention.

[FIG. 8A] FIG. 8A shows a structure of a coded bitstream according to the first embodiment of the present invention.

[FIG. 8B] FIG. 8B shows a structure of a coded bitstream according to a variation of the first embodiment of the present invention.

[FIG. 9] FIG. 9 shows a syntax structure of a sequence parameter set according to the first embodiment of the present invention.

[FIG. 10] FIG. 10 is a block diagram of an image decoding apparatus according to the first embodiment of the present invention.

[FIG. 11] FIG. 11 is a flowchart of an image decoding method according to the first embodiment of the present invention.

[FIG. 12] FIG. 12 is a flowchart of a process of obtaining the reference list description defining information according to the first embodiment of the present invention.

[FIG. 13] FIG. 13 is a flowchart of the first example of a decoding process according to the first embodiment of the present invention.

[FIG. 14] FIG. 14 is a flowchart of the second example of the decoding process according to the first embodiment of the present invention.

[FIG. 15] FIG. 15 is a flowchart of an image coding method according to the second embodiment of the present invention.

[FIG. 16] FIG. 16 is a flowchart of a writing process of reference list description updating information according to the second embodiment of the present invention.

[FIG. 17A] FIG. 17A shows a structure of a coded bitstream according to the second embodiment of the present invention.

[FIG. 17B] FIG. 17B shows a structure of a coded bitstream according to a variation of the second embodiment of the present invention.

[FIG. 18] FIG. 18 shows a syntax structure of a sequence parameter set according to the second embodiment of the present invention.

[FIG. 19] FIG. 19 is a flowchart of an image decoding method according to the second embodiment of the present invention.

[FIG. 20] FIG. 20 is a flowchart of a process of obtaining the reference list description updating information according to the second embodiment of the present invention.

[FIG. 21] FIG. 21 is a flowchart of an image coding method according to the third embodiment of the present invention.

[FIG. 22A] FIG. 22A shows a structure of a coded bitstream according to the third embodiment of the present invention.

[FIG. 22B] FIG. 22B shows a structure of a coded bitstream according to a variation of the third embodiment of the present invention.

[FIG. 23] FIG. 23 shows a syntax structure of a sequence parameter set according to the third embodiment of the present invention.

[FIG. 24] FIG. 24 is a flowchart of an image decoding method according to the third embodiment of the present invention.

[FIG. 25] FIG. 25 is a flowchart of an image coding method according to the fourth embodiment of the present invention.

[FIG. 26] FIG. 26 shows a structure of a coded bitstream according to the fourth embodiment of the present invention.

[FIG. 27] FIG. 27 shows a syntax structure of a slice header according to the fourth embodiment of the present invention.

[FIG. 28] FIG. 28 is a flowchart of an image decoding method according to the fourth embodiment of the present invention.

[FIG. 29] FIG. 29 shows an overall configuration of a content

providing system for implementing content distribution services.

[FIG. 30] FIG. 30 shows an overall configuration of a digital broadcasting system.

[FIG. 31] FIG. 31 shows a block diagram illustrating an example of a configuration of a television.

[FIG. 32] FIG. 32 shows a block diagram illustrating an example of a configuration of an information reproducing/recording unit that reads and writes information from and on a recording medium that is an optical disk.

[FIG. 33] FIG. 33 shows an example of a configuration of a recording medium that is an optical disk.

[FIG. 34A] FIG. 34A shows an example of a cellular phone.

[FIG. 34B] FIG. 34B is a block diagram showing an example of a configuration of a cellular phone.

[FIG. 35] FIG. 35 illustrates a structure of multiplexed data.

[FIG. 36] FIG. 36 schematically shows how each stream is multiplexed in multiplexed data.

[FIG. 37] FIG. 37 shows how a video stream is stored in a stream of PES packets in more detail.

[FIG. 38] FIG. 38 shows a structure of TS packets and source packets in the multiplexed data.

[FIG. 39] FIG. 39 shows a data structure of a PMT.

[FIG. 40] FIG. 40 shows an internal structure of multiplexed data information.

[FIG. 41] FIG. 41 shows an internal structure of stream attribute information.

[FIG. 42] FIG. 42 shows steps for identifying video data.

[FIG. 43] FIG. 43 is a block diagram showing an example of a configuration of an integrated circuit for implementing the moving picture coding method and the moving picture decoding method according to each of embodiments.

[FIG. 44] FIG. 44 shows a configuration for switching between driving frequencies.

[FIG. 45] FIG. 45 shows steps for identifying video data and switching between driving frequencies.

[FIG. 46] FIG. 46 shows an example of a look-up table in which video data standards are associated with driving frequencies.

[FIG. 47A] FIG. 47A is a diagram showing an example of a configuration for sharing a module of a signal processing unit.

[FIG. 47B] FIG. 47B is a diagram showing another example of a configuration for sharing a module of the signal processing unit.

[Description of Embodiments]

[0010]

(Underlying Knowledge Forming Basis of the Present Invention)

Recent developments in the HEVC video coding scheme include the introduction of DPB management using buffer descriptions. A buffer description defines the pictures that are retained in the DPB, instead of defining the pictures that are to be removed from the DPB. In other words, a buffer description is a list of picture identifiers indicating all reference pictures stored in the DPB. Each item in this list is referred to as a buffer element. A buffer element contains a picture identifier unique to each picture, such as a picture order count (POC) number, and additional information of the picture such as a temporal_id value.

[0011]

This buffer description is activated at the start of coding or decoding of a picture. Pictures that are not included in the active buffer description are removed from the DPB. Benefits of this buffer descriptions include improved robustness against transmission/delivery losses and simplified handling of non-existent pictures.

[0012]

In some cases, multiple pictures in a video sequence share the same picture referencing structure. For example, a low delay coding structure uses a periodic clustering structure in which the same layer structure is periodically repeated in unit of four pictures as shown in FIG. 1. This repeating unit (that is four pictures herein) is called a cluster.

[0013]

In the example shown in FIG. 1, the picture numbers (P0 to

P12) indicate both unique coding order and unique display or output order of pictures. The pictures P0, P4, P8 and P12 constitute the first layer of pictures. There pictures are coded with the highest quality, for example, by applying quantization least strongly. Pictures P2, P6 and P10 constitute the second layer. These pictures are coded with lower quality than the first layer. Pictures P1, P3, P5, P7, P9 and P11 constitute the third layer. These pictures are coded with the lowest quality. In such a periodic referencing structure, pictures located at the same relative position within their clusters (for example P1, P5 and P9) usually use the same relative picture referencing structure. For example, the picture P5 uses the pictures P4 and P2 as reference pictures, while the picture P9 uses the pictures P8 and P6 as reference pictures.

[0014]

In order to accommodate periodic clustering structures such as the above structure, a conceivable approach is periodic signaling of buffer descriptions. This buffer description specifies the temporal distances or positions of the reference pictures relative to a target picture to be coded or decoded. By so doing, the reference pictures stored in the DPB can be specified. For example, this buffer description is signalled once in the picture parameter set (PPS). This buffer description is then referred to repeatedly in the slice headers of the pictures having the same relative position within a cluster. For example, a buffer description specifying relative positions of {-1, -3} can be used in both P5 to specify {P4, P2} as reference pictures and by P9 to specify {P8, P6} as reference pictures.

[0015]

FIG. 2 shows an example of the signaling structure of buffer description in this case. A coded bitstream 500 shown in FIG. 2 includes a sequence parameter set (SPS) 501 (SPS0), a plurality of picture parameter sets (PPSs) 502 (PPS0 and PPS1), and a plurality of picture data 503. Each of the picture data 503 includes a plurality of slice data 535. Each of the slice data 535 includes a slice header 541 and a slice data part 542. The slice data part 542 includes a

plurality of coding unit (CU) data 543.

[0016]

Each of the PPSs 502 includes a PPS identifier 522 (pps_id) and buffer description defining information 512 (BD define). The buffer description defining information 512 indicates a plurality of buffer descriptions 515 (BD0 to BDn). Each of the buffer descriptions 515 includes a plurality of buffer elements 515A (BE0 to BE2).

[0017]

Thus, the plurality of buffer descriptions 515 are defined using the buffer description defining information 512 in the picture parameter sets 502. Each of the PPSs 502 is identified by a PPS identifier 522 unique to the PPS.

[0018]

The slice header 541 includes PPS selecting information 533 (pps_select) and buffer description updating information 523 (BD update).

[0019]

The PPS selecting information 533 indicates the PPS 502 referred to during coding or decoding of the slice. In the example in FIG. 2, pps_select = 0 is satisfied, and the PPS0 having pps_id = 0 is selected.

[0020]

The buffer description updating information 523 includes information which specifies the buffer description selected out of the buffer descriptions 515. In the example in FIG. 2, the buffer description BD1 is selected. Additionally, the buffer description updating information 523 includes buffer description modification information. The buffer description modification information assigns a picture identifier to a selected buffer element 515A within the selected buffer description 515. Here, the picture identifier is specified either using relative position or using an identifier unique to the picture. The identifier unique to the picture includes, for example, the picture order count (POC) number. In the example in FIG. 2, the picture P_{214} identified by its POC number = 214 is

assigned to the buffer element BE0 within the buffer description BD1. This modification applies only to the current target slice and does not apply to subsequent slices.

[0021]

In a coded bitstream, reference pictures used for the inter prediction process of prediction units (an N x N block) are identified using reference indexes. All available reference pictures and their associated reference indexes are described in a reference list. When bi-predictive inter prediction is used, two reference lists are used for describing two groups of reference pictures and the associated reference indexes. Smaller reference indexes are represented with fewer bits in the coded bitstream compared to larger reference indexes. Therefore, higher coding efficiency is achieved by assigning smaller reference indexes to frequently used reference pictures.

[0022]

At the start of the coding or decoding of a slice, a default reference list is constructed by assigning indexes to all available reference pictures according to a predetermined ordering scheme. The image coding apparatus may further reorder the reference indexes included in the default reference list and write reference list reordering information into the slice header in the coded bitstream. The reordered reference list applies only to the current target slice and does not apply to subsequent slices.

[0023]

Here, the inventors found that the above technique has a problem that the information (parameters) for describing reference list reordering is only applied once in a current slice to be coded or decoded. However, as described above, multiple pictures in a video sequence share the same referencing structure in some cases. Consequently, information for describing the same reference list reordering process is signalled repeatedly in the coded bitstream.

[0024]

Thus, the inventors found the problem of a decrease in coding efficiency which is due to repeated information included in the coded

bitstream.

[0025]

An image coding method according to an aspect of the present invention is an image coding method for generating a coded bitstream by coding an image using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, comprises: writing, into a sequence parameter set, buffer description defining information for defining a plurality of buffer descriptions; writing, into the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions; selecting, for each processing unit that is a picture or a slice, one of the buffer descriptions, and writing, into a first header of the processing unit, buffer description selecting information for specifying the selected buffer description, the first header being included in the coded bitstream; and coding the processing unit using the selected buffer description and one of the reference list descriptions which corresponds to the selected buffer description.

[0026]

By so doing, in the image coding method according to an aspect of the present invention, the buffer description defining information and the reference list description defining information are written into the sequence parameter set shared by a plurality of pictures, and a buffer description identifier indicating a buffer description to be selected is written into a header of each picture or slice. This allows a reduction in redundant information and thereby allows an improvement in coding efficiency in the image coding method as compared to the case where the buffer description defining information and the reference list description defining information are written into a picture parameter set.

[0027]

For example, the image coding method comprises: modifying at least one of the buffer descriptions, and writing, into a second header of the processing unit, buffer description updating

information for indicating details of the modification; and writing, into the second header, reference list description updating information for defining a reference list description which corresponds to the modified buffer description, wherein, in the coding, the processing unit is coded using (i) the modified buffer description and (ii) the reference list description which corresponds to the modified buffer description.

[0028]

By so doing, in the image coding method, the buffer description and the reference list description set in the sequence parameter set can be updated for each picture or slice. Thus, the image coding method allows a reduction in redundant information and also allows, when necessary, the buffer description and the reference list description to be modified for each picture or slice.

[0029]

For example, the second header is a picture parameter set, the first header is a picture header or a slice header, and in the selecting, when at least one of the buffer descriptions is modified, one buffer description is selected out of a plurality of buffer descriptions including the modified buffer description.

[0030]

For example, the first header and the second header are a slice header, and in the modifying, the selected buffer description is modified as the at least one of the buffer descriptions.

[0031]

For example, the first header and the second header are a picture parameter set, in the modifying and the writing, the selected buffer description is modified as the at least one of the buffer descriptions, and the buffer description updating information is written into a first picture parameter set that is one of picture parameter sets included in the coded bitstream, in the writing of reference list description updating information, the reference list description updating information is written into the first picture parameter set, and in the selecting and the writing, the buffer description selecting information is written into the first picture

parameter set, and picture parameter set selecting information for specifying the first picture parameter set out of the picture parameter sets is written into a header of the processing unit.

[0032]

For example, the reference list description defining information includes: a first reordering flag for indicating whether or not reordering of a reference list is performed; and first reference list reordering information for indicating details of the reordering, and the writing of reference list description defining information includes: writing the first reordering flag into the sequence parameter set; judging using the first reordering flag whether or not the reordering of the reference list is performed; and writing the first reference list reordering information into the sequence parameter set when the reordering of the reference list is performed.

[0033]

For example, the reference list description updating information includes: a reordering flag for indicating whether or not reordering of a reference list is performed; and reference list reordering information for indicating details of the reordering, and the writing of reference list description updating information includes: writing the reordering flag into the second header; judging using the reordering flag whether or not the reordering of the reference list is performed; and writing the reference list reordering information into the second header when the reordering of the reference list is performed.

[0034]

For example, the coding includes: constructing, according to a predetermined default reference list description, a reference list including picture identifiers of all pictures indicated in the selected buffer description; judging using the first reordering flag whether or not reordering of the constructed reference list is performed; reordering, according to the first reference list reordering information, the picture identifiers in the reference list when the reordering of the reference list is performed; and coding a current slice using the reordered reference list.

[0035]

For example, the coding includes: constructing, according to a predetermined default reference list description, a reference list including picture identifiers of all pictures indicated in the selected buffer description; writing, into a slice header of a current slice, an update flag for indicating whether or not the reference list description which corresponds to the selected buffer description is updated; judging using the update flag whether or not the reference list description is updated; writing, into the slice header, a second reordering flag for indicating whether or not reordering of the reference list is performed when the reference list description is updated; judging using the second reordering flag whether or not the reordering of the reference list is performed; writing, into the slice header, second reference list reordering information for indicating details of the reordering of the reference list when the reordering is performed; reordering the picture identifiers in the reference list according to the second reference list reordering information; judging using the first reordering flag whether or not the reordering of the reference list is performed when the reference list description is not updated; reordering, according to the first reference list reordering information, the picture identifiers in the reference list when the reordering of the reference list is performed; and coding the current slice using the reordered reference list.

[0036]

Furthermore, an image decoding method according to an aspect of the present invention is an image decoding method for decoding a coded bitstream using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, comprises: obtaining, from a sequence parameter set corresponding to the coded bitstream, buffer description defining information for defining a plurality of buffer descriptions; obtaining, from the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions; obtaining, from a first header of a processing

unit that is a picture or a slice, buffer description selecting information for specifying one of the buffer descriptions, the first header being included in the coded bitstream; and decoding the processing unit using (i) a buffer description specified in the buffer description selecting information and (ii) one of the reference list descriptions which corresponds to the specified buffer description.

[0037]

By so doing, a bitstream coded with improved coding efficiency can be decoded in the image decoding method according to an aspect of the present invention.

[0038]

For example, the image decoding method further comprises: obtaining, from a second header of the processing unit, buffer description updating information for indicating details of modification of at least one of the buffer descriptions, the second header being included in the coded bitstream; and obtaining, from the second header, reference list description updating information for defining a reference list description which corresponds to the modified buffer description, wherein, in the decoding, the at least one of the buffer descriptions is modified according to the details of modification indicated in the buffer description updating information, and the processing unit is decoded using (i) the modified buffer description and (ii) the reference list description which corresponds to the modified buffer description.

[0039]

For example, the second header is a picture parameter set, and the first header is a picture header or a slice header.

[0040]

For example, the first header and the second header are a slice header.

[0041]

For example, the first header and the second header are a picture parameter set, and in the obtaining of buffer description selecting information, picture parameter set selecting information for specifying one of picture parameter sets included in the coded

bitstream is obtained from a header of the processing unit, and the buffer description selecting information is obtained from a picture parameter set specified in the picture parameter set selecting information.

