compared to a previous standard without sacrificing picture quality. Although the latest high efficiency video coding (High Efficiency video coding, HEVC) can compress a video about twice as much as AVC without sacrificing picture quality, it is hunger for a new technology to further compress the video as compared with HEVC.

SUMMARY

[0005] Embodiments of this application provide a video decoding method and a video decoder, to improve decoding efficiency.

[0006] The foregoing and other objects are achieved by the subject matter of the independent claims. Other implementations are apparent from the dependent claims, the specification, and the accompanying drawings.

[0007] According to a first aspect, the present invention relates to a video decoding method. The method is performed by a video decoder. The method includes: parsing coding tree split information to obtain a current node; determining, based on a depth N of the current node, a region covered by a current quantization group; obtaining a QP delta of a current CU in the region covered by the current quantization group; and obtaining a reconstructed picture of the current CU based on the QP delta of the current CU.

[0008] It can be learned that, according to the video decoding method provided in the present invention, the region covered by the current quantization group can be determined based on the depth N of the current node, to ensure that a QP can match a CU, so as to avoid that one CU corresponds to two different QGs, and improve decoding efficiency.

[0009] According to the first aspect, in a possible implementation of the method, the depth N of the current node is a quadtree depth N of the current node. The determining, based on a depth N of the current node, a region covered by a current quantization group includes: determining, based on the depth N of the current node, the region covered by the current quantization group; or determining, based on a multi-type tree depth M of the current node, the region covered by the current quantization group. If N is greater than a first threshold T1 or M is greater than 0, the region covered by the current quantization group is a region covered by a K^{th}-layer quadtree node of the current node. K is a smaller value between N and T1, and the K^{th}-layer quadtree node is a quadtree node that includes the current node and that is generated after K times of quadtree split starting

[0040] According to the first aspect, in a possible implementation of the method, if a QP delta of a first CU having a residual in the current quantization group is not equal to 0, luminance QPs of all CUs whose coding sequences are before that of the first CU having a residual in the current quantization group are modified to a luminance QP of the first CU having a residual.

[0041] If the current CU is a CU before the first CU having a residual in the current quantization group, the obtaining a reconstructed picture of the current CU based on the QP delta of the current CU is specifically:

obtaining the reconstructed picture of the current CU based on the luminance QP of the first CU having a residual.

[0042] According to a second aspect, the present invention relates to a video decoder. The video decoder includes: an entropy decoding unit, configured to: parse coding tree split information to obtain a current node, determine, based on a depth N of the current node, a region covered by a current quantization group, obtain a QP delta of a current CU in the region covered by the current quantization group, and determine a luminance QP of the current CU based on the QP delta of the current CU; an inverse quantization unit, configured to obtain a dequantized coefficient of the current CU based on the luminance QP of the current CU; an inverse transform processing unit, configured to obtain a reconstructed residual block of the current CU based on the dequantized coefficient of the current CU; and a reconstruction unit, configured to obtain a reconstructed picture of the current CU based on the reconstructed residual block of the current CU.

[0043] According to the second aspect, in a possible implementation of the video decoder, the depth N of the current node is a quadtree depth N of the current node. The entropy decoding unit is specifically configured to: determine, based on the depth N of the current node, the region covered by the current quantization group; or determine, based on a multi-type tree depth M of the current node, the region covered by the current quantization group. If N is greater than a first threshold T1 or M is greater than 0, the region covered by the current quantization group is a region covered by a K^{th}-layer quadtree node of the current node. K is a smaller value between N and T1, and the K^{th}-layer quadtree node is a quadtree node that includes the current node and that is generated after K times of quadtree split starting from a coding tree unit CTU.

[0044] The K^{th}-layer quadtree node is an $(M + N – K)^{th}$-layer parent node of the current node.

[0045] According to the second aspect, in a possible implementation of the video decoder, the

having a residual in the current quantization group, the inverse quantization unit is specifically configured to obtain the dequantized coefficient of the current CU based on the luminance QP of the first CU having a residual.

[0063] According to a third aspect, an embodiment of the present invention provides a video decoding method, including: parsing coding tree split information to obtain a current node; determining, based on a depth N of the current node, coordinates of an upper-left corner of a region covered by a current quantization group; obtaining a quantization parameter QP delta of a current coding unit CU in the region covered by the current quantization group; and obtaining a reconstructed picture of the current CU based on the QP delta of the current CU.

[0064] According to the third aspect, in a possible implementation of the method, the depth N of the current node is a quadtree depth N of the current node. The determining, based on a depth N of the current node, coordinates of an upper-left corner of a region covered by a current quantization group includes: determining, based on the depth N of the current node, the coordinates of the upper-left corner of the region covered by the current quantization group; or determining, based on a multi-type tree depth M of the current node, the coordinates of the upper-left corner of the region covered by the current quantization group. If N is greater than a first threshold T1 or M is greater than 0, the coordinates of the upper-left corner of the region covered by the current quantization group are coordinates of an upper-left corner of a region covered by a K^{th}-layer quadtree node of the current node. K is a smaller value between N and T1, and the K^{th}-layer quadtree node is a quadtree node that includes the current node and that is generated after K times of quadtree split starting from a coding tree unit CTU.

[0065] According to the third aspect, in a possible implementation of the method, the depth N of the current node is a quadtree depth N of the current node. The determining, based on a depth N of the current node, coordinates of an upper-left corner of a region covered by a current quantization group includes: determining, based on the quadtree depth N of the current node and a multi-type tree depth M of the current node, the coordinates of the upper-left corner of the region covered by the current quantization group. If N is less than or equal to a first threshold T1 and M is equal to 0, the coordinates of the upper-left corner of the region covered by the current quantization group are coordinates of an upper-left corner of a region covered by the current node.

