

POINT CLOUD ENCODING METHOD AND APPARATUS, POINT CLOUD DECODING METHOD AND APPARATUS, AND STORAGE MEDIUM

[0001] This application claims the earliest priority to Chinese Patent Application No.
5 201910210181.3, filed on March 19, 2019 and entitled "POINT CLOUD ENCODING METHOD
AND APPARATUS, POINT CLOUD DECODING METHOD AND APPARATUS, AND
STORAGE MEDIUM", which is incorporated herein by reference in its entirety. This application
further claims the priority to Chinese Patent Application No. 201910214557.8, filed on March 20,
2019 and entitled "POINT CLOUD ENCODING METHOD AND APPARATUS, POINT
10 CLOUD DECODING METHOD AND APPARATUS, AND STORAGE MEDIUM", which is
incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This application relates to the field of data processing technologies, and in particular,
to a point cloud encoding method and apparatus, a point cloud decoding method and apparatus,
15 and a storage medium.

BACKGROUND

[0003] With continuous development of three-dimensional sensing technologies, point cloud
collection is becoming more convenient, and a collected point cloud has increasingly high quality
and is also becoming increasingly large. Therefore, currently how to effectively encode and decode
20 the point cloud becomes an urgent problem to be resolved.

SUMMARY

[0004] This application provides a point cloud encoding method and apparatus, a point cloud
decoding method and apparatus, and a storage medium, so as to resolve a problem about how to

information of the to-be-decoded patch is parsed from the bitstream, the auxiliary information of the to-be-decoded patch may be further obtained based on auxiliary information of the reference patch of the to-be-decoded patch, where the auxiliary information includes the two-dimensional information, the rotation transformation information, and the normal coordinate axis information.

5 In this way, the reconstructing the to-be-decoded patch based on the auxiliary information of the to-be-decoded patch includes: reconstructing the to-be-decoded patch based on the two-dimensional information, the three-dimensional information, the normal coordinate axis information, and the rotation transformation information of the to-be-decoded patch.

[0022] When patches in a point cloud are encoded in an arrangement order of the first-type patch, the second-type patch, and the third-type patch, the reference patch of the to-be-decoded patch may be a patch whose location in the reference frame of the current point cloud frame is the same as the location of the to-be-decoded patch in the current point cloud frame. However, in some cases, first-type patches, second-type patches, and third-type patches in each frame of point cloud in the current point cloud group are not arranged in order. In this case, when the first index is the first value, the auxiliary information of the to-be-decoded patch parsed from the bitstream may further include the index information of the reference patch of the to-be-decoded patch. In this way, during decoding, when the parsed first index is the first value, the auxiliary information parsed from the bitstream may further include the index information of the reference patch of the to-be-decoded patch. Then, the reference patch of the to-be-decoded patch may be determined based on the index information of the reference patch of the to-be-decoded patch.

[0023] When the first index is the second value, the index information of the reference patch of the to-be-decoded patch may be parsed from the bitstream by using a method matching that on the encoder side, for example, may be parsed in a fixed-length decoding scheme. For the rotation transformation information and the normal coordinate axis information of the to-be-decoded patch, the reference patch of the to-be-decoded patch may be determined by using the index information of the reference patch of the to-be-decoded patch, rotation transformation information and normal coordinate axis information of the reference patch of the to-be-decoded patch are further obtained, and the rotation transformation information and the normal coordinate axis information of the reference patch are used as the rotation transformation information and the normal coordinate axis information of the to-be-decoded patch. The two-dimensional information and the three-dimensional information of the to-be-decoded patch may be decoded, for example, by using a

for the third-type patch, the two-dimensional information and the three-dimensional information of the non-first third-type patch may be parsed from the bitstream, but the rotation transformation information and the normal coordinate axis information are derived or obtained. In this way, it is unnecessary to encode the rotation transformation information and the normal coordinate axis information into the bitstream, so that the bit overheads of the bitstream are reduced, and the encoding efficiency is improved.

[0026] The first value, the second value, and the third value are binary numbers 10, 11, and 00 respectively, or the first value, the second value, and the third value are binary numbers 11, 10, and 00 respectively. The reference patch of the to-be-decoded patch is included in the reference frame of the current point cloud frame.