[0042]

For example, the reference list description defining information includes: a first reordering flag for indicating whether or not reordering of a reference list is performed; and first reference list reordering information for indicating details of the reordering, and the obtaining of reference list description defining information includes: obtaining the first reordering flag; judging using the first reordering flag whether or not the reordering of the reference list is performed; and obtaining the first reference list reordering information when the reordering of the reference list is performed.

[0043]

For example, the reference list description updating information includes: a reordering flag for indicating whether or not reordering of a reference list is performed; and reference list reordering information for indicating details of the reordering, and the obtaining of reference list description updating information includes: obtaining the reordering flag from the second header; judging using the reordering flag whether or not the reordering of the reference list is performed; and obtaining, from the second header, the reference list reordering information when the reordering of the reference list is performed.

[0044]

For example, the decoding includes: constructing, according to a predetermined default reference list description, a reference list including picture identifiers of all pictures indicated in the selected buffer description; judging using the first reordering flag whether or not reordering of the constructed reference list is performed; reordering, according to the first reference list reordering information, the picture identifiers in the reference list when the reordering of the reference list is performed; and decoding a current slice using the reordered reference list.

[0045]

For example, the decoding includes: constructing, according to a predetermined default reference list description, a reference list including picture identifiers of all pictures indicated in the selected buffer description; obtaining, from a slice header of a current slice, an update flag for indicating whether or not the reference list description which corresponds to the selected buffer description is updated; judging using the update flag whether or not the reference list description is updated; obtaining, from the slice header, a second reordering flag for indicating whether or not reordering of the reference list is performed when the reference list description is updated; judging using the second reordering flag whether or not the reordering of the reference list is performed; obtaining, from the slice header, second reference list reordering information for indicating details of the reordering of the reference list when the reordering is performed; reordering the picture identifiers in the reference list according to the second reference list reordering information; judging using the first reordering flag whether or not the reordering of the reference list is performed when the reference list description is not updated; reordering, according to the first reference list reordering information, the picture identifiers in the reference list when the reordering of the reference list is performed; and decoding the current slice using the reordered reference list.

[0046]

Furthermore, an image coding apparatus according to an aspect of the present invention is an image coding apparatus for generating a coded bitstream by coding an image using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, comprises a frame memory control unit configured to perform the following: writing, into a sequence parameter set, buffer description defining information for defining a plurality of buffer descriptions; writing, into the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions; and selecting,

for each processing unit that is a picture or a slice, one of the buffer descriptions, and writing, into a first header of the processing unit, buffer description selecting information for specifying the selected buffer description, the first header being included in the coded bitstream, wherein the image coding apparatus codes the processing unit using the selected buffer description and one of the reference list descriptions which corresponds to the selected buffer description.

[0047]

By so doing, the image coding apparatus according to an aspect of the present invention writes the buffer description defining information and the reference list description defining information into the sequence parameter set shared by a plurality of pictures, and writes, into a header of each picture or slice, a buffer description identifier indicating a buffer description to be selected. This allows the image coding apparatus to reduce redundant information and thereby improve the coding efficiency as compared to the case where the buffer description defining information and the reference list description defining information are written into a picture parameter set.

[0048]

Furthermore, an image decoding apparatus according to an aspect of the present invention is an image decoding apparatus for decoding a coded bitstream using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, comprises a frame memory control unit configured to perform the following: writing, into a sequence parameter set, buffer description defining information for defining a plurality of buffer descriptions; writing, into the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions; and selecting, for each processing unit that is a picture or a slice, one of the buffer descriptions, and writing, into a first header of the processing unit, buffer description selecting information for specifying the selected buffer description, the first header being included in the coded

bitstream, wherein the image coding apparatus codes the processing unit using the selected buffer description and one of the reference list descriptions which corresponds to the selected buffer description.

[0049]

This allows the image decoding apparatus according to an aspect of the present invention to decode a bitstream coded with the improved coding efficiency.

[0050]

Furthermore, an image coding and decoding apparatus according to an aspect of the present invention comprises the image coding apparatus and the image decoding apparatus.

[0051]

These general and specific aspects may be implemented using a system, a method, an integrated circuit, a computer program, or a computer-readable recording medium such as a CD-ROM, or any combination of systems, methods, integrated circuits, computer programs, or computer-readable recording media.

[0052]

Hereinafter, exemplary embodiments are described in greater detail with reference to the accompanying Drawings.

[0053]

Each of the exemplary embodiments described below shows a general or specific example. The numerical values, shapes, materials, structural elements, the arrangement and connection of the structural elements, steps, the processing order of the steps etc. shown in the following exemplary embodiments are mere examples, and therefore do not limit the present invention. Therefore, among the structural elements in the following exemplary embodiments, structural elements not recited in any one of the independent claims defining the most generic part of the inventive concept are described as arbitrary structural elements.

[0054]

Four embodiments are described in the following. It will be apparent to those skilled in the art that combinations of these embodiments can be carried out to further increase the usability and

adaptability of periodic reference list descriptions.

[0055]

(First Embodiment)

In this embodiment, buffer description defining information and reference list description defining information are written into SPS. This allows a reduction in redundant information and thereby allows an improvement in coding efficiency as compared to the case where the buffer description defining information and the reference list description information are written into a picture parameter set.

[0056]

[Coding apparatus]

FIG. 3 is a block diagram which shows a structure of an image coding apparatus 100 according to this embodiment.

[0057]

The image coding apparatus 100 codes an input image signal 120 on a block-by-block basis so as to generate a coded bitstream 132. As shown in FIG. 3, the image coding apparatus 100 includes a subtractor 101, an orthogonal transformation unit 102, a quantization unit 103, an inverse quantization unit 104, an inverse orthogonal transformation unit 105, an adder 106, a block memory 107, a frame memory 108, an intra prediction unit 109, an inter prediction unit 110, a picture type determination unit 111, a variable-length coding unit 112, and a frame memory control unit 113.

[0058]

The input image signal 120 is a video or image bitstream. The subtractor 101 calculates a difference between prediction image data 131 and the input image signal 120, thereby generating prediction error data 121. The orthogonal transformation unit 102 performs orthogonal transformation on the prediction error data 121 to generate frequency coefficients 122. The quantization unit 103 quantizes the frequency coefficients 122, thereby generating quantized values 123. The variable-length coding unit 112 performs entropy coding (variable-length coding) on the quantized values 123, thereby generating the coded bitstream 132.

[0059]

The inverse quantization unit 104 inversely quantizes the quantized values 123, thereby generating frequency coefficients 124. The inverse orthogonal transformation unit 105 performs inverse orthogonal transformation on the frequency coefficients 122, thereby generating prediction error data 125. The adder 106 adds the prediction error data 125 and the prediction image data 131, thereby generating decoded image data 126. The block memory 107 holds the decoded image data 126 as decoded image data 127 on a block-by-block basis. The frame memory 108 holds the decoded image data 126 as decoded image data 128 on a frame-by-frame basis.

[0060]

The intra prediction unit 109 performs intra prediction to generate prediction image data 129 of a current block to be coded. Specifically, the intra prediction unit 109 searches within the decoded image data 127 stored in the block memory 107, and estimates an image area which is most similar to the input image signal 120.

[0061]

The inter prediction unit 110 performs inter prediction using the per-frame decoded image data 128 stored in the frame memory 108, to generate prediction image data 130 of the current block.

[0062]

The picture type determination unit 111 selects one of the prediction image data 129 and the prediction image data 130 and outputs the selected data as the prediction image data 131.

[0063]

The frame memory control unit 113 manages the decoded image data 128 stored in the frame memory 108. Specifically, the frame memory control unit 113 determines whether the decoded image data 128 is kept in the frame memory 208 or removed from the frame memory 208. Furthermore, the frame memory control unit 113 constructs reference lists to be used by the inter prediction unit 110. Furthermore, the frame memory control unit 113 generates

frame memory control information 133 which includes the buffer description defining information and the reference list description defining information. The variable-length coding unit 112 generates the coded bitstream 132 which includes this frame memory control information 133.

[0064]

[Coding process]

Next, a description is given to an image coding method which is performed by the image coding apparatus 100 as mentioned above.

[0065]

FIG. 4 is a flowchart of an image coding method according to this embodiment. Furthermore, FIG. 4 shows a coding process which is performed on a single video sequence including a plurality of pictures.

[0066]

Firstly, the image coding apparatus 100 determines a plurality of buffer descriptions and the reference list descriptions corresponding to the plurality of buffer descriptions which are to be used over a plurality of pictures in a video sequence (S101). The buffer descriptions are used to specify pictures to be held in the buffer (frame memory). Specifically, each of the buffer descriptions includes a plurality of buffer elements. Each buffer element contains a unique picture identifier corresponding to one reference picture stored in the frame memory. This means that each of the buffer descriptions indicates a plurality of reference pictures stored in the frame memory.

[0067]

The reference list descriptions are used to specify pictures to be referred to. Specifically, each reference list description corresponds exclusively (one-to-one) to one buffer description. The reference list descriptions are used to generate a reference list indicating a correspondence relationship between reference pictures and reference indexes. Specifically, each of the reference list descriptions describes the reference indexes and the associated

reference pictures in the reference lists. These reference indexes are written into a coded bitstream as information which indicates the reference pictures actually referred to and are thus transmitted from the image coding apparatus 100 to an image decoding apparatus. One reference list is used when uni-directional prediction is used, while two reference lists are used when bi-directional prediction is used.

[0068]

Next, the image coding apparatus 100 writes, into a sequence parameter set (SPS) in the coded bitstream 132, the buffer description defining information which defines the determined buffer descriptions (S102). Here, SPS is a parameter set (header information) in each video sequence.

[0069]

Next, the image coding apparatus 100 writes, into SPS, the reference list description defining information for defining the plurality of reference list descriptions (S103).

[0070]

Next, the image coding apparatus 100 selects, for each picture, one of the buffer descriptions which is to be used to code the picture (S104). It is to be noted that the image coding apparatus 100 may select one buffer description for each slice.

[0071]

Next, the image coding apparatus 100 writes the buffer description selecting information which specifies the selected buffer description into a picture header corresponding to the current picture (or a slice header corresponding to the current slice) and included in the coded bitstream 132 (S105). In addition, one reference list description corresponding to the selected buffer description is selected.

[0072]

Finally, the image coding apparatus 100 codes a current picture or slice using the buffer description selected for the picture or slice and the reference list description corresponding to the buffer description (S106). Furthermore, the image coding apparatus 100

generates the coded bitstream 132 which includes the resulting coded data.

[0073]

The following describes a process of writing the reference list description defining information (S103) shown in FIG. 4. FIG. 5 is a flowchart of a writing process (S103) of reference list description defining information.

[0074]

In this embodiment, the reference list description defining information is written into SPS of the coded bitstream 132 in this writing process (S103).

[0075]

Firstly, the image coding apparatus 100 determines whether a default reference list or a reordered reference list is used (S111). Here, the default reference list is a reference list which is constructed according to a predetermined default reference list constructing scheme in the image coding apparatus and the image decoding apparatus. In other words, as the default reference list for the same picture (or slice), the same reference list is constructed in the image coding apparatus and the image decoding apparatus.

[0076]

Next, the image coding apparatus 100 writes, into SPS, a first reordering flag for indicating whether or not reference list reordering is performed (S112). The image coding apparatus 100 then judges using the written first reordering flag whether or not reference list reordering is performed (S113).

[0077]

When reference list reordering is performed (Yes in S113), the image coding apparatus 100 writes, into SPS, first reference list reordering information for reordering picture identifiers in a reference list (S114) and terminates the writing process (S103). In other words, the first reference list reordering information indicates the details of reordering of the picture identifiers.

[0078]

On the other hand, when reference list reordering is not

performed (No in S113), the image coding apparatus 100 terminates the writing process (S103).

[0079]

Thus, the reference list description defining information includes the first reordering flag and the first reference list reordering information.

[0080]

The following describes a coding process (S106) shown in FIG. 4. FIG. 6 is a flowchart which shows a first embodiment of the coding process (S106).

[0081]

Firstly, the image coding apparatus 100 constructs a default reference list comprising all picture identifiers in the selected buffer description according to a default reference list constructing scheme (S121). Next, the image coding apparatus 100 judges using a first reordering flag included in the reference list description defining information whether or not reference list reordering is performed (S122).

[0082]

When reference list reordering is performed (Yes in S123), the image coding apparatus 100 reorders the picture identifiers in the reference list according to reference list reordering information included in the reference list description defining information (S124). The image coding apparatus 100 then codes the current picture or slice using the reordered reference list (S125).

[0083]

On the other hand, when reference list reordering is not performed (No in S123), the image coding apparatus 100 codes the current picture or slice using the default reference list (S125).

[0084]

FIG. 7 is a flowchart which shows a second embodiment of the coding process (S106).

[0085]

Firstly, the image coding apparatus 100 constructs a default reference list comprising all picture identifiers in the selected buffer

description according to a default reference list constructing scheme (S131). Next, the image coding apparatus 100 determines whether or not a reference list description is updated (reference list description override is used) (S132). Here, update (override) means modifying, in a lower layer, the reference list description defined in an upper layer. Specifically, the update (override) is to modify, for each picture or slice, the reference list description defined in the reference list description defining information in SPS.

[0086]

Next, the image coding apparatus 100 writes, into a slice header of the current slice, an update flag for indicating whether or not a reference list description is updated (S133). The image coding apparatus 100 then judges using the update flag whether or not a reference list description is updated (S134).

[0087]

When a reference list description is updated (Yes in S134), the image coding apparatus 100 writes, into the slice header of the current slice, a second reordering flag for indicating whether or not reference list reordering is performed (S135). The image coding apparatus 100 then judges using the second reordering flag whether or not reference list reordering is performed (S136).

[0088]

When reference list reordering is performed (Yes in S136), the image coding apparatus 100 writes, into the slice header of the current slice, second reference list reordering information for reordering picture identifiers in the reference list (S137). The image coding apparatus 100 then reorders the picture identifiers in the reference list according to the second reference list reordering information (S138).

[0089]

Next, the image coding apparatus 100 codes the current slice using the reordered reference list (S142).

[0090]

On the other hand, when a reference list description is not updated (No in S134), the image coding apparatus 100 judges using

the first reordering flag included in the reference list description defining information whether or not reference list reordering is performed (S139 and S140).

[0091]

When reference list reordering is performed (Yes in S140), the image coding apparatus 100 reorders the picture identifiers in the reference list according to the first reference list reordering information included in the reference list description defining information (S141).

[0092]

Next, the image coding apparatus 100 codes the current slice using the reordered reference list (S142).

[0093]

On the other hand, when reference list reordering is not performed (No in S136 or No in S140), the image coding apparatus 100 codes the current slice using the default reference list (S142).

[0094]

[Syntax diagram]

FIGS. 8A and 8D are each a syntax diagram which shows the locations of the buffer description defining information and the reference list description defining information in a coded bitstream in this embodiment. Two exemplary syntax locations are described in the following.

[0095]

The coded bitstream 132 shown in FIG. 8A includes SPS 301 (SPS0), a plurality of PPSs 302 (PPS0 and PPS1), and a plurality of picture data 303. Each of the picture data 303 includes a picture header 331 and a picture data part 332. The picture data part 332 includes a plurality of slice data 335.

[0096]

The SPS 301 includes buffer description defining information 312 (BD define), reference list description defining information 313 (RLD define), and an SPS identifier 311 (sps_id).

[0097]

The buffer description defining information 312 defines a

plurality of buffer descriptions 315. For example, like the above-mentioned buffer descriptions 515, the buffer descriptions 315 each include a plurality of buffer elements. Furthermore, the buffer description defining information 312 includes the number of buffer descriptions 314 (number_of_bds) indicating the number of buffer descriptions 315 included in the buffer description defining information 312.

[0098]

The reference list description defining information 313 defines a plurality of reference list descriptions 316. Each reference list description 316 (e.g. RLD2) is associated exclusively with a buffer description 315 (e.g. BD2). Furthermore, the SPS 301 is identified by the unique SPS identifier 311 (e.g. sps_id = 0).

[0099]

Each of the PPSs 302 includes SPS selecting information 321 (sps_select) and a PPS identifier 322 (pps_id). The SPS selecting information 321 (e.g. sps_select = 0) indicates the SPS301 which is referred to. Furthermore, each of the PPSs 302 is identified by the unique PPS identifier 322 (e.g. pps_id = 0).

[0100]

The picture header 331 includes PPS selecting information (pps_select) 333 and buffer description selecting information 334 (bd_select).