[0066] According to the third aspect, in a possible implementation of the method, the depth N of the current node is a quadtree depth N of the current node. The determining, based on a depth

[0076] According to the third aspect, in a possible implementation of the method, the method further includes: obtaining a split mode of the current node. The determining, based on a depth N of the current node, coordinates of an upper-left corner of a region covered by a current quantization group includes: if the depth N of the current node is equal to a third threshold T3 minus 1, and the split mode of the current node is a ternary split mode or a quadtree split mode, determining that the coordinates of the upper-left corner of the region covered by the current quantization group are coordinates of an upper-left corner of a region covered by the current node; or if the depth N of the current node is equal to a third threshold T3, and the split mode of the current node is a binary split mode, determining that the coordinates of the upper-left corner of the region covered by the current quantization group are coordinates of an upper-left corner of a region covered by the current node.

[0077] According to the third aspect, in a possible implementation of the method, the depth N of the current node is determined based on a QT depth of the current node and a binary depth Db of the current node.

[0078] According to the third aspect, in a possible implementation of the method, the depth N of the current node is determined by using the following calculation formula: N = Dq * 2 + Db, where Dq is the QT depth of the current node.

[0079] According to the third aspect, in a possible implementation of the method, if the current node is a multi-type tree MTT root node, the binary depth Db of the current node is 0; or if the current node is an MTT node and is not an MTT root node, and the current node is a child node obtained in the binary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 1; or if the current node is an MTT node and is not an MTT root node, and the current node is a middle child node obtained in the ternary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 1; or if the current node is an MTT node and is not an MTT root node, and the current node is a non-middle child node obtained in the ternary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 2.

[0080] According to the third aspect, in a possible implementation of the method, if a QP delta of a first CU having a residual in the current quantization group is not equal to 0, luminance QPs of all CUs whose coding sequences are before that of the first CU having a residual in the current quantization group are modified to a luminance QP of the first CU having a residual. If the current

CU is a CU before the first CU having a residual in the current quantization group, the obtaining a reconstructed picture of the current CU based on the QP delta of the current CU is specifically: obtaining the reconstructed picture of the current CU based on the luminance QP of the first CU having a residual.

[0081] According to a fourth aspect, an embodiment of the present invention provides a video decoder, including: an entropy decoding unit, configured to: parse coding tree split information to obtain a current node, determine, based on a depth N of the current node, coordinates of an upper-left corner of a region covered by a current quantization group, obtain a quantization parameter QP delta of a current coding unit CU that covers the coordinates of the upper-left corner of the region covered by the current quantization group, and determine a luminance QP of the current CU based on the QP delta of the current CU; an inverse quantization unit, configured to obtain a dequantized coefficient of the current CU based on the luminance QP of the current CU; an inverse transform processing unit, configured to obtain a reconstructed residual block of the current CU based on the dequantized coefficient of the current CU; and a reconstruction unit, configured to obtain a reconstructed picture of the current CU based on the reconstructed residual block of the current CU.

[0082] According to the fourth aspect, in a possible implementation of the video decoder, the depth N of the current node is a quadtree depth N of the current node. The entropy decoding unit is specifically configured to: determine, based on the depth N of the current node, the coordinates of the upper-left corner of the region covered by the current quantization group; or determine, based on a multi-type tree depth M of the current node, the coordinates of the upper-left corner of the region covered by the current quantization group. If N is greater than a first threshold T1 or M is greater than 0, the coordinates of the upper-left corner of the region covered by the current quantization group are coordinates of an upper-left corner of a region covered by a K^{th}-layer quadtree node of the current node. K is a smaller value between N and T1, and the K^{th}-layer quadtree node is a quadtree node that includes the current node and that is generated after K times of quadtree split starting from a coding tree unit CTU.

[0083] According to the fourth aspect, in a possible implementation of the video decoder, the depth N of the current node is a quadtree depth N of the current node. The entropy decoding unit is specifically configured to determine, based on the quadtree depth N of the current node and a multi-type tree depth M of the current node, the coordinates of the upper-left corner of the region

depth N of the current node is equal to a third threshold T3 minus 1, and the split mode of the current node is a ternary split mode or a quadtree split mode, determine that the coordinates of the upper-left corner of the region covered by the current quantization group are coordinates of an upper-left corner of a region covered by the current node; or if the depth N of the current node is equal to a third threshold T3, and the split mode of the current node is a binary split mode, determine that the coordinates of the upper-left corner of the region covered by the current quantization group are coordinates of an upper-left corner of a region covered by the current node.

[0095] According to the fourth aspect, in a possible implementation of the video decoder, the entropy decoding unit is specifically configured to determine the depth N of the current node based on a QT depth of the current node and a binary depth Db of the current node.

[0096] According to the fourth aspect, in a possible implementation of the video decoder, the entropy decoding unit is specifically configured to determine the depth N of the current node by using the following calculation formula: N = Dq * 2 + Db, where Dq is the QT depth of the current node.

[0097] According to the fourth aspect, in a possible implementation of the video decoder, if the current node is a multi-type tree MTT split node, the binary depth Db of the current node is 0; or if the current node is an MTT node and is not an MTT root node, and the current node is a child node obtained in the binary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 1; or if the current node is an MTT node and is not an MTT root node, and the current node is a middle child node obtained in the ternary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 1; or if the current node is an MTT node and is not an MTT root node, and the current node is a non-middle child node obtained in the ternary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 2.

[0098] According to the fourth aspect, in a possible implementation of the video decoder, the entropy decoding unit is further configured to: if a QP delta of a first CU having a residual in the current quantization group is not equal to 0, modify luminance QPs of all CUs whose coding sequences are before that of the first CU having a residual in the current quantization group to a luminance QP of the first CU having a residual. If the current CU is a CU before the first CU having a residual in the current quantization group, the inverse quantization unit is specifically configured to obtain the dequantized coefficient of the current CU based on the luminance QP of

representation. Furthermore, the encoder duplicates a decoder processing loop, so that the encoder and the decoder generate a same prediction (for example, an intra prediction and an inter prediction) and/or reconstruction, for processing, that is, for coding subsequent blocks.

[00119] As used in this specification, the term "block" may be a part of a picture or a frame. For convenience of description, the embodiments of the present invention are described herein with reference to versatile video coding (VVC: Versatile Video Coding) or high efficiency video coding (High-Efficiency Video Coding, HEVC) developed by the joint collaboration team on video coding (Joint Collaboration Team on Video Coding, JCT-VC) of ITU-T video coding experts group (Video Coding Experts Group, VCEG) and ISO/IEC motion picture experts group (Motion Picture Experts Group, MPEG). A person of ordinary skill in the art understands that the embodiments of the present invention are not limited to HEVC or VVC. The block may be a CU, a PU, or a TU. In HEVC, a CTU is split into a plurality of CUs by using a quadtree structure represented as a coding tree. A decision on whether to encode a picture region through inter-picture (temporal) or intra-picture (spatial) prediction is made at a CU level. Each CU may be further split into one, two, or four PUs based on a PU splitting pattern. Inside one PU, a same prediction process is applied, and related information is transmitted to the decoder on a PU basis. After obtaining a residual block by applying the prediction process based on the PU splitting pattern, the CU may be partitioned into transform units (transform unit, TU) based on another quadtree structure similar to the coding tree used for the CU. In the recent development of video compression technologies, a quadtree plus binary tree (Quad-tree plus binary tree, QTBT) partition frame is used to partition a coding block. In a QTBT block structure, the CU may be square or rectangular. In the VVC, a coding tree unit (coding tree unit, CTU) is first partitioned by using a quadtree structure. A leaf node of a quadtree is further partitioned by using a binary tree structure. A leaf node of a binary tree is referred to as a coding unit (CU), and the CU is used for prediction and transform processing without any further partition. This means that the CU, PU and TU have a same block size in the QTBT coding block structure. In addition, multiply partition, such as triple tree partition, is proposed to be used in combination with the QTBT block structure.

[00120] The following describes embodiments of an encoder 20, a decoder 30, and coding systems 10 and 40 based on FIG. 1 to FIG. 4 (before the embodiments of the present invention are described in more detail based on FIG. 9).

[00121] FIG. 1 is a conceptual or schematic block diagram of an example coding system 10, for

the communications interface 22 is configured to process the encoded picture data 21 before correspondingly storing encoded data 13 and/or transmitting the encoded data 13 to another device. The another device is, for example, the destination device 14 or any other device used for decoding or storage.

[00130] The destination device 14 includes the decoder 30 (for example, the video decoder 30), and optionally may include a communications interface or communications unit 28, a post-processing unit 32 and a display device 34.

[00131] The communications interface 28 of the destination device 14 is configured to, for example, receive the encoded picture data 21 or the encoded data 13 directly from the source device 12 or any other source. The any other source is, for example, a storage device. The storage device is, for example, an encoded picture data storage device.

[00132] The communications interface 22 and the communications interface 28 may be configured to transmit or receive the encoded picture data 21 or the encoded data 13 through a direct communication link between the source device 12 and the destination device 14 or through any type of network. The direct communication link is, for example, a direct wired or wireless connection. The any type of network is, for example, a wired or wireless network or any combination thereof, or any type of private or public network, or any combination thereof.

[00133] The communications interface 22 may be, for example, configured to package the encoded picture data 21 into an appropriate format, for example, a packet, for transmission over a communications link or communications network.

[00134] The communications interface 28 forming a corresponding part of the communications interface 22 may be, for example, configured to de-package the encoded data 13, to obtain the encoded picture data 21.

[00135] Both the communications interface 22 and the communications interface 28 may be configured as unidirectional communications interfaces, as indicated by an arrow that points from the source device 12 to the destination device 14 and that is used for the encoded picture data 21 in FIG. 1, or may be configured as bidirectional communications interfaces, and may be configured to, for example, send and receive messages to establish a connection, and acknowledge and exchange any other information related to a communication link and/or data transmission such as encoded picture data transmission.

[00136] The decoder 30 is configured to receive the encoded picture data 21 and provide

prediction processing unit 260) and mode selection performed (for example, by the mode selection unit 262) by an example of the encoder 20.

[00175] As described above, the encoder 20 is configured to determine or select an optimal or optimum prediction mode from a set of (pre-determined) prediction modes. The set of prediction modes may include, for example, an intra prediction mode and/or an inter prediction mode.

[00176] A set of intra prediction modes may include 35 different intra prediction modes, for example, non-directional modes such as a DC (or average) mode and a planar mode, or directional modes such as those defined in H.265, or may include 67 different intra prediction modes, for example, non-directional modes such as a DC (or average) mode and a planar mode, or directional modes such as those defined in H.266 under development.

[00177] A (possible) set of inter prediction modes depends on available reference pictures (namely, for example, at least some decoded pictures stored in the DPB 230, as described above) and other inter prediction parameters, for example, depends on whether an entire reference picture or only a part of the reference picture, for example, a search window region around a region of the current picture block, is used to search for a best matching reference block, and/or for example, depends on whether pixel interpolation such as half-pel and/or quarter-pel interpolation is applied.

[00178] In addition to the foregoing prediction modes, a skip mode and/or a direct mode may also be applied.