[0101]

PPS selecting information 333 (e.g. pps_select = 0) indicates the PPS 302 which is referred to. Using this PPS selecting information 333, one of the PPSs 302 is referred to from the picture header 331. Furthermore, using the SPS selecting information 321 included in the PPS 302, the SPS 301 is referred to from the PPS 302 referred to. This links the current picture to the available plurality of buffer descriptions and reference list descriptions defined in the SPS 301.

[0102]

With the buffer description selecting information 334 (e.g. bd_select = 2), one of the buffer descriptions is specified. Thus,

one buffer description and its corresponding reference list description are selected out of the plurality of buffer descriptions and reference list descriptions.

[0103]

The slice data 335 included in the picture data 303 is coded and decoded using ordered reference pictures according to the selected buffer description and the selected reference list description.

[0104]

Furthermore, as shown in FIG. 8B, each of the slice data 335 includes a slice header 341 and a slice data part 342. The slice data part 342 includes a plurality of coding unit (CU) data 343.

[0105]

In a coded bitstream 132A, the PPS selecting information 333 and the buffer description selecting information 334 are not included in a picture header 331A, but are included in the slice header 341. Also in this case, the effects the same as those in the case shown in FIG. 8A can be obtained.

[0106]

It is to be noted that "slice" in the above explanation may be replaced by "sub-picture unit". The sub-picture unit includes, for example, a tile, an entropy slice, and a group of blocks constituting a wavefront processing sub-picture partition (Wavefront Parallel Processing (WPP) unit).

[0107]

The above buffer description defining information and reference list description defining information are signalled in the SPS syntax structure according to the pseudo code in the table shown in FIG. 9.

[0108]

The descriptors define the parsing process of each syntax element according to the same bit representation as the AVC video coding scheme as follows:

[0109]

ue(v): unsigned integer Exp-Golomb-coded syntax element

with the left bit first.

[0110]

u(n): unsigned integer using n bits. When n is "v" in the syntax table, the number of bits varies in a manner dependent on the value of other syntax elements.

[0111]

The following explains the semantics associated with the syntax elements representing the buffer description defining information and the reference list description defining information. The following syntax elements are included in the SPS 301.

[0112]

bits_for_temporal_id indicates the number of bits of first_temporal_id and temporal_id.

[0113]

number_of_bds (the number of buffer descriptions 314) indicates the number of number_of_bes_minus1 included in the SPS 301. In other words, number_of_bds indicates the number of buffer descriptions 315 included in the SPS 301.

[0114]

number_of_bes_minus1[i] indicates the number of buffer elements in the buffer description BD[i].

[0115]

first_delta_poc_sign_flag[i] indicates the sign (plus or minus) of the POC difference between a current picture and the reference picture associated with the buffer element BE[i][0] in the buffer description BD[i]. first_delta_poc_sign_flag[i] equal to 0 specifies that the POC difference has a positive value, while first_delta_poc_sign_flag[i] equal to 1 specifies that the POC difference has a negative value.

[0116]

first_delta_poc_minus1[i] indicates an absolute POC difference value between a current picture and the reference picture associated with the buffer element BE[i][0] in the buffer description BD[i]. first_delta_poc_sign_flag[i] and first_delta_poc[i] define the value of the signed variable BDDeltaPOC[i][0] as

[0117]

BDDeltaPOC[i][0] = (first_delta_poc_minus1[i] + 1) *
(1 − 2 * first_delta_poc_sign_flag[i])

[0118]

BDDeltaPOC[i][0] shall be the highest signed POC difference value among all reference pictures associated with the buffer elements BE[i][j] in the buffer description BD[i].

[0119]

first_temporal_id[i] specifies a temporal identifier and is represented by bits_for_temporal_id bits. first_temporal_id[i] defines the value of the unsigned variable BDTemporalID[i][0] as

[0120]

BDTemporalID[i][0] = first_temporal_id[i]

[0121]

delta_poc_minus1[i][j] indicates an negative POC distance value from the reference picture associated with the buffer element BE[i][j] to reference picture associated with the buffer element BE[i][j+1] in the buffer description BD[i]. delta_poc_minus1[i][j] defines the value of the signed variable BDDeltaPOC[i][j+1] as

[0122]

BDDeltaPOC[i][j+1] =
BDDeltaPOC[i][j] - (delta_poc_minus1[i][j] + 1)

[0123]

temporal_id[i][j] specifies a temporal identifier and is represented by bits_for_temporal_id bits. temporal_id[i] defines the value of the unsigned variable BDTemporalID[i][j+1] as

[0124]

BDTemporalID[i][j+1] = temporal_id[i][j]

[0125]

ref_pic_list_modification_flag_l0[i] equal to 1 specifies that num_ref_idx_l0_active_minus1[i] and more_modification_flag are present for specifying the reference picture list RL0[i] corresponding to the buffer description BD[i]. ref_pic_list_modification_flag_l0[i] equal to 0 specifies that num_ref_idx_l0_active_minus1[i] and more_modification_flag are not present.

[0126]

When ref_pic_list_modification_flag_l0[i] is equal to 1, the number of times that more_modification_flag is equal to 1 following ref_pic_list_modification_flag_l0[i] shall not exceed (num_ref_idx_l0_active_minus1[i] + 1).

[0127]

ref_pic_list_modification_flag_l1[i] equal to 1 specifies that num_ref_idx_l1_active_minus1[i] and more_modification_flag are present for specifying the reference picture list RL1[i] corresponding to the buffer description BD[i]. ref_pic_list_modification_flag_l1[i] equal to 0 specifies that num_ref_idx_l1_active_minus1[i] and more_modification_flag are not present.

[0128]

When ref_pic_list_modification_flag_l1[i] is equal to 1, the number of times that more_modification_flag is equal to 1 following ref_pic_list_modification_flag_l1[i] shall not exceed (num_ref_idx_l1_active_minus1[i] + 1).

[0129]

num_ref_idx_l0_active_minus1[i] indicates the maximum reference index for reference picture list RL0[i] corresponding to the buffer description BD[i].

[0130]

num_ref_idx_l1_active_minus1[i] indicates the maximum reference index for reference picture list RL1[i] corresponding to the buffer description BD[i].

[0131]

more_modification_flag together with be_idx specifies which of the reference pictures are re-mapped. more_modification_flag equal to 1 specifies that be_idx is present immediately following more_modification_flag. more_modification_flag equal to 0 specifies the end of the loop for re-mapping reference pictures in the reference picture list.

[0132]

be_idx_in_ref_pic_list indicates the reference picture associated with the buffer element BE[i][be_idx] in the current

buffer description BD[i]. be_idx identifies the picture to be re-mapped in the current reference list RL0[i] or RL1[i] associated with the buffer description BD[i]. In this embodiment, the re-mapping process for reference pictures in a reference list is performed according to the same scheme as AVC video coding scheme.

[0133]

The variables or lists BDDeltaPOC[i] and BDTemporalID[i] represent the plurality of periodic buffer descriptions BD[i]. One out of this plurality of buffer descriptions is subsequently selected, and the selected buffer description is used in the slice coding and decoding process as mentioned above.

[0134]

It is to be noted that the syntax loop describing buffer description defining information and reference list description defining information may be combined as one. In such implementations, the parameters for defining a reference list description immediately follows the parameters for defining the corresponding buffer description. In the example in FIG. 8A, the sequence of parameters becomes [number_of_bds = 3], [BD0 define], [RLD0 define], [BD1 define], [RLD1 define], [BD2 define], [RLD2 define].

[0135]

[Effect of coding method]

With the foregoing, the image coding apparatus 100 according to this embodiment is capable of preventing redundant repetition of the same parameters for constructing the reference lists in the coded bitstream. This allows the image coding apparatus 100 to improve the coding efficiency of the parameters describing reference list construction. Furthermore, the image coding apparatus 100 is capable of achieving design harmonization of reference list description data units with the buffer description data units and with the hierarchically structured signaling units of a coded bitstream.

[0136]

[Decoding apparatus]

FIG. 10 is a block diagram which shows a structure of an image decoding apparatus 200 according to this embodiment.

[0137]

The image decoding apparatus 200 shown in FIG. 10 decodes a coded bitstream 232 on a block-by-block basis, thereby generating decoded image data 226. This image decoding apparatus 200 includes a variable-length decoding unit 212, an inverse quantization unit 204, an inverse orthogonal transformation unit 205, an adder 206, a block memory 207, a frame memory 208, an intra prediction unit 209, an inter prediction unit 210, a picture type determination unit 211, and a frame memory control unit 213.

[0138]

The coded bitstream 232 is, for example, the coded bitstream 132 generated by the above image coding apparatus 100.

[0139]

The variable-length decoding unit 212 performs variable-length decoding (entropy decoding) on the coded bitstream 232 to generate quantized values 223 and frame memory control information 233. Here, the frame memory control information 233 corresponds to the above frame memory control information 133.

[0140]

The inverse quantization unit 204 inversely quantizes the quantized values 233, thereby generating frequency coefficients 224. The inverse orthogonal transformation unit 205 performs inverse frequency transform on the frequency coefficients 224, thereby generating prediction error data 225. The adder 206 adds the prediction error data 225 and the prediction image data 231, thereby generating the decoded image data 226. The decoded image data 226 is output from the image decoding apparatus 200 and, for example, is displayed.

[0141]

The block memory 207 holds the decoded image data 226 as decoded image data 227 on a block-by-block basis. The frame memory 208 holds the decoded image data 226 as decoded image data 228 on a frame-by-frame basis.

[0142]

The intra prediction unit 209 performs intra prediction to generate prediction image data 229 of a current block to be decoded. Specifically, the intra prediction unit 209 searches within the decoded image data 227 stored in the block memory 207, and estimates an image area which is most similar to the decoded image data 226.

[0143]

The inter prediction unit 210 performs inter prediction using the per-frame decoded image data 228 stored in the frame memory 208, to generate prediction image data 230 of the current block.

[0144]

The picture type determination unit 211 selects one of the prediction image data 229 and the prediction image data 230 and outputs the selected data as the prediction image data 231.

[0145]

The frame memory control unit 213 manages the decoded image data 228 stored in the frame memory 208. Specifically, the frame memory control unit 213 performs memory management processes according to the frame memory control information 223. Specifically, the frame memory control unit 213 determines whether the decoded image data 128 is kept in the frame memory 208 or removed from the frame memory 208. Furthermore, the frame memory control unit 213 constructs reference lists to be used by the inter prediction unit 210.

[0146]

[Decoding process]

Next, a description is given as to an image decoding method which is performed by the image decoding apparatus 200 as mentioned above.

[0147]

FIG. 11 is a flowchart of an image decoding method according to this embodiment. Furthermore, FIG. 11 shows a decoding process which is performed on a single video sequence including a plurality of pictures.

[0148]

Firstly, the image decoding apparatus 200 obtains, from SPS in the coded bitstream 232, buffer description defining information which defines a plurality of buffer descriptions (S201). Next, the image decoding apparatus 200 obtains, from the above SPS, reference list description defining information which defines a plurality of reference list descriptions (S202). Here, the reference list descriptions correspond one-to-one with the buffer descriptions.

[0149]

Next, the image decoding apparatus 200 obtains buffer description selecting information from a picture header (or a slice header) in the coded bitstream 232 (S203). For the current picture (or slice), the image decoding apparatus 200 then selects, out of the buffer descriptions, one buffer description specified in the buffer description selecting information (S204). Furthermore, the image decoding apparatus 200 selects one reference list description corresponding to the selected buffer description.

[0150]

Finally, the image decoding apparatus 200 decodes the current picture (or slice) using the selected buffer description and the selected reference list description (S205).

[0151]

The following describes a process of obtaining the reference list description defining information (S202) shown in FIG. 11. FIG. 12 is a flowchart of a process of obtaining the reference list description defining information.

[0152]

In this embodiment, the reference list description defining information is obtained from SPS of the coded bitstream 232 in this obtaining process.

[0153]

Firstly, the image decoding apparatus 200 obtains, from the SPS, a first reordering flag included in the reference list description defining information (S212). The first reordering flag indicates whether or not reference list reordering is performed. Next, the

image decoding apparatus 200 judges using the first reordering flag whether or not reference list reordering is performed (S213).

[0154]

When reference list reordering is performed (Yes in S213), the image decoding apparatus 200 obtains, from SPS, first reference list reordering information included in the reference list description defining information (S214) and terminates the process of obtaining the reference list determination defining information (S202). The first reference list reordering information indicates the details of reordering of the picture identifiers included in the reference list.

[0155]

On the other hand, when reference list reordering is not performed (No in S213), the image decoding apparatus 200 terminates the process of obtaining the reference list description defining information (S202).

[0156]

The following describes a decoding process (S205) shown in FIG. 11. FIG. 13 is a flowchart which shows a first embodiment of the decoding process (S205).

[0157]

Firstly, the image decoding apparatus 200 constructs a default reference list comprising all picture identifiers in the buffer description according to a default reference list constructing scheme (S221). Next, the image decoding apparatus 200 judges using a first reordering flag whether or not reference list reordering is performed (S222).

[0158]

When reference list reordering is performed (Yes in S223), the image decoding apparatus 200 reorders the picture identifiers in the reference list according to the first reference list reordering information (S224). The image decoding apparatus 200 then decodes the current picture or slice using the reordered reference list (S225).

[0159]

On the other hand, when reference list reordering is not

performed, the image decoding apparatus 200 decodes the current picture or slice using the default reference list (S225).

[0160]

FIG. 14 is a flowchart which shows a second embodiment of the decoding process (S205).

[0161]

Firstly, the image decoding apparatus 200 constructs a default reference list comprising all picture identifiers in the buffer description according to a default reference list constructing scheme (S231). Next, the image decoding apparatus 200 obtains, from a slice header of the current slice, an update flag for indicating whether or not a reference list description is updated (S232). The image decoding apparatus 200 then judges using the obtained update flag whether or not a reference list description is updated (S233).

[0162]

When a reference list description is updated (Yes in S234), the image decoding apparatus 200 obtains, from the slice header of the current slice, a second reordering flag for indicating whether or not reference list reordering is performed (S235). The image decoding apparatus 200 then judges using the obtained second reordering flag whether or not reference list reordering is performed (S236).

[0163]

When reference list reordering is performed (Yes in S236), the image decoding apparatus 200 obtains second reference list reordering information from the slice header for reordering picture identifiers in the reference list (S237). The image decoding apparatus 200 then reorders the picture identifiers in the reference list according to the obtained second reference list reordering information (S238). Next, the image decoding apparatus 200 decodes the current slice using the reordered reference list (S242).

[0164]

On the other hand, when a reference list description is not updated (No in S234), the image decoding apparatus 200 judges using the first reordering flag included in the reference list description defining information whether or not reference list

reordering is performed (S239 and S240).

[0165]

When reference list reordering is performed (Yes in S240), the image decoding apparatus 200 reorders the picture identifiers in the reference list according to the reference list reordering information included in the reference list description defining information (S241). Next, the image decoding apparatus 200 decodes the current slice using the reordered reference list (S242).

[0166]

On the other hand, when reference list reordering is not performed (No in S236 or No in S240), the image decoding apparatus 200 decodes the current slice using the default reference list (S242).

[0167]

[Effect of decoding method]

With the foregoing, the image decoding apparatus 200 according to this embodiment is capable of decoding a coded bitstream which is coded in the form of improved coding efficiency and harmonized design of reference list description data.

[0168]

(Second Embodiment)

This embodiment describes a variation of the above first embodiment. The image coding apparatus according to this embodiment further writes, into PPS, buffer description updating information for modifying buffer descriptions, and reference list description updating information for modifying reference list descriptions.

[0169]

The following mainly describes differences from the first embodiment and thus omits overlapping explanations.

[0170]

[Coding apparatus]

The block diagram of the image coding apparatus 100 according to this embodiment is the same or alike as that shown in FIG. 3 and therefore is not explained.

[0171]

[Coding process]

The following describes an image coding method which is performed by the image coding apparatus 100 according to this embodiment.

[0172]

FIG. 15 is a flowchart of the image coding method according to this embodiment. The processing shown in FIG. 15 additionally includes Steps S301 to S303 as compared to those shown in FIG. 4 in the image coding method according to the first embodiment.