[00179] The prediction processing unit 260 may further be configured to partition the block 203 into smaller block partitions or subblocks, for example, by iteratively using quadtree (quad-tree, QT) partitioning, binary tree (binary-tree, BT) partitioning, triple tree (triple-tree or ternary-tree, TT) partitioning, or any combination thereof, and perform, for example, prediction on each of the block partitions or subblocks. Mode selection includes selection of a tree structure of the partitioned block 203 and selection of a prediction mode applied to each of the block partitions or subblocks.

[00180] The inter prediction unit 244 may include a motion estimation (motion estimation, ME) unit (not shown in FIG. 2) and a motion compensation (motion compensation, MC) unit (not shown in FIG. 2). The motion estimation unit is configured to receive or obtain the picture block 203 (the current picture block 203 of the current picture 201) and a decoded picture 231, or at least one or more previously reconstructed blocks, for example, one or more reconstructed blocks of other/different previously decoded pictures 231, for motion estimation. For example, a video

decoder 30 implemented by using the logic circuit may include a picture buffer (which is implemented by the processing unit 46 or the memory 44) and a graphics processing unit (which is implemented by, for example, the processing unit 46). The graphics processing unit may be communicatively coupled to the picture buffer. The graphics processing unit may include the video decoder 30 implemented by using the logic circuit 47, to implement various modules described with reference to FIG. 3 and/or any other decoder system or subsystem described in this specification.

[00207] In some examples, the antenna 42 of the video coding system 40 may be configured to receive the encoded bitstream of the video data. As described, the encoded bitstream may include data, an indicator, an index value, mode selection data, or the like that is related to video frame coding and that is described in this specification, for example, data related to coding partitioning (for example, a transform coefficient or a quantized transform coefficient, an optional indicator (as described), and/or data defining the coding partitioning). The video coding system 40 may further include the video decoder 30 that is coupled to the antenna 42 and that is configured to decode the encoded bitstream. The display device 45 is configured to present a video frame.

[00208] FIG. 5 is a simplified block diagram of an apparatus 500 that may be used as either or two of the source device 12 and the destination device 14 in FIG. 1 according to an example embodiment. The apparatus 500 may implement the technologies in this application. The apparatus 500 may be in a form of a computing system including a plurality of computing devices, or may be in a form of a single computing device such as a mobile phone, a tablet computer, a laptop computer, a notebook computer, or a desktop computer.

[00209] A processor 502 in the apparatus 500 may be a central processing unit. Alternatively, the processor 502 may be any other type of device or a plurality of devices, capable of manipulating or processing information existing or to be developed in the future. As shown in the figure, although the disclosed implementations may be practiced by using a single processor such as the processor 502, advantages in speed and efficiency may be achieved by using more than one processor.

[00210] In an implementation, a memory 504 in the apparatus 500 may be a read-only memory (Read Only Memory, ROM) device or a random access memory (random access memory, RAM) device. Any other suitable type of storage device may be used as the memory 504. The memory 504 may include code and data 506 that is accessed by the processor 502 through a bus 512. The

and may be configured to receive a sound, for example, a voice or another sound, made by the user when the user runs the apparatus 500.

[00214] Although the processor 502 and the memory 504 of the apparatus 500 are depicted in FIG. 5 as being integrated into a single unit, another configuration may still be used. Running of the processor 502 may be distributed in a plurality of machines (each machine has one or more processors) that can be directly coupled, or distributed in a local region or another network. The memory 504 may be distributed in a plurality of machines. For example, the memory 504 is a network-based memory or memories in a plurality of machines that run the apparatus 500. Although depicted as a single bus herein, the bus 512 of the apparatus 500 may be formed by a plurality of buses. Further, the secondary memory 514 may be directly coupled to another component of the apparatus 500 or may be accessed through a network. In addition, the secondary memory 514 may include a single integrated unit, for example, one memory card, or a plurality of units, for example, a plurality of memory cards. Therefore, the apparatus 500 may be implemented in a plurality of configurations.

[00215] FIG. 6 describes split modes of a binary tree, a triple tree, and a quadtree.

[00216] The quadtree is a tree structure, indicating that one node can be split into four child nodes. In the H.265 video coding standard, a quadtree-based CTU split mode is used. A CTU is used as a root node, and each node corresponds to a square region. A node may not be split (in this case, a region corresponding to the node is a CU), or the node is split into four lower-level nodes, to be specific, the square region is split into four equal-sized square regions (a length and a width of each of the four square regions are half of a length and a width of the square region before split), and each region corresponds to one node, as shown in (a) of FIG. 6.

[00217] The binary tree is a tree structure, indicating that one node can be split into two child nodes. In an existing coding method in which the binary tree is used, a node on a binary tree structure may not be split, or the node is split into two lower-level nodes. There are two manners of splitting the node into two nodes: (1) a horizontal binary split: A region corresponding to the node is split into two equal-sized regions: an upper region and a lower region, and each region corresponds to one node, as shown in (b) of FIG. 6; or (2) a vertical binary split: A region corresponding to the node is split into two equal-sized regions: a left region and a right region, and each region corresponds to one node, as shown in (c) of FIG. 6.

[00218] The triple tree is a tree structure, indicating that one node can be split into three child

become a 64 x 64 CU, or the CTU node is split into four 32 x 32 nodes (whose quadtree depths are 1). Each of the four 32 x 32 nodes may further be split or not split based on split_cu_flag corresponding to the node. If a 32 x 32 node is further split, four 16 x 16 nodes (whose quadtree depths are 2) are generated. The rest may be deduced by analogy, until no node is further split. In this way, one CTU is split into one group of CUs. A minimum size (size) of the CU is identified in a sequence parameter set (SPS: Sequence Parameter Set). For example, an 8 x 8 CU is a minimum CU. In the foregoing recursive split process, if a size of a node is equal to the minimum CU size (minimum CU size), the node is not further split by default, and a split flag of the node does not need to be included in the bitstream.

[00222] After a node is parsed to be a leaf node, the leaf node is a CU, coding information (including information such as a prediction mode and a transform coefficient of the CU, for example, a coding_unit() syntax structure in H.265) corresponding to the CU is further parsed. Then, decoding processing such as prediction, dequantization, inverse transform, and loop filtering is performed on the CU based on the coding information, to generate a reconstructed picture corresponding to the CU. The quadtree structure enables the CTU to be split into a group of CUs of appropriate sizes based on a local picture feature. For example, a flat region is split into relatively large CUs, and a region with rich textures is split into relatively small CUs.

[00223] Based on the quadtree split, a binary split mode and a ternary split mode are added to versatile video coding test model (VTM: Versatile video coding Test Model) reference software. The VTM is a new codec reference software developed by the JVET.

[00224] The binary split is to split a node into two child nodes. There are two specific binary split modes: (1) the horizontal binary split: A region corresponding to the node is split into two equal-sized regions: an upper region and a lower region (to be specific, a width remains unchanged, and a height is half of a height of the region before split), and each region corresponds to one node, as shown in (b) of FIG. 6; or (2) the vertical binary split: A region corresponding to the node is split into two equal-sized regions: a left region and a right region (to be specific, a height remains unchanged, and a width is half of a width of the region before split), as shown in (c) of FIG. 6.

[00225] The ternary split is to split a node into three child nodes. There are two specific ternary split modes:

(1) the horizontal ternary split: A region corresponding to the node is split into three

regions: an upper region, a middle region, and a lower region, where each region corresponds to one node, and heights of the upper region, the middle region, and the lower region are respectively 1/4, 1/2, and 1/4 of a height of the node, as shown in (d) of FIG. 6; or (2) the vertical ternary split: A region corresponding to the node is split into three regions: a left region, a middle region, and a right region, where each region corresponds to one node, and widths of the left region, the middle region, and the right region are respectively 1/4, 1/2, and 1/4 of a width of the node, as shown in (e) of FIG. 6.

[00226] In the VTM, a split mode cascading a QT and a BT/TT is used, which is referred to as QT-MTT (Quad Tree plus Multi-Type Tree) split mode for short. More specifically, the CTU is split by using the QT, to generate a QT leaf node. A node in the QT may further be split into four QT child nodes by using the quadtree split, or one QT leaf node is generated without using the quadtree split. A QT leaf node functions as a root node of an MTT. A node in the MTT may be split into child nodes by using one of the four split modes: the horizontal binary split, the vertical binary split, the horizontal ternary split, and the vertical ternary split, or becomes an MTT leaf node without being further split. A leaf node of the MTT is a coding unit CU.

[00227] FIG. 7 shows an example in which a CTU is split into 16 CUs from a to p by using a QT-MTT. In the right figure in FIG. 7, each endpoint represents one node. Four lines connected to one node indicate a quadtree split, two lines connected to one node indicate a binary split, and three lines connected to one node indicate a ternary split. A solid line indicates the QT split, a dashed line indicates a first-layer split of a MTT split, and a dot-dashed line indicates a second-layer split of the MTT split. a to p are 16 MTT leaf nodes, and each MTT leaf node is one CU. A CU split diagram shown in the left figure in FIG. 7 is obtained for a CTU by using a split mode shown in the right figure in FIG. 7.

[00228] In the QT-MTT split mode, each CU has a QT depth (Quad-tree depth, QT depth) and an MTT depth (Multi-Type Tree depth, MTT depth). The QT depth indicates a QT depth of a QT leaf node to which the CU belongs, and the MTT depth indicates an MTT depth of an MTT leaf node to which the CU belongs. For a root node of a coding tree, a QT depth is 0 and an MTT depth is 0. If the QT split is used for a node on the coding tree, a QT depth of a child node obtained through split is a QT depth of the node plus 1, and an MTT depth remains unchanged. Similarly, if the MTT split (namely, one of the BT split or the TT split) is used for a node on the coding tree, an MTT depth of a child node

obtained through split is an MTT depth of the node plus 1, and a QT depth remains unchanged. For example, in FIG. 7, a QT depth of a, b, c, d, e, f, g, i, or j is 1, and an MTT depth is 2; a QT depth of h is 1, and an MTT depth is 1; a QT depth of n, o or p is 2, and an MTT depth is 0; and a QT depth of l or m is 2, and an MTT depth is 1. If the CTU is split into only one CU, a QT depth of the CU is 0, and an MTT depth is 0.

[00229] In HEVC, one CU includes one luminance block quantization parameter (Quantization Parameter, QP) and two chrominance block quantization parameters, where the chrominance block quantization parameter is derived from the luminance block quantization parameter. The chrominance block quantization parameter is referred to as a chrominance QP for short, and the luminance block quantization parameter is referred to as a luminance QP for short. Decoding of a luminance QP of a current CU (current CU) includes the following processing:

[00230] A diff_cu_qp_delta_depth syntax element is obtained from a picture parameter set (Picture Parameter Set, PPS), and a quantization group (Quantization Group, QG) is derived based on the syntax element. To be specific, the quantization group is an N x N region, where N = CTUSize >> diff_cu_qp_delta_depth, and CTUSize is a side length of a CTU. For example, CTUSize of a 64 x 64 CTU is 64. A 64 x 64 CTU is split into M QGs whose sizes are N x N, and M is a positive integer. For example, when diff_cu_qp_delta_depth = 2, the CTU is split into 16 QGs whose sizes are 16 x 16, as shown in FIG. 8. Because only the QT split is used in HEVC, if a QG obtained in the foregoing QG determining manner includes a plurality of CUs whose sizes are less than a size of the QG, the QG definitely includes a plurality of complete CUs. In other words, a plurality of CUs whose sizes are less than a size of a QG are fully included in the QG, and a CU whose size is less than a size of a QG cannot be included in a plurality of QGs. In addition, when only the QT split is used, a QG obtained in the foregoing QG determining manner can further ensure that if a CU has a same size as the QG, the CU is definitely included in the QG. When a CU is greater than a QG, the CU certainly includes a plurality of complete QGs.