[0173]

After Step S103, the image coding apparatus 100 modifies a plurality of buffer descriptions and the corresponding reference list descriptions (S301). Specifically, the image coding apparatus 100 modifies one or more buffer descriptions out of the plurality of buffer descriptions and the reference list descriptions corresponding to the one or more buffer descriptions. It is to be noted that the image coding apparatus 100 may add new buffer descriptions and the corresponding new reference list descriptions instead of modifying the original buffer descriptions. The image coding apparatus 100 may modify some or all of the buffer descriptions. For example, the image coding apparatus 100 may modify some or all of the buffer elements included in the buffer descriptions. In this case, the image coding apparatus 100 modifies the part of the reference list descriptions corresponding to the modified part of the buffer descriptions.

[0174]

Next, in order to modify some buffer descriptions out of the plurality of buffer descriptions, the image coding apparatus 100 writes, into PPS of the coded bitstream 132, buffer description updating information which indicates the details of the modification (S302). Next, the image coding apparatus 100 writes, into the above PPS, reference list description updating information which defines the modified reference list descriptions corresponding to the modified part of buffer descriptions (S303). Here, each modified reference list description corresponds exclusively to one buffer

description.

[0175]

It is to be noted that, when new buffer descriptions and reference list descriptions are determined to be created in Step S301, the buffer description updating information and the reference list description updating information comprise information for defining new additional buffer descriptions and the corresponding new reference list descriptions.

[0176]

When a modified buffer description is selected, reference list description updating information is written in Step S303. By so doing, the modified reference list description replaces (overrides) the reference list description defined in the reference list description defining information.

[0177]

Next, the image coding apparatus 100 selects one buffer description out of the modified plurality of buffer descriptions (S104) and writes, into the picture header of the current picture in the coded bitstream 132, buffer description selecting information which specifies the selected buffer description (S105). Finally, the image coding apparatus 100 codes the current picture or slice using the selected buffer description and the corresponding reference list description (S106).

[0178]

The details of Steps S103 and S106 are the same or alike as those shown in FIGS. 5 to 7 in the processing of the first embodiment.

[0179]

The following describes a process of writing the reference list description updating information (S303). FIG. 16 is a flowchart of a writing process (S303) of reference list description updating information. In this embodiment, the reference list description updating information is written into PPS of the coded bitstream 132 in this writing process (S303).

[0180]

Firstly, the image coding apparatus 100 determines which of a default reference list and a reordered reference list is used (S311). Next, the image coding apparatus 100 writes, into PPS, a third reordering flag for indicating whether or not reference list reordering is performed (S312). The image coding apparatus 100 then judges using the written third reordering flag whether or not reference list reordering is performed (S313).

[0181]

When reference list reordering is performed (Yes in S313), the image coding apparatus 100 writes, into PPS, third reference list reordering information which indicates the details of the reordering, for reordering picture identifiers in a reference list (S314), and terminates the writing process (S303).

[0182]

On the other hand, when reference list reordering is not performed (No in S313), the image coding apparatus 100 terminates the writing process (S303).

[0183]

Thus, the reference list description updating information includes the third reordering flag and the third reference list reordering information.

[0184]

[Syntax diagram]

FIGS. 17A and 17D are each a syntax diagram which shows the locations of the buffer description updating information and the reference list description updating information in a coded bitstream in this embodiment. Two exemplary syntax locations are described in the following.

[0185]

A coded bitstream 132B shown in FIG. 17A is different from the coded bitstream 132 shown in FIG. 8A in that PPS 302B replaces PPS 302. Specifically, the PPS 302B further includes buffer description updating information 323 (BD update) and reference list description updating information 324 (RLD update).

[0186]

The buffer description updating information 323 includes number-of-updates information 325 (number_of_bd_updates) and one or more pieces of updating information 326. Each piece of the updating information 326 includes buffer description selecting information 327 (bd_select) and buffer description modifying information 328 (BD modify).

[0187]

The number-of-updates information 325 (e.g. number_of_bd_updates = 2) indicates the number of buffer descriptions to be modified and the number of corresponding reference list descriptions to be modified.

[0188]

The buffer description selecting information 327 specifies a buffer description to be updated. The buffer description modifying information 328 indicates the details of modification of the buffer description.

[0189]

The reference list description updating information 324 includes one or more pieces of reference list description defining information 329 (RLD define). Each piece of the reference list description defining information 329 defines the reference list description corresponding to the updated buffer description.

[0190]

In a coded bitstream 132C shown in FIG. 17B, the PPS selecting information 333 and the buffer description selecting information 334 are not included in the picture header 331A, but are included in the slice header 341. Also in this case, the effects the same as those in the case shown in FIG. 17A can be obtained.

[0191]

The buffer description updating information 323 and the reference list description updating information 324 may be located in signalling units other than PPS in a coded bitstream. Such other signalling units possess the same characteristics as PPS in that they contain the parameters used in common by a plurality of slices in one or more pictures. The extension and adaptation from PPS to these

other signalling units will be apparent to those skilled in the art.

[0192]

The above buffer description updating information and reference list description updating information are signalled in the sequence parameter set syntax structure according to the pseudo code in the table shown in FIG. 18.

[0193]

The semantics of the descriptors is the same as that in FIG. 9.

[0194]

The semantics associated with the syntax elements representing the buffer description updating information is specified in the following.

[0195]

number_of_bd_updates specifies the number of times the syntax element bd_select is present in PPS. In other words, number_of_bd_updates represents the number of buffer descriptions to be modified by PPS.

[0196]

bd_select specifies an index into the lists BDDeltaPOC and BDTemporalID representing the buffer description BD[bd_select] to be modified by PPS.

[0197]

bd_modification_operation specifies a modification operation to be applied on the selected buffer description BD[bd_select]. bd_modification_operation equal to 0 specifies the end of the loop for modifying the buffer description BD[bd_select]. bd_modification_operation shall not be equal to 0 immediately following the syntax element bd_select.

[0198]

In this embodiment, while bd_modification_operation equal to 1 specifies that a buffer element indicated by be_idx_in_bd_update in the buffer description BD[bd_select] is to be assigned a POC difference value to a current picture. This POC difference value replaces the existing stored POC difference value.

[0199]

In alternative implementations, additional buffer description modification operations indicated by bd_modification_operation may be defined. One example is the operation for assigning marking for a picture indicated by a buffer element as a short term or long term reference picture. Another example is the operation for defining new additional buffer description. In this case, bd_select specifies an index to a plurality of new (non-existing) buffer descriptions and subsequent buffer description modification operations assigns picture indicators to the buffer elements in the new buffer descriptions.

[0200]

be_idx_in_bd_update specifies the buffer element to be modified in the buffer description BD[bd_select].

[0201]

delta_poc_sign_flag specifies the sign (plus or minus) of the POC difference between a current picture and the reference picture to be associated with the buffer element BE[bd_select][be_idx_in_bd_update] in the buffer description BD[bd_select]. delta_poc_sign_flag equal to 0 specifies that the POC difference has a positive value, while delta_poc_sign_flag equal to 1 specifies that the POC difference has a negative value.

[0202]

delta_poc_minus1 specifies an absolute POC difference value between a current picture and the reference picture to be associated with the buffer element BE[bd_select][be_idx_in_bd_update] in the buffer description BD[bd_select]. first_delta_poc_sign_flag and first_delta_poc define the value of the signed variable BDDeltaPOC[bd_select][be_idx_in_bd_update] as

[0203]

BDDeltaPOC[bd_select][be_idx_in_bd_update] =
(delta_poc_minus1 + 1) * (1 − 2 * delta_poc_sign_flag)

[0204]

temporal_id specifies a temporal identifier and is represented by bits_for_temporal_id bits. temporal_id defines the value of the unsigned variable BDTemporalID[bd_select][be_idx_in_bd_update]

as

[0205]

BDTemporalID[bd_select][be_idx_in_bd_update] = temporal_id

The semantics associated with the syntax elements representing the reference list description updating information is the same as the semantics associated with the syntax elements representing the reference list description defining information, as detailed in the previous description above. As mentioned above, when a buffer description is modified by PPS, reference list description updating information is written to define a modified reference list description. The modified reference list description replaces (overrides) the initial reference list description defined previously by the referred active SSP.

[0206]

It is to be noted that the syntax loop describing buffer description updating information and reference list description updating information may be combined as one. In such implementations, the parameters for defining a modified reference list description immediately follows the parameters for modifying the corresponding buffer description. In the example in FIG. 17A, the sequence of parameters becomes [number_of_bd_updates = 2], [bd_select = 2], [BD2 modify], [RLD2 define], [bd_select = 3], [BD3 modify], [RLD3 define].

[0207]

[Effect of coding method]

With the foregoing, the image coding apparatus 100 according to this embodiment is capable of preventing redundant repetition of the same parameters for constructing the reference lists in the coded bitstream. This allows the image coding apparatus 100 to improve the coding efficiency of the parameters describing reference list construction. Furthermore, the image coding apparatus 100 is capable of achieving design harmonization of reference list description data units with the buffer description data units and with the hierarchically structured signaling units of a coded bitstream.

[0208]

[Decoding apparatus]

The block diagram of the image decoding apparatus 200 according to this embodiment is the same or alike as that shown in FIG. 10 and therefore is not explained.

[0209]

[Decoding process]

The following describes an image decoding method which is performed by the image decoding apparatus 200 according to this embodiment.

[0210]

FIG. 19 is a flowchart of an image decoding method according to this embodiment. The processing shown in FIG. 19 additionally includes Steps S401 and S402 as compared to those shown in FIG. 11 in the image decoding method according to the first embodiment.

[0211]

After Step S202, the image decoding apparatus 200 obtains buffer description updating information from PPS of the coded bitstream 232 for modifying a plurality of buffer descriptions (S401). Next, the image decoding apparatus 200 obtains reference list description updating information from the above PPS for defining a modified reference list description corresponding to the modified buffer description (S402). Here, each modified reference list description corresponds exclusively to one modified buffer description.

[0212]

Next, the image decoding apparatus 200 obtains buffer description selecting information from the picture header of the current picture in the coded bitstream 232 for selecting one buffer description out of the modified plurality of buffer descriptions (S203). Next, the image decoding apparatus 200 selects, for the current picture (or slice), one buffer description specified in the buffer description selecting information and one reference list description corresponding to the buffer description (S204). Finally, the image decoding apparatus 200 decodes the current picture or slice using

the selected buffer description and the corresponding reference list description (S205).

[0213]

The details of Steps S202 and S205 are the same or alike as those shown in FIGS. 12 to 14 in the processing of the first embodiment.

[0214]

The following describes a process of obtaining the reference list description updating information (S402). FIG. 20 is a flowchart of a process of obtaining reference list description updating information (S402). In this embodiment, the reference list description updating information is obtained from PPS of the coded bitstream 232 in the obtaining process (S402).

[0215]

Firstly, the image decoding apparatus 200 obtains, from the reference list description updating information, a third reordering flag for indicating whether or not reference list reordering is performed (S412). The image decoding apparatus 200 then judges using the obtained third reordering flag whether or not reference list reordering is performed (S413).

[0216]

When reference list reordering is performed (Yes in S413), the image decoding apparatus 200 obtains, for reordering picture identifiers in a reference list, reference list reordering information which indicates the details of the reordering (S414), and terminates the obtaining process (S402).

[0217]

On the other hand, when reference list reordering is not performed (No in S423), the image decoding apparatus 200 terminates the obtaining process (S402).

[0218]

[Effect of decoding method]

With the foregoing, the image decoding apparatus 200 according to this embodiment is capable of decoding a coded bitstream which is coded in the form of improved coding efficiency

and harmonized design of reference list description data.

[0219]

(Third Embodiment)

This embodiment describes a variation of the above second embodiment. A coded bitstream in this embodiment is different from that in the second embodiment in the structures of the buffer description updating information and the reference list description updating information. The following mainly describes differences from the first or second embodiment and thus omits overlapping explanations.

[0220]

[Coding apparatus]

The block diagram of the image coding apparatus 100 according to this embodiment is the same or alike as that shown in FIG. 3 and therefore is not explained.

[0221]

[Coding process]

The following describes an image coding method which is performed by the image coding apparatus 100 according to this embodiment.

[0222]

FIG. 21 is a flowchart of the image coding method according to this embodiment. The processing shown in FIG. 21 additionally includes Steps S301A to S303A as compared to those shown in FIG. 4 in the image coding method according to the first embodiment. Furthermore, the processing in Step S105A is different from that in Step S105.

[0223]

After Step S104, the image coding apparatus 100 determines modifications for the selected buffer description and the corresponding reference list description (S301A). The image coding apparatus 100 then writes, for selecting and modifying the selected buffer description, buffer description updating information which indicates the details of the modification (S302A), into PPS of the coded bitstream 132. Next, the image coding apparatus 100 writes,

into the above PPS, reference list description updating information which defines a modified reference list description corresponding to the selected buffer description (S303A).

[0224]

Here, the buffer description updating information includes a parameter to indicate whether or not the selected buffer description is modified. When the selected buffer description is modified, a modified reference list description is defined by the reference list updating information. This modified reference list description replaces the initial reference list description corresponding to the selected buffer description. When the selected buffer description is not modified, the reference list updating information is not present in the above PPS and the initial reference list description corresponding to the selected buffer description applies.

[0225]

Next, the image coding apparatus 100 writes PPS selecting information into a picture header of a current picture (or a slice header of a current slice) in the coded bitstream 132 for indicating that the above PPS is referred by the picture (S105A). One corresponding buffer description and one corresponding reference list description are thereby referred. Finally, the image coding apparatus 100 codes the current picture or slice using the selected buffer description and the corresponding reference list description (S106).

[0226]

The details of Steps S103 and S106 are the same or alike as those shown in FIGS. 5 to 7 in the processing of the first embodiment. The details of Step S303A are the same or alike as those shown in FIG. 16 in the processing of the second embodiment.

[0227]

[Syntax diagram]

FIGS. 22A and 22B are each a syntax diagram which shows the locations of the buffer description updating information and the reference list description updating information in a coded bitstream in exemplary embodiments. Two exemplary syntax locations are

described in the following.

[0228]

A coded bitstream 132D shown in FIG. 22A is different from the coded bitstream 132B shown in FIG. 17A in that buffer description updating information 323D and reference list description updating information 324D in PPS302D replace the buffer description updating information 323 and the reference list description updating information 324 in PPS 302B. Furthermore, a picture header 331D is different from the picture header 331.

[0229]

The buffer description updating information 323D includes buffer description selecting information 351 (e.g. bd_select = 2) to specify one selected buffer description and a buffer description modifying flag 352 (e.g. modify_flag = 1) indicating whether or not the selected buffer description and the reference list description corresponding to the selected buffer description are to be modified. When the buffer description modifying flag 352 indicates that modification is performed, the buffer description updating information 323D further includes the buffer description modifying information 328 (BD modify). Furthermore, when the buffer description modifying flag 352 indicates that modification is performed, the PPS 302B includes the reference list description updating information 324D including the reference list description defining information 329 (RLD define) which defines the modified reference list. On the other hand, when the buffer description modifying flag 352 indicates that modification is not performed, the PPS302D does not include the buffer description modifying information 328 and the reference list description defining information 329.

[0230]

It is to be noted that the picture header 331D does not include the buffer description selecting information 334.

[0231]

With the foregoing, the PPS 302D is identified by the PPS identifier 322 (e.g. pps_id = 0) and is referred in the picture header

331D using the PPS selecting information 333 (e.g. pps_select = 0). When the PPS 302D is referred, the selected buffer description and the associated reference list description are also referred. Slices (or sub-picture units) in the current picture are coded or decoded using ordered reference pictures according to the selected buffer description and the selected reference list description.

[0232]

In a coded bitstream 132E shown in FIG. 22B, the PPS selecting information 333 is not included in the picture header 331A, but is included in a slice header 341E. Also in this case, the effects the same as those in the case shown in FIG. 22A can be obtained.

[0233]

It is to be noted that the buffer description updating information 323D and the reference list description updating information 324D may be located in signalling units other than PPS in a coded bitstream.

[0234]

The above buffer description defining information and reference list description defining information are signalled in the sequence parameter set syntax structure according to the pseudo code detailed in the previous description above. The buffer description updating information and reference list description updating information are signalled in the sequence parameter set syntax structure according to the pseudo code in the table shown in FIG. 23.

[0235]

The semantics of the descriptors is the same as that in FIG. 9.

[0236]

The semantics associated with the syntax elements representing the buffer description updating information is specified in the following.

[0237]

bd_select specifies an index into the lists BDDeltaPOC and BDTemporalID representing the buffer description BD[bd_select] to be referred to and optionally be modified by PPS.

[0238]

The semantics of bd_modification_operation, be_idx_in_bd_update, delta_poc_sign_flag, delta_poc_minus1, first_delta_poc_sign_flag, first_delta_poc, and temporal_id is the same as those in FIG. 18.

[0239]

The semantics associated with the syntax elements representing the reference list description updating information is the same as the semantics associated with the syntax elements representing the reference list description defining information, as detailed in the previous description above. When the selected buffer description is not modified as indicated by the internal variable IsBDModified not equal to 1, the syntax elements representing the reference list description updating information are not present in PPS, and the initial reference list description written in SPS is used. When the selected buffer description is modified, the reference list description updating information is written into PPS for defining the modified reference lists which replace the initial reference lists previously defined in SPS.

[0240]

[Effect of coding method]

With the foregoing, the image coding apparatus 100 according to this embodiment is capable of preventing redundant repetition of the same parameters for constructing the reference lists in the coded bitstream. This allows the image coding apparatus 100 to improve the coding efficiency of the parameters describing reference list construction. Furthermore, the image coding apparatus 100 is capable of achieving design harmonization of reference list description data units with the buffer description data units and with the hierarchically structured signaling units of a coded bitstream.

[0241]

[Decoding apparatus]

The block diagram of the image decoding apparatus 200 according to this embodiment is the same or alike as that shown in FIG. 10 and therefore is not explained.

[0242]

[Decoding process]

The following describes an image decoding method which is performed by the image decoding apparatus 200 according to this embodiment.

[0243]

FIG. 24 is a flowchart of the image decoding method according to this embodiment. The processing shown in FIG. 24 additionally includes Steps S401A and S402 as compared to that shown in FIG. 11 in the image decoding method according to the first embodiment. Furthermore, the processing in Steps S203A and S204A is different from that in Steps S203 and S204.

[0244]

After Step S202, the image decoding apparatus 200 obtains buffer description selecting information and buffer description updating information from PPS of the coded bitstream for selecting and modifying one buffer description out of the plurality of buffer descriptions (S401A). Next, the image decoding apparatus 200 obtains, from the above PPS, reference list description updating information for defining a modified reference list description corresponding to the selected buffer description (S402).

[0245]

Next, the image decoding apparatus 200 obtains, from the picture header of the current picture in the coded bitstream, a PPS identifier for indicating that the above PPS is referred by the current picture (S203A). Next, the image decoding apparatus 200 selects, for the current picture (or slice), one buffer description specified in the buffer description selecting information in PPS specified by the PPS identifier, and one reference list description corresponding to the buffer description (S204A). Finally, the image decoding apparatus 200 decodes the current picture or slice using the selected buffer description and the corresponding reference list description (S205).

[0246]

The details of Steps S202 and S205 are the same or alike as those shown in FIGS. 12 to 14 in the processing of the first

embodiment. The details of Step S402 are the same or alike as those shown in FIG. 20 in the processing of the second embodiment.

[0247]

[Effect of decoding method]

With the foregoing, the image decoding apparatus 200 according to this embodiment is capable of decoding a coded bitstream which is coded in the form of improved coding efficiency and harmonized design of reference list description data.

[0248]

(Fourth Embodiment)

This embodiment describes a variation of the above third embodiment. In this embodiment, the buffer description updating information and the reference list description updating information are included in the slice header. The following mainly describes differences from the first, second, or third embodiment and thus omits overlapping explanations.

[0249]

[Coding apparatus]

The block diagram of the image coding apparatus 100 according to this embodiment is the same or alike as that shown in FIG. 3 and therefore is not explained.

[0250]

[Coding process]

The following describes an image coding method which is performed by the image coding apparatus 100 according to this embodiment.

[0251]

FIG. 25 is a flowchart of the image decoding method according to this embodiment. The processing shown in FIG. 25 includes Steps S302B and S303B instead of Steps S302A, S303A, and S105A shown in FIG. 21 in the image coding method according to the third embodiment.

[0252]

After Step S301A, the image coding apparatus 100 writes, for modifying the selected buffer description, buffer description

selecting information, which specifies the selected buffer description, and buffer description updating information, into the slice header of the current slice in the coded bitstream (S302B). Next, the image coding apparatus 100 writes, into the slice header, reference list description updating information which defines a modified reference list description corresponding to the selected buffer description (S303B).

[0253]

In this implementation, the buffer description updating information includes a parameter to indicate whether or not the selected buffer description is modified. When the selected buffer description is modified, the reference list updating information defines a modified reference list description. This modified reference list description replaces the initial reference list description corresponding to the selected buffer description. When the selected buffer description is not modified, the reference list updating information is not present in the slice header and the initial reference list description corresponding to the selected buffer description applies.

[0254]

Finally, the image coding apparatus 100 codes the current slice using the selected buffer description and the corresponding reference list description (S106).

[0255]

The details of Steps S103 and S106 are the same or alike as those shown in FIGS. 5 and 6 in the processing of the first embodiment. The details of Step S303B are the same or alike as the processing resulting from changing, from PPS to a slice header, where to write the third reordering flag and the third reference list reordering information in the processing shown in FIG. 16 in the second embodiment.

[0256]

[Syntax diagram]

FIG. 26 is a syntax diagram which shows the locations of the buffer description updating information and the reference list

description updating information in a coded bitstream in this embodiment.

[0257]

A coded bitstream 132F shown in FIG. 26 is different from the coded bitstream 132E shown in FIG. 22B in that the buffer description updating information 323D and the reference list description updating information 324D are included not in the PPS 302D, but in the slice header 341E.

[0258]

When the buffer description modifying flag 352 indicates that modification is performed, the buffer description updating information 323D further includes the buffer description modifying information 328. Furthermore, when the buffer description modifying flag 352 indicates that modification is performed, a slice header 341F includes the reference list description updating information 324D including the reference list description defining information 329 (RLD define) which defines the modified reference list. On the other hand, when the buffer description modifying flag 352 indicates that modification is not performed, the slice header 341F does not include the buffer description modifying information 328 and the reference list description defining information 329.

[0259]

Slices (or sub-picture units) in the current picture are coded or decoded using ordered reference pictures according to the selected buffer description and the selected reference list description.

[0260]

The above buffer description defining information and reference list description defining information are signalled in the sequence parameter set syntax structure according to the pseudo code detailed in the previous description above. The buffer description updating information and reference list description updating information are signalled in the slice header syntax structure according to the pseudo code in the table shown in FIG. 27.

[0261]

The semantics of the descriptors is the same as that in FIG. 9.

[0262]

The semantics associated with the syntax elements representing the buffer description updating information according to this embodiment is the same as the semantics associated with the syntax elements representing the reference list description updating information according to the third embodiment, as detailed in the previous description above.

[0263]

The semantics associated with the syntax elements representing the reference list description updating information is the same as the semantics associated with the syntax elements representing the reference list description defining information, as detailed in the previous description above. When the selected buffer description is not modified as indicated by the internal variable IsBDModified not equal to 1, the syntax elements representing the reference list description updating information are not present in the slice header, and the initial reference list description written in SPS is used. When the selected buffer description is modified, the reference list updating information in the slice header is written for defining the modified reference lists which replace the initial reference lists previously defined in SPS.

[0264]

[Effect of coding method]

With the foregoing, the image coding apparatus 100 according to this embodiment is capable of preventing redundant repetition of the same parameters for constructing the reference lists in the coded bitstream. This allows the image coding apparatus 100 to improve the coding efficiency of the parameters describing reference list construction. Furthermore, the image coding apparatus 100 is capable of achieving design harmonization of reference list description data units with the buffer description data units and with the hierarchically structured signaling units of a coded bitstream.

[0265]

[Decoding apparatus]

The block diagram of the image decoding apparatus 200

according to this embodiment is the same or alike as that shown in FIG. 10 and therefore is not explained.

[0266]

[Decoding process]

The following describes an image decoding method which is performed by the image decoding apparatus 200 according to this embodiment.

[0267]

FIG. 28 is a flowchart of the image decoding method according to this embodiment. The processing shown in FIG. 28 includes Steps S401B and S402B instead of Step S203 shown in FIG. 11 in the image decoding method according to the first embodiment.

[0268]

After Step S202, the image decoding apparatus 200 obtains buffer description selecting information and buffer description updating information from the slice header of the current slice in the coded bitstream for selecting and modifying one buffer description out of the plurality of buffer descriptions (S401B). Next, the image decoding apparatus 200 obtains reference list description updating information from the slice header for defining a modified reference list description corresponding to the selected buffer description (S402B).

[0269]

Next, the image decoding apparatus 200 obtains the buffer description indicated in the buffer description selecting information (S204). Finally, the image decoding apparatus 200 decodes the current slice using the selected buffer description and the corresponding reference list description (S205).

[0270]

The details of Steps S202 and S205 are the same or alike as those shown in FIGS. 12 and 13 in the processing of the first embodiment. The details of Step S402 are the same or alike as those shown in FIG. 20 in the processing of the second embodiment.

[0271]

[Effect of decoding method]

With the foregoing, the image decoding apparatus 200 according to this embodiment is capable of decoding a coded bitstream which is coded in the form of improved coding efficiency and harmonized design of reference list description data.

[0272]

As above, in the image coding method according to this embodiment, the buffer description defining information, which defines a plurality of buffer descriptions, and the reference list description defining information, which defines a plurality of reference list descriptions corresponding to the buffer descriptions, are written into SPS corresponding to the coded bitstream.

[0273]

Furthermore, in the image coding method, for each processing unit that is a picture or a slice, one of the buffer descriptions is selected, and buffer description selecting information which specifies the selected buffer description is written into a first header of the processing unit which is included in the coded bitstream. Here, the first header is a header of a picture or a slice and specifically is PPS, a picture header, or a slice header.

[0274]

In the image coding method, the processing unit is coded using the selected buffer description and the reference list description which corresponds to the selected buffer description.

[0275]

By so doing, in the image coding method, the buffer description defining information and the reference list description defining information are written into the sequence parameter set shared by a plurality of pictures, and a buffer description identifier indicating a buffer description to be selected is written into a header of each picture or slice. This allows a reduction in redundant information and thereby allows an improvement in coding efficiency in the image coding method as compared to the case where the buffer description defining information and the reference list description defining information are written into a picture parameter set.

[0276]

Furthermore, in the image coding method, at least one of the buffer descriptions is modified, and buffer description updating information, which indicates the details of the modification, and reference list description updating information, which defines the reference list description corresponding to the modified buffer description, are written into a second header of the processing unit. Here, the second header is a header of a picture or a slice and specifically is PPS, a picture header, or a slice header.

[0277]

In this case, in the image coding method, the processing unit is coded using the modified buffer description and the reference list description which corresponds to the modified buffer description.

[0278]

By so doing, in the image coding method, the buffer description and the reference list description set in SPS can be updated for each picture or slice. Thus, the image coding method allows a reduction in redundant information and also allows, when necessary, the buffer description and the reference list description to be modified for each picture or slice.

[0279]

Although the image coding apparatus and the image decoding apparatus according to the embodiments of the present invention have been described above, the present invention is not limited to these embodiments.

[0280]

For example, although the above describes an example in which SPS is included in the coded bitstream which includes slice data and the like, SPS may be transmitted from the image coding apparatus to the image decoding apparatus separately from the coded bitstream which includes the slice data and the like.

[0281]

Respective processing units included in the image coding apparatus and the image decoding apparatus according to each of the above embodiments are typically implemented as a large scale

integration (LSI) that is an integrated circuit. These processing units may be each provided on a single chip, and part or all of them may be formed into a single chip.

[0282]

Moreover, ways to achieve integration are not limited to the LSI, and a special circuit or a general purpose processor and so forth can also achieve the integration. Field Programmable Gate Array (FPGA) that can be programmed after manufacturing LSIs, or a reconfigurable processor that allows re-configuration of the connection or configuration of an LSI can be used for the same purpose.

[0283]

Each of the structural elements in each of the above-described embodiments may be configured in the form of an exclusive hardware product, or may be realized by executing a software program suitable for the structural element. Each of the structural elements may be realized by means of a program executing unit, such as a CPU and a processor, reading and executing the software program recorded on a recording medium such as a hard disk or a semiconductor memory.

[0284]

Furthermore, the present invention may be implemented as the above software program and may also be implemented as a non-transitory computer-readable recording medium on which such a program is recorded. In addition, it goes without saying that such a program may be distributed via a communication network such as the Internet.

[0285]

The numerals herein are all given to specifically illustrate the present invention and therefore do not limit it.

[0286]

The segmentation of the functional blocks in each block diagram is an example, and some of the functional blocks may be implemented as one functional block while one functional block may be divided into plural parts, or part of the function of one functional

block may be shifted to another function block. Furthermore, the functions of a plurality of functional blocks which have similar functions may be processed in parallel or in time-sliced fashion by single hardware or software.

[0287]

The processing order of the steps included in the above image coding or decoding method are given to specifically illustrate the present invention and therefore may be any other order. Part of the above steps may be performed at the same time as (in parallel with) another step.

[0288]

(Fifth Embodiment)

The processing described in each of embodiments can be simply implemented in an independent computer system, by recording, in a recording medium, a program for implementing the configurations of the moving picture coding method and the moving picture decoding method described in each of embodiments. The recording media may be any recording media as long as the program can be recorded, such as a magnetic disk, an optical disk, a magnetic optical disk, an IC card, and a semiconductor memory.

[0289]

Hereinafter, the applications to the moving picture coding method and the moving picture decoding method described in each of embodiments and systems using thereof will be described. The system has a feature of having an image coding and decoding apparatus that includes an image coding apparatus using the image coding method and an image decoding apparatus using the image decoding method. Other configurations in the system can be changed as appropriate depending on the cases.

[0290]

FIG. 29 illustrates an overall configuration of a content providing system ex100 for implementing content distribution services. The area for providing communication services is divided into cells of desired size, and base stations ex106, ex107, ex108, ex109, and ex110 which are fixed wireless stations are placed in each

of the cells.

[0291]

The content providing system ex100 is connected to devices, such as a computer ex111, a personal digital assistant (PDA) ex112, a camera ex113, a cellular phone ex114 and a game machine ex115, via the Internet ex101, an Internet service provider ex102, a telephone network ex104, as well as the base stations ex106 to ex110, respectively.

[0292]

However, the configuration of the content providing system ex100 is not limited to the configuration shown in FIG. 29, and a combination in which any of the elements are connected is acceptable. In addition, each device may be directly connected to the telephone network ex104, rather than via the base stations ex106 to ex110 which are the fixed wireless stations. Furthermore, the devices may be interconnected to each other via a short distance wireless communication and others.

[0293]

The camera ex113, such as a digital video camera, is capable of capturing video. A camera ex116, such as a digital camera, is capable of capturing both still images and video. Furthermore, the cellular phone ex114 may be the one that meets any of the standards such as Global System for Mobile Communications (GSM) (registered trademark), Code Division Multiple Access (CDMA), Wideband-Code Division Multiple Access (W-CDMA), Long Term Evolution (LTE), and High Speed Packet Access (HSPA). Alternatively, the cellular phone ex114 may be a Personal Handyphone System (PHS).

[0294]

In the content providing system ex100, a streaming server ex103 is connected to the camera ex113 and others via the telephone network ex104 and the base station ex109, which enables distribution of images of a live show and others. In such a distribution, content (for example, video of a music live show) captured by the user using the camera ex113 is coded as described above in each of embodiments (i.e., the camera functions as the

image coding apparatus according to an aspect of the present invention), and the coded content is transmitted to the streaming server ex103. On the other hand, the streaming server ex103 carries out stream distribution of the transmitted content data to the clients upon their requests. The clients include the computer ex111, the PDA ex112, the camera ex113, the cellular phone ex114, and the game machine ex115 that are capable of decoding the above-mentioned coded data. Each of the devices that have received the distributed data decodes and reproduces the coded data (i.e., functions as the image decoding apparatus according to an aspect of the present invention).

[0295]

The captured data may be coded by the camera ex113 or the streaming server ex103 that transmits the data, or the coding processes may be shared between the camera ex113 and the streaming server ex103. Similarly, the distributed data may be decoded by the clients or the streaming server ex103, or the decoding processes may be shared between the clients and the streaming server ex103. Furthermore, the data of the still images and video captured by not only the camera ex113 but also the camera ex116 may be transmitted to the streaming server ex103 through the computer ex111. The coding processes may be performed by the camera ex116, the computer ex111, or the streaming server ex103, or shared among them.

[0296]

Furthermore, the coding and decoding processes may be performed by an LSI ex500 generally included in each of the computer ex111 and the devices. The LSI ex500 may be configured of a single chip or a plurality of chips. Software for coding and decoding video may be integrated into some type of a recording medium (such as a CD-ROM, a flexible disk, and a hard disk) that is readable by the computer ex111 and others, and the coding and decoding processes may be performed using the software. Furthermore, when the cellular phone ex114 is equipped with a camera, the video data obtained by the camera may be transmitted.