[00231] A current quantization group (current quantization group, current QG for short) in which the current CU is located is determined, where the current QG is a QG that covers coordinates of an upper-left corner of the current CU. If the coordinates of the upper-left corner of the current CU are Pcu = (xCb, yCb), coordinates of an upper-left corner of the current quantization group are Pqg = (xQg, yQg), where

$$xQg = xCb - (xCb \,\&\, ((1 \ll Log2MinCuQpDeltaSize) - 1))$$

$$yQg = yCb - (yCb \,\&\, ((1 \ll Log2MinCuQpDeltaSize) - 1))$$

[00232] Log2MinCuQpDeltaSize = log2(CTUSize) – diff_cu_qp_delta_depth, and log2(x) is a logarithm of x with 2 as the base.

[00233] A QP delta of the current CU is obtained, for example, CuQpDeltaVal in the HEVC standard. If the current CU is a first CU having a residual in the QG (for example, if one of coded block flags cbf_luma, cbf_cb, cbf_cr of the current CU has a non-zero value, it indicates that the current CU has a residual), the QP delta of the current CU is parsed from a bitstream. The QP delta is used as QP deltas of all CUs whose coding sequences are after that of the current CU in the current QG. QP deltas of all CUs whose coding sequences are before that of the current CU in the current QG are 0.

[00234] A luminance block quantization parameter predictor of the current QG is obtained, for example, qP_{Y_PRED} in the HEVC standard. qP_{Y_PRED} may be obtained through prediction based on a luminance QP at a left neighboring location and a luminance QP at an upper neighboring location of the current QG. The left neighboring location of the current QG is (xQg – 1, yQg), and the upper neighboring location is (xQg, yQg – 1). The luminance QP at the upper neighboring location is a luminance QP of a coding unit covering the upper neighboring location. If the upper neighboring location is unavailable or does not belong to a same tile (Tile) as the current block, the luminance QP at the upper neighboring location is set to a luminance QP of a last CU in a previous QG (for example, qP_{Y_PREV} in the HEVC standard). Similarly, the luminance QP at the left neighboring location is a luminance QP of a coding unit covering the left neighboring location. If the left neighboring location is unavailable or does not belong to a same tile as the current block, the luminance QP at the left neighboring location is set to the luminance QP of the last CU in the previous QG. There may be a plurality of methods for determining that a neighboring location is unavailable. For example, if a neighboring location is outside a current strip, the neighboring location is unavailable. For another example, if a neighboring location is outside a current picture, the neighboring location is unavailable. For another example, if a neighboring location is not inside a current CTU, the neighboring location is unavailable. For another example, if a pixel at a neighboring location is not reconstructed, the neighboring location is not available.

[00235] A luminance QP of the current CU is obtained by adding the luminance block quantization parameter predictor of the current QG to the QP delta (QP delta) of the current CU.

[00236] It can be learned that in the QT-MTT split mode, using the foregoing QG split mode

obtained in the binary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 1.

[00274] Alternatively, if the current node is an MTT node and is not an MTT root node, and the current node is a middle child node (namely, a middle child node in three child nodes) obtained in the ternary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 1.

[00275] Alternatively, if the current node is an MTT node and is not an MTT root node, and the current node is a non-middle child node obtained in the ternary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 2.

[00276] It can be learned that a depth determined in an N = Dq * 2 + Db manner is in a one-to-one correspondence with an area of a node. For example, when the CTU is 128 x 128, and a depth of the node is N, the area of the node is (128 x 128) >> N.

[00277] Manner 9: Determine, based on the depth N of the current node, a split mode of the current node, and a third threshold T3, the region covered by the current quantization group.

[00278] Details are as follows:

[00279] 1. If the depth N of the current node is equal to the third threshold T3 minus 1, and the split mode of the current node is a ternary split mode or a quadtree split mode, it is determined that the region covered by the current quantization group is a region covered by the current node.

[00280] 2. Alternatively, if the depth N of the current node is equal to the third threshold T3, and the split mode of the current node is a binary split mode, it is determined that the region covered by the current quantization group is a region covered by the current node.

[00281] 3. Alternatively, if the depth N of the current node is equal to the third threshold T3, and the current node is no longer split, it is determined that the region covered by the current quantization group is a region covered by the current node. In this case, the region covered by the current quantization group is a coverage region of a CU.

[00282] The third threshold T3 may be a preset positive integer, for example, may be 3, 4, or 5.

[00283] For a manner of determining the depth N of the current node, refer to Manner 3.

[00284] 903: Obtain a QP delta of a current CU in the region covered by the current quantization group.

[00285] For a specific implementation of this step, refer to an existing implementation, for example, refer to a CuQpDeltaVal manner in the HEVC standard. More specifically, if the current

[00303] A reconstruction unit 314 is configured to obtain a reconstructed picture of the current CU based on the reconstructed residual block of the current CU.

[00304] For a specific implementation of the video decoder 30, refer to the method described in FIG. 9. Details are not described herein again.