The video data is data coded by the LSI ex500 included in the cellular phone ex114.

[0297]

Furthermore, the streaming server ex103 may be composed of servers and computers, and may decentralize data and process the decentralized data, record, or distribute data.

[0298]

As described above, the clients may receive and reproduce the coded data in the content providing system ex100. In other words, the clients can receive and decode information transmitted by the user, and reproduce the decoded data in real time in the content providing system ex100, so that the user who does not have any particular right and equipment can implement personal broadcasting.

[0299]

Aside from the example of the content providing system ex100, at least one of the moving picture coding apparatus (image coding apparatus) and the moving picture decoding apparatus (image decoding apparatus) described in each of embodiments may be implemented in a digital broadcasting system ex200 illustrated in FIG. 30. More specifically, a broadcast station ex201 communicates or transmits, via radio waves to a broadcast satellite ex202, multiplexed data obtained by multiplexing audio data and others onto video data. The video data is data coded by the moving picture coding method described in each of embodiments (i.e., data coded by the image coding apparatus according to an aspect of the present invention). Upon receipt of the multiplexed data, the broadcast satellite ex202 transmits radio waves for broadcasting. Then, a home-use antenna ex204 with a satellite broadcast reception function receives the radio waves. Next, a device such as a television (receiver) ex300 and a set top box (STB) ex217 decodes the received multiplexed data, and reproduces the decoded data (i.e., functions as the image decoding apparatus according to an aspect of the present invention).

[0300]

Furthermore, a reader/recorder ex218 (i) reads and decodes the multiplexed data recorded on a recording medium ex215, such as a DVD and a BD, or (i) codes video signals in the recording medium ex215, and in some cases, writes data obtained by multiplexing an audio signal on the coded data. The reader/recorder ex218 can include the moving picture decoding apparatus or the moving picture coding apparatus as shown in each of embodiments. In this case, the reproduced video signals are displayed on the monitor ex219, and can be reproduced by another device or system using the recording medium ex215 on which the multiplexed data is recorded. It is also possible to implement the moving picture decoding apparatus in the set top box ex217 connected to the cable ex203 for a cable television or to the antenna ex204 for satellite and/or terrestrial broadcasting, so as to display the video signals on the monitor ex219 of the television ex300. The moving picture decoding apparatus may be implemented not in the set top box but in the television ex300.

[0301]

FIG. 31 illustrates the television (receiver) ex300 that uses the moving picture coding method and the moving picture decoding method described in each of embodiments. The television ex300 includes: a tuner ex301 that obtains or provides multiplexed data obtained by multiplexing audio data onto video data, through the antenna ex204 or the cable ex203, etc. that receives a broadcast; a modulation/demodulation unit ex302 that demodulates the received multiplexed data or modulates data into multiplexed data to be supplied outside; and a multiplexing/demultiplexing unit ex303 that demultiplexes the modulated multiplexed data into video data and audio data, or multiplexes video data and audio data coded by a signal processing unit ex306 into data.

[0302]

The television ex300 further includes: a signal processing unit ex306 including an audio signal processing unit ex304 and a video signal processing unit ex305 that decode audio data and video data and code audio data and video data, respectively (which function as

the image coding apparatus and the image decoding apparatus according to the aspects of the present invention); and an output unit ex309 including a speaker ex307 that provides the decoded audio signal, and a display unit ex308 that displays the decoded video signal, such as a display. Furthermore, the television ex300 includes an interface unit ex317 including an operation input unit ex312 that receives an input of a user operation. Furthermore, the television ex300 includes a control unit ex310 that controls overall each constituent element of the television ex300, and a power supply circuit unit ex311 that supplies power to each of the elements. Other than the operation input unit ex312, the interface unit ex317 may include: a bridge ex313 that is connected to an external device, such as the reader/recorder ex218; a slot unit ex314 for enabling attachment of the recording medium ex216, such as an SD card; a driver ex315 to be connected to an external recording medium, such as a hard disk; and a modem ex316 to be connected to a telephone network. Here, the recording medium ex216 can electrically record information using a non-volatile/volatile semiconductor memory element for storage. The constituent elements of the television ex300 are connected to each other through a synchronous bus.

[0303]

First, the configuration in which the television ex300 decodes multiplexed data obtained from outside through the antenna ex204 and others and reproduces the decoded data will be described. In the television ex300, upon a user operation through a remote controller ex220 and others, the multiplexing/demultiplexing unit ex303 demultiplexes the multiplexed data demodulated by the modulation/demodulation unit ex302, under control of the control unit ex310 including a CPU. Furthermore, the audio signal processing unit ex304 decodes the demultiplexed audio data, and the video signal processing unit ex305 decodes the demultiplexed video data, using the decoding method described in each of embodiments, in the television ex300. The output unit ex309 provides the decoded video signal and audio signal outside, respectively. When the output unit ex309 provides the video signal and the audio signal,

the signals may be temporarily stored in buffers ex318 and ex319, and others so that the signals are reproduced in synchronization with each other. Furthermore, the television ex300 may read multiplexed data not through a broadcast and others but from the recording media ex215 and ex216, such as a magnetic disk, an optical disk, and a SD card. Next, a configuration in which the television ex300 codes an audio signal and a video signal, and transmits the data outside or writes the data on a recording medium will be described. In the television ex300, upon a user operation through the remote controller ex220 and others, the audio signal processing unit ex304 codes an audio signal, and the video signal processing unit ex305 codes a video signal, under control of the control unit ex310 using the coding method described in each of embodiments. The multiplexing/demultiplexing unit ex303 multiplexes the coded video signal and audio signal, and provides the resulting signal outside. When the multiplexing/demultiplexing unit ex303 multiplexes the video signal and the audio signal, the signals may be temporarily stored in the buffers ex320 and ex321, and others so that the signals are reproduced in synchronization with each other. Here, the buffers ex318, ex319, ex320, and ex321 may be plural as illustrated, or at least one buffer may be shared in the television ex300. Furthermore, data may be stored in a buffer so that the system overflow and underflow may be avoided between the modulation/demodulation unit ex302 and the multiplexing/demultiplexing unit ex303, for example.

[0304]

Furthermore, the television ex300 may include a configuration for receiving an AV input from a microphone or a camera other than the configuration for obtaining audio and video data from a broadcast or a recording medium, and may code the obtained data. Although the television ex300 can code, multiplex, and provide outside data in the description, it may be capable of only receiving, decoding, and providing outside data but not the coding, multiplexing, and providing outside data.

[0305]

Furthermore, when the reader/recorder ex218 reads or writes multiplexed data from or on a recording medium, one of the television ex300 and the reader/recorder ex218 may decode or code the multiplexed data, and the television ex300 and the reader/recorder ex218 may share the decoding or coding.

[0306]

As an example, FIG. 32 illustrates a configuration of an information reproducing/recording unit ex400 when data is read or written from or on an optical disk. The information reproducing/recording unit ex400 includes constituent elements ex401, ex402, ex403, ex404, ex405, ex406, and ex407 to be described hereinafter. The optical head ex401 irradiates a laser spot in a recording surface of the recording medium ex215 that is an optical disk to write information, and detects reflected light from the recording surface of the recording medium ex215 to read the information. The modulation recording unit ex402 electrically drives a semiconductor laser included in the optical head ex401, and modulates the laser light according to recorded data. The reproduction demodulating unit ex403 amplifies a reproduction signal obtained by electrically detecting the reflected light from the recording surface using a photo detector included in the optical head ex401, and demodulates the reproduction signal by separating a signal component recorded on the recording medium ex215 to reproduce the necessary information. The buffer ex404 temporarily holds the information to be recorded on the recording medium ex215 and the information reproduced from the recording medium ex215. The disk motor ex405 rotates the recording medium ex215. The servo control unit ex406 moves the optical head ex401 to a predetermined information track while controlling the rotation drive of the disk motor ex405 so as to follow the laser spot. The system control unit ex407 controls overall the information reproducing/recording unit ex400. The reading and writing processes can be implemented by the system control unit ex407 using various information stored in the buffer ex404 and generating and adding new information as necessary, and by the modulation

recording unit ex402, the reproduction demodulating unit ex403, and the servo control unit ex406 that record and reproduce information through the optical head ex401 while being operated in a coordinated manner. The system control unit ex407 includes, for example, a microprocessor, and executes processing by causing a computer to execute a program for read and write.

[0307]

Although the optical head ex401 irradiates a laser spot in the description, it may perform high-density recording using near field light.

[0308]

FIG. 33 illustrates the recording medium ex215 that is the optical disk. On the recording surface of the recording medium ex215, guide grooves are spirally formed, and an information track ex230 records, in advance, address information indicating an absolute position on the disk according to change in a shape of the guide grooves. The address information includes information for determining positions of recording blocks ex231 that are a unit for recording data. Reproducing the information track ex230 and reading the address information in an apparatus that records and reproduces data can lead to determination of the positions of the recording blocks. Furthermore, the recording medium ex215 includes a data recording area ex233, an inner circumference area ex232, and an outer circumference area ex234. The data recording area ex233 is an area for use in recording the user data. The inner circumference area ex232 and the outer circumference area ex234 that are inside and outside of the data recording area ex233, respectively are for specific use except for recording the user data. The information reproducing/recording unit 400 reads and writes coded audio, coded video data, or multiplexed data obtained by multiplexing the coded audio and video data, from and on the data recording area ex233 of the recording medium ex215.

[0309]

Although an optical disk having a layer, such as a DVD and a BD is described as an example in the description, the optical disk is

not limited to such, and may be an optical disk having a multilayer structure and capable of being recorded on a part other than the surface. Furthermore, the optical disk may have a structure for multidimensional recording/reproduction, such as recording of information using light of colors with different wavelengths in the same portion of the optical disk and for recording information having different layers from various angles.

[0310]

Furthermore, a car ex210 having an antenna ex205 can receive data from the satellite ex202 and others, and reproduce video on a display device such as a car navigation system ex211 set in the car ex210, in the digital broadcasting system ex200. Here, a configuration of the car navigation system ex211 will be a configuration, for example, including a GPS receiving unit from the configuration illustrated in FIG. 31. The same will be true for the configuration of the computer ex111, the cellular phone ex114, and others.

[0311]

FIG. 34A illustrates the cellular phone ex114 that uses the moving picture coding method and the moving picture decoding method described in embodiments. The cellular phone ex114 includes: an antenna ex350 for transmitting and receiving radio waves through the base station ex110; a camera unit ex365 capable of capturing moving and still images; and a display unit ex358 such as a liquid crystal display for displaying the data such as decoded video captured by the camera unit ex365 or received by the antenna ex350. The cellular phone ex114 further includes: a main body unit including an operation key unit ex366; an audio output unit ex357 such as a speaker for output of audio; an audio input unit ex356 such as a microphone for input of audio; a memory unit ex367 for storing captured video or still pictures, recorded audio, coded or decoded data of the received video, the still pictures, e-mails, or others; and a slot unit ex364 that is an interface unit for a recording medium that stores data in the same manner as the memory unit ex367.

[0312]

Next, an example of a configuration of the cellular phone ex114 will be described with reference to FIG. 34B. In the cellular phone ex114, a main control unit ex360 designed to control overall each unit of the main body including the display unit ex358 as well as the operation key unit ex366 is connected mutually, via a synchronous bus ex370, to a power supply circuit unit ex361, an operation input control unit ex362, a video signal processing unit ex355, a camera interface unit ex363, a liquid crystal display (LCD) control unit ex359, a modulation/demodulation unit ex352, a multiplexing/demultiplexing unit ex353, an audio signal processing unit ex354, the slot unit ex364, and the memory unit ex367.

[0313]

When a call-end key or a power key is turned ON by a user's operation, the power supply circuit unit ex361 supplies the respective units with power from a battery pack so as to activate the cell phone ex114.

[0314]

In the cellular phone ex114, the audio signal processing unit ex354 converts the audio signals collected by the audio input unit ex356 in voice conversation mode into digital audio signals under the control of the main control unit ex360 including a CPU, ROM, and RAM. Then, the modulation/demodulation unit ex352 performs spread spectrum processing on the digital audio signals, and the transmitting and receiving unit ex351 performs digital-to-analog conversion and frequency conversion on the data, so as to transmit the resulting data via the antenna ex350. Also, in the cellular phone ex114, the transmitting and receiving unit ex351 amplifies the data received by the antenna ex350 in voice conversation mode and performs frequency conversion and the analog-to-digital conversion on the data. Then, the modulation/demodulation unit ex352 performs inverse spread spectrum processing on the data, and the audio signal processing unit ex354 converts it into analog audio signals, so as to output them via the audio output unit ex357.

[0315]

Furthermore, when an e-mail in data communication mode is

transmitted, text data of the e-mail inputted by operating the operation key unit ex366 and others of the main body is sent out to the main control unit ex360 via the operation input control unit ex362. The main control unit ex360 causes the modulation/demodulation unit ex352 to perform spread spectrum processing on the text data, and the transmitting and receiving unit ex351 performs the digital-to-analog conversion and the frequency conversion on the resulting data to transmit the data to the base station ex110 via the antenna ex350. When an e-mail is received, processing that is approximately inverse to the processing for transmitting an e-mail is performed on the received data, and the resulting data is provided to the display unit ex358.

[0316]

When video, still images, or video and audio in data communication mode is or are transmitted, the video signal processing unit ex355 compresses and codes video signals supplied from the camera unit ex365 using the moving picture coding method shown in each of embodiments, and transmits the coded video data to the multiplexing/demultiplexing unit ex353. In contrast, during when the camera unit ex365 captures video, still images, and others, the audio signal processing unit ex354 codes audio signals collected by the audio input unit ex356, and transmits the coded audio data to the multiplexing/demultiplexing unit ex353.

[0317]

The multiplexing/demultiplexing unit ex353 multiplexes the coded video data supplied from the video signal processing unit ex355 and the coded audio data supplied from the audio signal processing unit ex354, using a predetermined method. Then, the modulation/demodulation unit (modulation/demodulation circuit unit) ex352 performs spread spectrum processing on the multiplexed data, and the transmitting and receiving unit ex351 performs digital-to-analog conversion and frequency conversion on the data so as to transmit the resulting data via the antenna ex350.

[0318]

When receiving data of a video file which is linked to a Web

page and others in data communication mode or when receiving an e-mail with video and/or audio attached, in order to decode the multiplexed data received via the antenna ex350, the multiplexing/demultiplexing unit ex353 demultiplexes the multiplexed data into a video data bit stream and an audio data bit stream, and supplies the video signal processing unit ex355 with the coded video data and the audio signal processing unit ex354 with the coded audio data, through the synchronous bus ex370. The video signal processing unit ex355 decodes the video signal using a moving picture decoding method corresponding to the moving picture coding method shown in each of embodiments (i.e., functions as the image decoding apparatus according to the aspect of the present invention), and then the display unit ex358 displays, for instance, the video and still images included in the video file linked to the Web page via the LCD control unit ex359. Furthermore, the audio signal processing unit ex354 decodes the audio signal, and the audio output unit ex357 provides the audio.

[0319]

Furthermore, similarly to the television ex300, a terminal such as the cellular phone ex114 probably has 3 types of implementation configurations including not only (i) a transmitting and receiving terminal including both a coding apparatus and a decoding apparatus, but also (ii) a transmitting terminal including only a coding apparatus and (iii) a receiving terminal including only a decoding apparatus. Although the digital broadcasting system ex200 receives and transmits the multiplexed data obtained by multiplexing audio data onto video data in the description, the multiplexed data may be data obtained by multiplexing not audio data but character data related to video onto video data, and may be not multiplexed data but video data itself.

[0320]

As such, the moving picture coding method and the moving picture decoding method in each of embodiments can be used in any of the devices and systems described. Thus, the advantages described in each of embodiments can be obtained.

[0321]

Furthermore, the present invention is not limited to each of embodiments, and various modifications and revisions can be made in any of the embodiments in the present invention.

[0322]

(Sixth Embodiment)

Video data can be generated by switching, as necessary, between (i) the moving picture coding method or the moving picture coding apparatus shown in each of embodiments and (ii) a moving picture coding method or a moving picture coding apparatus in conformity with a different standard, such as MPEG-2, MPEG-4 AVC, and VC-1.

[0323]

Here, when a plurality of video data that conforms to the different standards is generated and is then decoded, the decoding methods need to be selected to conform to the different standards. However, since to which standard each of the plurality of the video data to be decoded conforms cannot be detected, there is a problem that an appropriate decoding method cannot be selected.