[00305] In an implementation, the depth N of the current node is a quadtree depth N of the current node. The entropy decoding unit 304 is specifically configured to: determine, based on the depth N of the current node, the region covered by the current quantization group; or determine, based on a multi-type tree depth M of the current node, the region covered by the current quantization group. If N is greater than a first threshold T1 or M is greater than 0, the region covered by the current quantization group is a region covered by a K^{th}-layer quadtree node of the current node. K is a smaller value between N and T1, and the K^{th}-layer quadtree node is a quadtree node that includes the current node and that is generated after K times of quadtree split starting from a coding tree unit CTU.

[00306] The K^{th}-layer quadtree node is an $(M + N – K)^{th}$-layer parent node of the current node.

[00307] In an implementation, the depth N of the current node is a quadtree depth N of the current node. The entropy decoding unit 304 is specifically configured to determine, based on the quadtree depth N of the current node and a multi-type tree depth M of the current node, the region covered by the current quantization group. If N is less than or equal to a first threshold T1 and M is equal to 0, the region covered by the current quantization group is a region covered by the current node.

[00308] In an implementation, the depth N of the current node is a quadtree depth N of the current node. The entropy decoding unit 304 is specifically configured to: determine, based on the quadtree depth N of the current node, the region covered by the current quantization group, or determine, based on the quadtree depth N of the current node and a multi-type tree depth M of the current node, the region covered by the current quantization group. If N is equal to a first threshold T1 and M is equal to 0, the region covered by the current quantization group is a region covered by the current node. Alternatively, if N is less than a first threshold T1, the region covered by the current quantization group is a region covered by the current node.

[00309] In an implementation, the depth N of the current node is a quadtree depth N of the current node. The entropy decoding unit 304 is specifically configured to determine, based on the quadtree depth N of the current node and a multi-type tree depth M of the current node, the region

[00324] In an implementation, the entropy decoding unit 304 is further configured to: if a QP delta of a first CU having a residual in the current quantization group is not equal to 0, modify luminance QPs of all CUs whose coding sequences are before that of the first CU having a residual in the current quantization group to a luminance QP of the first CU having a residual. Correspondingly, if the current CU is a CU before the first CU having a residual in the current quantization group, the inverse quantization unit 310 is specifically configured to obtain the dequantized coefficient of the current CU based on the luminance QP of the first CU having a residual.

[00325] An embodiment of the present invention further provides a video decoder, including an execution circuit configured to perform any one of the foregoing methods.

[00326] An embodiment of the present invention further provides a video decoder, including at least one processor and a non-volatile computer-readable storage medium coupled to the at least one processor. The non-volatile computer-readable storage medium stores a computer program that can be executed by the at least one processor, and when the computer program is executed by the at least one processor, the video decoder is configured to perform any one of the foregoing methods.

[00327] An embodiment of the present invention further provides a computer-readable storage medium, configured to store a computer program that can be executed by at least one processor. When the computer program is executed by the at least one processor, any one of the foregoing methods is performed.

[00328] An embodiment of the present invention further provides a computer program. When the computer program is executed, any one of the foregoing methods is performed.

[00329] In one or more examples, the described functions may be implemented by hardware, software, firmware, or any combination thereof. If implemented by software, the functions may be stored in or transmitted over on a computer-readable medium as one or more instructions or code and executed by a hardware-based processing unit. The computer-readable medium may include a computer-readable storage medium, which corresponds to a tangible medium such as a data storage medium or a communications medium. The communications medium includes, for example, according to a communications protocol, any medium that facilitates transmission of a computer program from one place to another. In this manner, the computer-readable medium may generally correspond to: (1) a non-transitory tangible computer-readable storage medium, or (2) a

communications medium such as a signal or a carrier. The data storage medium may be any usable medium that can be accessed by one or more computers or one or more processors to retrieve instructions, code, and/or data structures for implementing the technologies described in the embodiments of the present invention. A computer program product may include the computer-readable medium.

[00330] By way of example but not limitation, such computer-readable storage media may include a RAM, a ROM, an EEPROM, a CD-ROM or another optical disk storage, a magnetic disk storage or another magnetic storage device, a flash memory, or any other medium that can be used to store required program code in a form of an instruction or a data structure and that can be accessed by a computer. In addition, any connection may be appropriately referred to as a computer-readable medium. For example, if an instruction is transmitted from a website, a server, or another remote source by using a coaxial cable, an optical fiber cable, a twisted pair, a digital subscriber line (digital subscriber line, DSL), or wireless technologies such as infrared, radio, and microwave, the coaxial cable, the optical fiber cable, the twisted pair, the DSL, or the wireless technologies such as infrared, radio, and microwave are included in a definition of the medium. However, it should be understood that the computer-readable storage medium and the data storage medium do not include connections, carriers, signals, or other transitory media, but actually mean non-transitory tangible storage media. As used in this specification, a disk and a disc include a compact disc (compact disc, CD), a laser disc, an optical disc, a digital versatile disc (digital versatile disc, DVD), a floppy disk, and a Blu-ray disc. The disk usually reproduces data magnetically, but the disc reproduces data optically by using a laser. A combination of the foregoing items should also be included in a scope of the computer-readable medium.

[00331] The instruction may be executed by one or more processors. The one or more processors are, for example, one or more digital signal processors (digital signal processor, DSP), general-purpose microprocessors, application-specific integrated circuits (application specific integrated circuit, ASIC), field programmable logic array (field programmable logic array, FPGA), or other equivalent integrated or discrete logic circuits. Therefore, the term "processor" used in this specification may be any of the foregoing structures or any other structure suitable for implementing the technologies described in this specification. In addition, in some aspects, the functionality described in this specification may be provided within dedicated hardware and/or software modules configured for encoding and decoding, or incorporated in a combined codec. In

CLAIMS

What is claimed is:

1. A video decoding method, comprising:

parsing coding tree split information to obtain a current node;

determining, based on a depth N of the current node, coordinates of an upper-left corner of a region covered by a current quantization group;

obtaining a quantization parameter QP delta of a current coding unit CU in the region covered by the current quantization group;

obtaining a reconstructed picture of the current CU based on the QP delta of the current CU; and

obtaining a split mode of the current node,

wherein the determining, based on a depth N of the current node, coordinates of an upper-left corner of a region covered by a current quantization group comprises:

if the depth N of the current node is equal to a second threshold T2 minus 1, and the split mode of the current node is a ternary split mode, determining that the coordinates of the upper-left corner of the region covered by the current quantization group are coordinates of an upper-left corner of a region covered by the current node; or

if the depth N of the current node is equal to a second threshold T2, and the split mode of the current node is a binary split mode or a quadtree split mode, determining that the coordinates of the upper-left corner of the region covered by the current quantization group are coordinates of an upper-left corner of a region covered by the current node.

2. The method according to claim 1, wherein the depth N of the current node is determined based on a QT depth of the current node and a binary depth Db of the current node.

3. The method according to claim 2, wherein the depth N of the current node is determined by using the following calculation formula:

N = Dq * 2 + Db, wherein

Dq is the QT depth of the current node.

4. The method according to claim 2or 3, wherein if the current node is a multi-type tree MTT root node, the binary depth Db of the current node is 0; or

if the current node is an MTT node and is not an MTT root node, and the current node is a child node obtained in a binary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 1; or

if the current node is an MTT node and is not an MTT root node, and the current node is a middle child node obtained in a ternary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 1; or

if the current node is an MTT node and is not an MTT root node, and the current node is a non-middle child node obtained in a ternary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 2.

5. The method according to any one of claims 1 to 4, wherein if a QP delta of a first CU having a residual in the current quantization group is not equal to 0, luminance QPs of all CUs whose coding sequences are before that of the first CU having a residual in the current quantization group are modified to a luminance QP of the first CU having a residual; and

if the current CU is a CU before the first CU having a residual in the current quantization group, the obtaining a reconstructed picture of the current CU based on the QP delta of the current CU comprises:

obtaining the reconstructed picture of the current CU based on the luminance QP of the first CU having a residual.

6. A video decoder, comprising:

an entropy decoding unit, configured to: parse coding tree split information to obtain a current node; determine, based on a depth N of the current node, coordinates of an upper-left corner of a region covered by a current quantization group; obtain a quantization parameter QP delta of a current coding unit CU that covers the coordinates of the upper-left corner of the region covered by the current quantization group; and determine a luminance QP of the current CU based on the QP delta of the current CU;

an inverse quantization unit, configured to obtain a dequantized coefficient of the current CU based on the luminance QP of the current CU;

an inverse transform processing unit, configured to obtain a reconstructed residual block of the current CU based on the dequantized coefficient of the current CU; and

a reconstruction unit, configured to obtain a reconstructed picture of the current CU based on the reconstructed residual block of the current CU,

wherein the entropy decoding unit is further configured to: obtain a split mode of the current node; and

if the depth N of the current node is equal to a second threshold T2 minus 1, and the split mode of the current node is a ternary split mode, determine that the coordinates of the upper-left corner of the region covered by the current quantization group are coordinates of an upper-left corner of a region covered by the current node; or

if the depth N of the current node is equal to a second threshold T2, and the split mode of the current node is a binary split mode or a quadtree split mode, determine that the coordinates of the upper-left corner of the region covered by the current quantization group are coordinates of an upper-left corner of a region covered by the current node.

7. The video decoder according to claim 6, wherein the entropy decoding unit is further configured to determine the depth N of the current node based on a QT depth of the current node and a binary depth Db of the current node.

8. The video decoder according to claim 7, wherein the entropy decoding unit is further configured to:

determine the depth N of the current node by using the following calculation formula:

N = Dq * 2 + Db, wherein

Dq is the QT depth of the current node.

9. The video decoder according to claim 7 or 8, wherein if the current node is a multi-type tree MTT root node, the binary depth Db of the current node is 0; or

if the current node is an MTT node and is not an MTT root node, and the current node is a child node obtained in a binary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 1; or

if the current node is an MTT node and is not an MTT root node, and the current node is a middle child node obtained in a ternary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 1; or

if the current node is an MTT node and is not an MTT root node, and the current node is a non-middle child node obtained in a ternary split mode, the binary depth Db of the current node is a binary depth of a direct parent node of the current node plus 2.

10. The video decoder according to any one of claims 6 to 9, wherein the entropy decoding unit is further configured to: if a QP delta of a first CU having a residual in the current quantization

group is not equal to 0, modify luminance QPs of all CUs whose coding sequences are before that of the first CU having a residual in the current quantization group to a luminance QP of the first CU having a residual; and

if the current CU is a CU before the first CU having a residual in the current quantization group, the inverse quantization unit is further configured to obtain the dequantized coefficient of the current CU based on the luminance QP of the first CU having a residual.

11. A video decoder, comprising an execution circuit configured to perform the method according to any one of claims 1 to 5.

12. A video decoder, comprising:

at least one processor; and

a non-volatile computer-readable storage medium coupled to the at least one processor, wherein the non-volatile computer-readable storage medium stores a computer program that can be executed by the at least one processor, and when the computer program is executed by the at least one processor, the video decoder is configured to perform the method according to any one of claims 1 to 5.

13. A computer-readable storage medium having a program recorded thereon; where the program makes the computer execute method of any of claims 1 to 5.

14. A computer program configured to cause a computer to execute method of any of claims 1 to 5.