[0324]

In order to solve the problem, multiplexed data obtained by multiplexing audio data and others onto video data has a structure including identification information indicating to which standard the video data conforms. The specific structure of the multiplexed data including the video data generated in the moving picture coding method and by the moving picture coding apparatus shown in each of embodiments will be hereinafter described. The multiplexed data is a digital stream in the MPEG-2 Transport Stream format.

[0325]

FIG. 35 illustrates a structure of the multiplexed data. As illustrated in FIG. 35, the multiplexed data can be obtained by multiplexing at least one of a video stream, an audio stream, a presentation graphics stream (PG), and an interactive graphics stream. The video stream represents primary video and secondary video of a movie, the audio stream (IG) represents a primary audio

part and a secondary audio part to be mixed with the primary audio part, and the presentation graphics stream represents subtitles of the movie. Here, the primary video is normal video to be displayed on a screen, and the secondary video is video to be displayed on a smaller window in the primary video. Furthermore, the interactive graphics stream represents an interactive screen to be generated by arranging the GUI components on a screen. The video stream is coded in the moving picture coding method or by the moving picture coding apparatus shown in each of embodiments, or in a moving picture coding method or by a moving picture coding apparatus in conformity with a conventional standard, such as MPEG-2, MPEG-4 AVC, and VC-1. The audio stream is coded in accordance with a standard, such as Dolby-AC-3, Dolby Digital Plus, MLP, DTS, DTS-HD, and linear PCM.

[0326]

Each stream included in the multiplexed data is identified by PID. For example, 0x1011 is allocated to the video stream to be used for video of a movie, 0x1100 to 0x111F are allocated to the audio streams, 0x1200 to 0x121F are allocated to the presentation graphics streams, 0x1400 to 0x141F are allocated to the interactive graphics streams, 0x1B00 to 0x1B1F are allocated to the video streams to be used for secondary video of the movie, and 0x1A00 to 0x1A1F are allocated to the audio streams to be used for the secondary audio to be mixed with the primary audio.

[0327]

FIG. 36 schematically illustrates how data is multiplexed. First, a video stream ex235 composed of video frames and an audio stream ex238 composed of audio frames are transformed into a stream of PES packets ex236 and a stream of PES packets ex239, and further into TS packets ex237 and TS packets ex240, respectively. Similarly, data of a presentation graphics stream ex241 and data of an interactive graphics stream ex244 are transformed into a stream of PES packets ex242 and a stream of PES packets ex245, and further into TS packets ex243 and TS packets ex246, respectively. These TS packets are multiplexed into a stream to obtain multiplexed data

ex247.

[0328]

FIG. 37 illustrates how a video stream is stored in a stream of PES packets in more detail. The first bar in FIG. 37 shows a video frame stream in a video stream. The second bar shows the stream of PES packets. As indicated by arrows denoted as yy1, yy2, yy3, and yy4 in FIG. 37, the video stream is divided into pictures as I-pictures, B-pictures, and P-pictures each of which is a video presentation unit, and the pictures are stored in a payload of each of the PES packets. Each of the PES packets has a PES header, and the PES header stores a Presentation Time-Stamp (PTS) indicating a display time of the picture, and a Decoding Time-Stamp (DTS) indicating a decoding time of the picture.

[0329]

FIG. 38 illustrates a format of TS packets to be finally written on the multiplexed data. Each of the TS packets is a 188-byte fixed length packet including a 4-byte TS header having information, such as a PID for identifying a stream and a 184-byte TS payload for storing data. The PES packets are divided, and stored in the TS payloads, respectively. When a BD ROM is used, each of the TS packets is given a 4-byte TP_Extra_Header, thus resulting in 192-byte source packets. The source packets are written on the multiplexed data. The TP_Extra_Header stores information such as an Arrival_Time_Stamp (ATS). The ATS shows a transfer start time at which each of the TS packets is to be transferred to a PID filter. The source packets are arranged in the multiplexed data as shown at the bottom of FIG. 38. The numbers incrementing from the head of the multiplexed data are called source packet numbers (SPNs).

[0330]

Each of the TS packets included in the multiplexed data includes not only streams of audio, video, subtitles and others, but also a Program Association Table (PAT), a Program Map Table (PMT), and a Program Clock Reference (PCR). The PAT shows what a PID in a PMT used in the multiplexed data indicates, and a PID of the PAT itself is registered as zero. The PMT stores PIDs of the streams of

video, audio, subtitles and others included in the multiplexed data, and attribute information of the streams corresponding to the PIDs. The PMT also has various descriptors relating to the multiplexed data. The descriptors have information such as copy control information showing whether copying of the multiplexed data is permitted or not. The PCR stores STC time information corresponding to an ATS showing when the PCR packet is transferred to a decoder, in order to achieve synchronization between an Arrival Time Clock (ATC) that is a time axis of ATSs, and an System Time Clock (STC) that is a time axis of PTSs and DTSs.

[0331]

FIG. 39 illustrates the data structure of the PMT in detail. A PMT header is disposed at the top of the PMT. The PMT header describes the length of data included in the PMT and others. A plurality of descriptors relating to the multiplexed data is disposed after the PMT header. Information such as the copy control information is described in the descriptors. After the descriptors, a plurality of pieces of stream information relating to the streams included in the multiplexed data is disposed. Each piece of stream information includes stream descriptors each describing information, such as a stream type for identifying a compression codec of a stream, a stream PID, and stream attribute information (such as a frame rate or an aspect ratio). The stream descriptors are equal in number to the number of streams in the multiplexed data.

[0332]

When the multiplexed data is recorded on a recording medium and others, it is recorded together with multiplexed data information files.

[0333]

Each of the multiplexed data information files is management information of the multiplexed data as shown in FIG. 40. The multiplexed data information files are in one to one correspondence with the multiplexed data, and each of the files includes multiplexed data information, stream attribute information, and an entry map.

[0334]

As illustrated in FIG. 40, the multiplexed data information includes a system rate, a reproduction start time, and a reproduction end time. The system rate indicates the maximum transfer rate at which a system target decoder to be described later transfers the multiplexed data to a PID filter. The intervals of the ATSs included in the multiplexed data are set to not higher than a system rate. The reproduction start time indicates a PTS in a video frame at the head of the multiplexed data. An interval of one frame is added to a PTS in a video frame at the end of the multiplexed data, and the PTS is set to the reproduction end time.

[0335]

As shown in FIG. 41, a piece of attribute information is registered in the stream attribute information, for each PID of each stream included in the multiplexed data. Each piece of attribute information has different information depending on whether the corresponding stream is a video stream, an audio stream, a presentation graphics stream, or an interactive graphics stream. Each piece of video stream attribute information carries information including what kind of compression codec is used for compressing the video stream, and the resolution, aspect ratio and frame rate of the pieces of picture data that is included in the video stream. Each piece of audio stream attribute information carries information including what kind of compression codec is used for compressing the audio stream, how many channels are included in the audio stream, which language the audio stream supports, and how high the sampling frequency is. The video stream attribute information and the audio stream attribute information are used for initialization of a decoder before the player plays back the information.

[0336]

In the present embodiment, the multiplexed data to be used is of a stream type included in the PMT. Furthermore, when the multiplexed data is recorded on a recording medium, the video stream attribute information included in the multiplexed data information is used. More specifically, the moving picture coding method or the moving picture coding apparatus described in each of

embodiments includes a step or a unit for allocating unique information indicating video data generated by the moving picture coding method or the moving picture coding apparatus in each of embodiments, to the stream type included in the PMT or the video stream attribute information. With the configuration, the video data generated by the moving picture coding method or the moving picture coding apparatus described in each of embodiments can be distinguished from video data that conforms to another standard.

[0337]

Furthermore, FIG. 42 illustrates steps of the moving picture decoding method according to the present embodiment. In Step exS100, the stream type included in the PMT or the video stream attribute information included in the multiplexed data information is obtained from the multiplexed data. Next, in Step exS101, it is determined whether or not the stream type or the video stream attribute information indicates that the multiplexed data is generated by the moving picture coding method or the moving picture coding apparatus in each of embodiments. When it is determined that the stream type or the video stream attribute information indicates that the multiplexed data is generated by the moving picture coding method or the moving picture coding apparatus in each of embodiments, in Step exS102, decoding is performed by the moving picture decoding method in each of embodiments. Furthermore, when the stream type or the video stream attribute information indicates conformance to the conventional standards, such as MPEG-2, MPEG-4 AVC, and VC-1, in Step exS103, decoding is performed by a moving picture decoding method in conformity with the conventional standards.

[0338]

As such, allocating a new unique value to the stream type or the video stream attribute information enables determination whether or not the moving picture decoding method or the moving picture decoding apparatus that is described in each of embodiments can perform decoding. Even when multiplexed data that conforms to a different standard is input, an appropriate decoding method or

apparatus can be selected. Thus, it becomes possible to decode information without any error. Furthermore, the moving picture coding method or apparatus, or the moving picture decoding method or apparatus in the present embodiment can be used in the devices and systems described above.

[0339]

(Seventh Embodiment)

Each of the moving picture coding method, the moving picture coding apparatus, the moving picture decoding method, and the moving picture decoding apparatus in each of embodiments is typically achieved in the form of an integrated circuit or a Large Scale Integrated (LSI) circuit. As an example of the LSI, FIG. 43 illustrates a configuration of the LSI ex500 that is made into one chip. The LSI ex500 includes elements ex501, ex502, ex503, ex504, ex505, ex506, ex507, ex508, and ex509 to be described below, and the elements are connected to each other through a bus ex510. The power supply circuit unit ex505 is activated by supplying each of the elements with power when the power supply circuit unit ex505 is turned on.

[0340]

For example, when coding is performed, the LSI ex500 receives an AV signal from a microphone ex117, a camera ex113, and others through an AV IO ex509 under control of a control unit ex501 including a CPU ex502, a memory controller ex503, a stream controller ex504, and a driving frequency control unit ex512. The received AV signal is temporarily stored in an external memory ex511, such as an SDRAM. Under control of the control unit ex501, the stored data is segmented into data portions according to the processing amount and speed to be transmitted to a signal processing unit ex507. Then, the signal processing unit ex507 codes an audio signal and/or a video signal. Here, the coding of the video signal is the coding described in each of embodiments. Furthermore, the signal processing unit ex507 sometimes multiplexes the coded audio data and the coded video data, and a stream IO ex506 provides the multiplexed data outside. The

provided multiplexed data is transmitted to the base station ex107, or written on the recording medium ex215. When data sets are multiplexed, the data should be temporarily stored in the buffer ex508 so that the data sets are synchronized with each other.

[0341]

Although the memory ex511 is an element outside the LSI ex500, it may be included in the LSI ex500. The buffer ex508 is not limited to one buffer, but may be composed of buffers. Furthermore, the LSI ex500 may be made into one chip or a plurality of chips.

[0342]

Furthermore, although the control unit ex501 includes the CPU ex502, the memory controller ex503, the stream controller ex504, the driving frequency control unit ex512, the configuration of the control unit ex501 is not limited to such. For example, the signal processing unit ex507 may further include a CPU. Inclusion of another CPU in the signal processing unit ex507 can improve the processing speed. Furthermore, as another example, the CPU ex502 may serve as or be a part of the signal processing unit ex507, and, for example, may include an audio signal processing unit. In such a case, the control unit ex501 includes the signal processing unit ex507 or the CPU ex502 including a part of the signal processing unit ex507.

[0343]

The name used here is LSI, but it may also be called IC, system LSI, super LSI, or ultra LSI depending on the degree of integration.

[0344]

Moreover, ways to achieve integration are not limited to the LSI, and a special circuit or a general purpose processor and so forth can also achieve the integration. Field Programmable Gate Array (FPGA) that can be programmed after manufacturing LSIs or a reconfigurable processor that allows re-configuration of the connection or configuration of an LSI can be used for the same purpose.

[0345]

In the future, with advancement in semiconductor technology,

a brand-new technology may replace LSI. The functional blocks can be integrated using such a technology. The possibility is that the present invention is applied to biotechnology.

[0346]

(Eighth Embodiment)

When video data generated in the moving picture coding method or by the moving picture coding apparatus described in each of embodiments is decoded, compared to when video data that conforms to a conventional standard, such as MPEG-2, MPEG-4 AVC, and VC-1 is decoded, the processing amount probably increases. Thus, the LSI ex500 needs to be set to a driving frequency higher than that of the CPU ex502 to be used when video data in conformity with the conventional standard is decoded. However, when the driving frequency is set higher, there is a problem that the power consumption increases.

[0347]

In order to solve the problem, the moving picture decoding apparatus, such as the television ex300 and the LSI ex500 is configured to determine to which standard the video data conforms, and switch between the driving frequencies according to the determined standard. FIG. 44 illustrates a configuration ex800 in the present embodiment. A driving frequency switching unit ex803 sets a driving frequency to a higher driving frequency when video data is generated by the moving picture coding method or the moving picture coding apparatus described in each of embodiments. Then, the driving frequency switching unit ex803 instructs a decoding processing unit ex801 that executes the moving picture decoding method described in each of embodiments to decode the video data. When the video data conforms to the conventional standard, the driving frequency switching unit ex803 sets a driving frequency to a lower driving frequency than that of the video data generated by the moving picture coding method or the moving picture coding apparatus described in each of embodiments. Then, the driving frequency switching unit ex803 instructs the decoding processing unit ex802 that conforms to the conventional standard to decode the

video data.

[0348]

More specifically, the driving frequency switching unit ex803 includes the CPU ex502 and the driving frequency control unit ex512 in FIG. 43. Here, each of the decoding processing unit ex801 that executes the moving picture decoding method described in each of embodiments and the decoding processing unit ex802 that conforms to the conventional standard corresponds to the signal processing unit ex507 in FIG. 43. The CPU ex502 determines to which standard the video data conforms. Then, the driving frequency control unit ex512 determines a driving frequency based on a signal from the CPU ex502. Furthermore, the signal processing unit ex507 decodes the video data based on the signal from the CPU ex502. For example, the identification information described in the sixth embodiment is probably used for identifying the video data. The identification information is not limited to the one described in the sixth embodiment but may be any information as long as the information indicates to which standard the video data conforms. For example, when which standard video data conforms to can be determined based on an external signal for determining that the video data is used for a television or a disk, etc., the determination may be made based on such an external signal. Furthermore, the CPU ex502 selects a driving frequency based on, for example, a look-up table in which the standards of the video data are associated with the driving frequencies as shown in FIG. 46. The driving frequency can be selected by storing the look-up table in the buffer ex508 and in an internal memory of an LSI, and with reference to the look-up table by the CPU ex502.

[0349]

FIG. 45 illustrates steps for executing a method in the present embodiment. First, in Step exS200, the signal processing unit ex507 obtains identification information from the multiplexed data. Next, in Step exS201, the CPU ex502 determines whether or not the video data is generated by the coding method and the coding apparatus described in each of embodiments based on the

identification information. When the video data is generated by the moving picture coding method and the moving picture coding apparatus described in each of embodiments, in Step exS202, the CPU ex502 transmits a signal for setting the driving frequency to a higher driving frequency to the driving frequency control unit ex512. Then, the driving frequency control unit ex512 sets the driving frequency to the higher driving frequency. On the other hand, when the identification information indicates that the video data conforms to the conventional standard, such as MPEG-2, MPEG-4 AVC, and VC-1, in Step exS203, the CPU ex502 transmits a signal for setting the driving frequency to a lower driving frequency to the driving frequency control unit ex512. Then, the driving frequency control unit ex512 sets the driving frequency to the lower driving frequency than that in the case where the video data is generated by the moving picture coding method and the moving picture coding apparatus described in each of embodiments.

[0350]

Furthermore, along with the switching of the driving frequencies, the power conservation effect can be improved by changing the voltage to be applied to the LSI ex500 or an apparatus including the LSI ex500. For example, when the driving frequency is set lower, the voltage to be applied to the LSI ex500 or the apparatus including the LSI ex500 is probably set to a voltage lower than that in the case where the driving frequency is set higher.

[0351]

Furthermore, when the processing amount for decoding is larger, the driving frequency may be set higher, and when the processing amount for decoding is smaller, the driving frequency may be set lower as the method for setting the driving frequency. Thus, the setting method is not limited to the ones described above. For example, when the processing amount for decoding video data in conformity with MPEG-4 AVC is larger than the processing amount for decoding video data generated by the moving picture coding method and the moving picture coding apparatus described in each of embodiments, the driving frequency is probably set in reverse order

to the setting described above.

[0352]

Furthermore, the method for setting the driving frequency is not limited to the method for setting the driving frequency lower. For example, when the identification information indicates that the video data is generated by the moving picture coding method and the moving picture coding apparatus described in each of embodiments, the voltage to be applied to the LSI ex500 or the apparatus including the LSI ex500 is probably set higher. When the identification information indicates that the video data conforms to the conventional standard, such as MPEG-2, MPEG-4 AVC, and VC-1, the voltage to be applied to the LSI ex500 or the apparatus including the LSI ex500 is probably set lower. As another example, when the identification information indicates that the video data is generated by the moving picture coding method and the moving picture coding apparatus described in each of embodiments, the driving of the CPU ex502 does not probably have to be suspended. When the identification information indicates that the video data conforms to the conventional standard, such as MPEG-2, MPEG-4 AVC, and VC-1, the driving of the CPU ex502 is probably suspended at a given time because the CPU ex502 has extra processing capacity. Even when the identification information indicates that the video data is generated by the moving picture coding method and the moving picture coding apparatus described in each of embodiments, in the case where the CPU ex502 has extra processing capacity, the driving of the CPU ex502 is probably suspended at a given time. In such a case, the suspending time is probably set shorter than that in the case where when the identification information indicates that the video data conforms to the conventional standard, such as MPEG-2, MPEG-4 AVC, and VC-1.

[0353]

Accordingly, the power conservation effect can be improved by switching between the driving frequencies in accordance with the standard to which the video data conforms. Furthermore, when the LSI ex500 or the apparatus including the LSI ex500 is driven using a

battery, the battery life can be extended with the power conservation effect.

[0354]

(Ninth Embodiment)

There are cases where a plurality of video data that conforms to different standards, is provided to the devices and systems, such as a television and a cellular phone. In order to enable decoding the plurality of video data that conforms to the different standards, the signal processing unit ex507 of the LSI ex500 needs to conform to the different standards. However, the problems of increase in the scale of the circuit of the LSI ex500 and increase in the cost arise with the individual use of the signal processing units ex507 that conform to the respective standards.

[0355]

In order to solve the problem, what is conceived is a configuration in which the decoding processing unit for implementing the moving picture decoding method described in each of embodiments and the decoding processing unit that conforms to the conventional standard, such as MPEG-2, MPEG-4 AVC, and VC-1 are partly shared. Ex900 in FIG. 47A shows an example of the configuration. For example, the moving picture decoding method described in each of embodiments and the moving picture decoding method that conforms to MPEG-4 AVC have, partly in common, the details of processing, such as entropy coding, inverse quantization, deblocking filtering, and motion compensated prediction. The details of processing to be shared probably include use of a decoding processing unit ex902 that conforms to MPEG-4 AVC. In contrast, a dedicated decoding processing unit ex901 is probably used for other processing unique to an aspect of the present invention. Since the aspect of the present invention is characterized by frame memory control in particular, for example, the dedicated decoding processing unit ex901 is used for frame memory control. Otherwise, the decoding processing unit is probably shared for one of the entropy decoding, deblocking filtering, and motion compensation, or all of the processing. The decoding processing unit for implementing the

moving picture decoding method described in each of embodiments may be shared for the processing to be shared, and a dedicated decoding processing unit may be used for processing unique to that of MPEG-4 AVC.

[0356]

Furthermore, ex1000 in FIG. 47B shows another example in that processing is partly shared. This example uses a configuration including a dedicated decoding processing unit ex1001 that supports the processing unique to an aspect of the present invention, a dedicated decoding processing unit ex1002 that supports the processing unique to another conventional standard, and a decoding processing unit ex1003 that supports processing to be shared between the moving picture decoding method according to the aspect of the present invention and the conventional moving picture decoding method. Here, the dedicated decoding processing units ex1001 and ex1002 are not necessarily specialized for the processing according to the aspect of the present invention and the processing of the conventional standard, respectively, and may be the ones capable of implementing general processing. Furthermore, the configuration of the present embodiment can be implemented by the LSI ex500.

[0357]

As such, reducing the scale of the circuit of an LSI and reducing the cost are possible by sharing the decoding processing unit for the processing to be shared between the moving picture decoding method according to the aspect of the present invention and the moving picture decoding method in conformity with the conventional standard.

[0358]

Although the image coding apparatus and the image decoding apparatus according to one or more aspects have been described above based on the embodiments, the present invention is not limited to these embodiments. Those skilled in the art will readily appreciate that the appended Claims are of a scope intended to cover and encompass not only the particular embodiments disclosed, but

also equivalent structures, methods, and/or uses which are obtained by making various modifications in the embodiments and by arbitrarily combining the structural elements in different embodiments, without materially departing from the principles and spirit of the present invention

[Industrial Applicability]

[0359]

The present invention is applicable to image coding methods, image decoding methods, image coding apparatuses, and image decoding apparatuses. The present invention can be used for information display devices and imaging devices with high resolution which include televisions, digital video recorders, car navigation systems, cellular phones, digital cameras, and digital video cameras, including the image coding apparatus.

[Reference Signs List]

[0360]

100 Image coding apparatus
101 Subtractor
102 Orthogonal transformation unit
103 Quantization unit
104, 204 Inverse quantization unit
105, 205 Inverse orthogonal transformation unit
106, 206 Adder
107, 207 Block memory
108, 208 Frame memory
109, 209 Intra prediction unit
110, 210 Inter prediction unit
111, 211 Picture type determination unit
112 Variable-length coding unit
113, 213 Frame memory control unit
120 Input image signal
121, 125, 225 Prediction error data
122, 124, 224 Frequency coefficient
123, 223 Quantized value
126, 127, 128, 226, 227, 228 Decoded image data

129, 130, 131, 229, 230, 231 Prediction image data

132, 132A, 132B, 132C, 132D, 132E, 132F, 232, 500 Coded bitstream

133, 233 Frame memory control information

200 Image decoding apparatus

212 Variable-length decoding unit

301, 501 Sequence parameter set (SPS)

302, 302B, 302D, 502 Picture parameter set (PPS)

303, 503 Picture data

311 SPS identifier

312, 512 Buffer description defining information

313 Reference list description defining information

314 The number of buffer descriptions

315, 515 Buffer description

316 Reference list description

321 SPS selecting information

322, 522 PPS identifier

323, 323D, 523 Buffer description updating information

324, 324D Reference list description updating information

325 Number-of-updates information

326 Updating information

327 Buffer description selecting information

328 Buffer description modifying information

329 Reference list description defining information

331, 331A, 331D Picture header

332 Picture data part

333, 533 PPS selecting information

334 Buffer description selecting information

335, 535 Slice data

341, 341E, 341F, 541 Slice header

342, 542 Slice data part

343, 543 CU data

351 Buffer description selecting information

352 Buffer description modifying flag

515A Buffer element

CLAIMS

[Claim 1]

An image coding method for generating a coded bitstream by coding an image using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, the image coding method comprising:

writing, into a sequence parameter set, buffer description defining information for defining a plurality of buffer descriptions;

writing, into the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions;

selecting, for each processing unit that is a picture or a slice, one of the buffer descriptions, and writing, into a first header of the processing unit, buffer description selecting information for specifying the selected buffer description, the first header being included in the coded bitstream; and

coding the processing unit using the selected buffer description and one of the reference list descriptions which corresponds to the selected buffer description.

[Claim 2]

The image coding method according to Claim 1, further comprising:

modifying at least one of the buffer descriptions, and writing, into a second header of the processing unit, buffer description updating information for indicating details of the modification; and

writing, into the second header, reference list description updating information for defining a reference list description which corresponds to the modified buffer description,

wherein, in the coding, the processing unit is coded using (i) the modified buffer description and (ii) the reference list description which corresponds to the modified buffer description.

[Claim 3]

The image coding method according to Claim 2,

wherein the second header is a picture parameter set,

the first header is a picture header or a slice header, and

in the selecting, when at least one of the buffer descriptions is modified, one buffer description is selected out of a plurality of buffer descriptions including the modified buffer description.

[Claim 4]

The image coding method according to Claim 2,

wherein the first header and the second header are a slice header, and

in the modifying, the selected buffer description is modified as the at least one of the buffer descriptions.

[Claim 5]

The image coding method according to Claim 2,

wherein the first header and the second header are a picture parameter set,

in the modifying and the writing, the selected buffer description is modified as the at least one of the buffer descriptions, and the buffer description updating information is written into a first picture parameter set that is one of picture parameter sets included in the coded bitstream,

in the writing of reference list description updating information, the reference list description updating information is written into the first picture parameter set, and

in the selecting and the writing, the buffer description selecting information is written into the first picture parameter set, and picture parameter set selecting information for specifying the first picture parameter set out of the picture parameter sets is written into a header of the processing unit.

[Claim 6]

The image coding method according to any one of Claims 1 to

5,

wherein the reference list description defining information includes:

a first reordering flag for indicating whether or not reordering of a reference list is performed; and

first reference list reordering information for indicating details of the reordering, and

the writing of reference list description defining information includes:

writing the first reordering flag into the sequence parameter set;

judging using the first reordering flag whether or not the reordering of the reference list is performed; and

writing the first reference list reordering information into the sequence parameter set when the reordering of the reference list is performed.

[Claim 7]

The image coding method according to Claim 2,

wherein the reference list description updating information includes:

a reordering flag for indicating whether or not reordering of a reference list is performed; and

reference list reordering information for indicating details of the reordering, and

the writing of reference list description updating information includes:

writing the reordering flag into the second header;

judging using the reordering flag whether or not the reordering of the reference list is performed; and

writing the reference list reordering information into the second header when the reordering of the reference list is performed.

[Claim 8]

The image coding method according to Claim 6,

wherein the coding includes:

constructing, according to a predetermined default reference list description, a reference list including picture identifiers of all pictures indicated in the selected buffer description;

judging using the first reordering flag whether or not reordering of the constructed reference list is performed;

reordering, according to the first reference list reordering information, the picture identifiers in the reference list when the reordering of the reference list is performed; and

coding a current slice using the reordered reference list.

[Claim 9]

The image coding method according to Claim 6,

wherein the coding includes:

constructing, according to a predetermined default reference list description, a reference list including picture identifiers of all pictures indicated in the selected buffer description;

writing, into a slice header of a current slice, an update flag for indicating whether or not the reference list description which corresponds to the selected buffer description is updated;

judging using the update flag whether or not the reference list description is updated;

writing, into the slice header, a second reordering flag for indicating whether or not reordering of the reference list is performed when the reference list description is updated;

judging using the second reordering flag whether or not the reordering of the reference list is performed;

writing, into the slice header, second reference list reordering information for indicating details of the reordering of the reference list when the reordering is performed;

reordering the picture identifiers in the reference list according to the second reference list reordering information;

judging using the first reordering flag whether or not the reordering of the reference list is performed when the reference list description is not updated;

reordering, according to the first reference list reordering information, the picture identifiers in the reference list when the reordering of the reference list is performed; and

coding the current slice using the reordered reference list.

[Claim 10]

An image decoding method for decoding a coded bitstream using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, the image decoding method comprising:

obtaining, from a sequence parameter set corresponding to the coded bitstream, buffer description defining information for defining a plurality of buffer descriptions;

obtaining, from the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions;

obtaining, from a first header of a processing unit that is a picture or a slice, buffer description selecting information for specifying one of the buffer descriptions, the first header being included in the coded bitstream; and

decoding the processing unit using (i) a buffer description specified in the buffer description selecting information and (ii) one of the reference list descriptions which corresponds to the specified buffer description.

[Claim 11]

The image decoding method according to Claim 10, further comprising:

obtaining, from a second header of the processing unit, buffer description updating information for indicating details of modification of at least one of the buffer descriptions, the second header being included in the coded bitstream; and

obtaining, from the second header, reference list description updating information for defining a reference list description which corresponds to the modified buffer description,

wherein, in the decoding, the at least one of the buffer descriptions is modified according to the details of modification indicated in the buffer description updating information, and the processing unit is decoded using (i) the modified buffer description and (ii) the reference list description which corresponds to the modified buffer description.

[Claim 12]

The image decoding method according to Claim 11,

wherein the second header is a picture parameter set, and

the first header is a picture header or a slice header.

[Claim 13]

The image decoding method according to Claim 11,

wherein the first header and the second header are a slice header.

[Claim 14]

The image decoding method according to Claim 11,

wherein the first header and the second header are a picture parameter set, and

in the obtaining of buffer description selecting information, picture parameter set selecting information for specifying one of picture parameter sets included in the coded bitstream is obtained from a header of the processing unit, and the buffer description selecting information is obtained from a picture parameter set specified in the picture parameter set selecting information.

[Claim 15]

The image decoding method according to any one of Claims 10 to 14,

wherein the reference list description defining information includes:

a first reordering flag for indicating whether or not reordering of a reference list is performed; and

first reference list reordering information for indicating details of the reordering, and

the obtaining of reference list description defining information includes:

obtaining the first reordering flag;

judging using the first reordering flag whether or not the reordering of the reference list is performed; and

obtaining the first reference list reordering information when the reordering of the reference list is performed.

[Claim 16]

The image decoding method according to Claim 11,

wherein the reference list description updating information includes:

a reordering flag for indicating whether or not reordering of a reference list is performed; and

reference list reordering information for indicating details of the reordering, and

the obtaining of reference list description updating information includes:

obtaining the reordering flag from the second header;

judging using the reordering flag whether or not the reordering of the reference list is performed; and

obtaining, from the second header, the reference list reordering information when the reordering of the reference list is performed.

[Claim 17]

The image decoding method according to Claim 15,

wherein the decoding includes:

constructing, according to a predetermined default reference list description, a reference list including picture identifiers of all pictures indicated in the selected buffer description;

judging using the first reordering flag whether or not reordering of the constructed reference list is performed;

reordering, according to the first reference list reordering information, the picture identifiers in the reference list when the reordering of the reference list is performed; and

decoding a current slice using the reordered reference list.

[Claim 18]

The image decoding method according to Claim 15,

wherein the decoding includes:

constructing, according to a predetermined default reference list description, a reference list including picture identifiers of all pictures indicated in the selected buffer description;

obtaining, from a slice header of a current slice, an update flag for indicating whether or not the reference list description which corresponds to the selected buffer description is updated;

judging using the update flag whether or not the reference list description is updated;

obtaining, from the slice header, a second reordering flag for indicating whether or not reordering of the reference list is performed when the reference list description is updated;

judging using the second reordering flag whether or not the reordering of the reference list is performed;

obtaining, from the slice header, second reference list reordering information for indicating details of the reordering of the reference list when the reordering is performed;

reordering the picture identifiers in the reference list according to the second reference list reordering information;

judging using the first reordering flag whether or not the reordering of the reference list is performed when the reference list description is not updated;

reordering, according to the first reference list reordering information, the picture identifiers in the reference list when the reordering of the reference list is performed; and

decoding the current slice using the reordered reference list.

[Claim 19]

An image coding apparatus for generating a coded bitstream by coding an image using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, the image coding apparatus comprising

a frame memory control unit configured to perform the following:

writing, into a sequence parameter set, buffer description defining information for defining a plurality of buffer descriptions;

writing, into the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions; and

selecting, for each processing unit that is a picture or a slice, one of the buffer descriptions, and writing, into a first header of the processing unit, buffer description selecting information for specifying the selected buffer description, the first header being included in the coded bitstream,

wherein the image coding apparatus codes the processing unit using the selected buffer description and one of the reference list descriptions which corresponds to the selected buffer description.

[Claim 20]

An image decoding apparatus for decoding a coded bitstream using (i) a buffer description for specifying a picture to be held in a buffer and (ii) a reference list description for specifying a picture to be referred to, the image decoding apparatus comprising

a frame memory control unit configured to perform the following:

obtaining, from a sequence parameter set corresponding to the coded bitstream, buffer description defining information for defining a plurality of buffer descriptions;

obtaining, from the sequence parameter set, reference list description defining information for defining a plurality of reference list descriptions corresponding to the buffer descriptions; and

obtaining, from a first header of a processing unit that is a

picture or a slice, buffer description selecting information for specifying one of the buffer descriptions, the first header being included in the coded bitstream,

wherein the image decoding apparatus decodes the processing unit using (i) a buffer description specified in the buffer description selecting information and (ii) one of the reference list descriptions which corresponds to the specified buffer description.

[Claim 21]

An image coding and decoding apparatus comprising:

the image coding apparatus according to Claim 19; and

the image decoding apparatus according to Claim 20.