[0027] Based on the foregoing description, first-type patches, second-type patches, and third-type patches in each frame of point cloud in the current point cloud group may be arranged in order. In this case, if the to-be-decoded patch is the first patch in the current point cloud frame, after the first index of the to-be-decoded patch is parsed from the bitstream, it may be determined, based on the value of the first index, whether the current point cloud frame is the first frame of point cloud in the current point cloud group. In other words, when the to-be-decoded patch is the first patch in the current point cloud frame, and the first index is the third value, it may be determined that the current point cloud frame is the first frame of point cloud in the current point cloud group. In this case, a length of a point cloud group does not need to be encoded into the bitstream.

[0028] However, in some cases, the first-type patches, the second-type patches, and the third-type patches in each frame of point cloud in the current point cloud group are not arranged in order, in other words, a first index of the first patch in any frame of point cloud in the current point cloud group may be the first value, the second value, or the third value. In this case, when the to-be-decoded patch is the first patch in the current point cloud frame, it cannot be determined, based on the first index parsed from the bitstream, whether the current point cloud frame is the first frame of point cloud in the current point cloud group. In this case, first indexes of a plurality of patches included in the current point cloud frame may be determined. In a possible implementation, the plurality of patches are all patches included in the current point cloud frame. If all the first indexes of the plurality of patches are the third value, it may be determined that the current point cloud frame is the first frame of point cloud in the current point cloud group.

[0029] It should be noted that after the auxiliary information of the to-be-decoded patch is

need to be encoded into the bitstream, in other words, the auxiliary information of the to-be-encoded patch may not include the three-dimensional information. When the second index is the fifth value, it may indicate that the three-dimensional information of the to-be-encoded patch is encoded into the bitstream. In other words, the three-dimensional information of the to-be-encoded patch is different from the three-dimensional information of the reference patch of the to-be-encoded patch. Therefore, the three-dimensional information of the to-be-encoded patch needs to be encoded into the bitstream, in other words, the auxiliary information of the to-be-encoded patch may include the three-dimensional information. A syntax element of the fourth value may be true, and a syntax element of the fifth value may be false.

10 **[0033]** When the first index is the second value, it may indicate that the to-be-encoded patch is a second-type patch. In other words, a reference patch that matches the to-be-encoded patch exists in a reference frame of a current point cloud frame. The auxiliary information of the to-be-encoded patch includes the two-dimensional information, the three-dimensional information, and the index information of the reference patch of the to-be-encoded patch.

15 **[0034]** When the first index is the third value, it may indicate that the to-be-encoded patch is a third-type patch. In other words, no reference patch that matches the to-be-encoded patch exists in the reference frame of the current point cloud frame. The auxiliary information of the to-be-encoded patch includes the two-dimensional information, the three-dimensional information, the rotation transformation information, and the normal coordinate axis information.

20 **[0035]** According to a fourth aspect, a point cloud decoding method is provided, where the method includes: parsing a first index of a to-be-decoded patch from a bitstream; parsing a second index of the to-be-decoded patch from the bitstream when the first index is a first value, and using auxiliary information of a reference patch of the to-be-decoded patch as auxiliary information of the to-be-decoded patch when the second index is a fourth value, or parsing auxiliary information

25 of the to-be-decoded patch from the bitstream when the second index is a fifth value, where the auxiliary information includes three-dimensional information of the to-be-decoded patch; or parsing auxiliary information of the to-be-decoded patch from the bitstream when the first index is a second value, where the auxiliary information includes two-dimensional information and three-dimensional information of the to-be-decoded patch, and index information of a reference

30 patch of the to-be-decoded patch; or parsing auxiliary information of the to-be-decoded patch from the bitstream when the first index is a third value, where the auxiliary information includes two-

based network may be a local area network, a wide area network, a global network (for example, Internet), or the like. The one or more communication media may include a router, a switch, a base station, another device that facilitates communication from the source apparatus 10 to the destination apparatus 20, or the like. This is not specifically limited in this embodiment of this application.

[00109] In a possible implementation, the storage apparatus 40 may store the received encoded point cloud data sent by the source apparatus 10, and the destination apparatus 20 may directly obtain the encoded point cloud data from the storage apparatus 40. In this way, the storage apparatus 40 may include any one of a plurality of distributed or locally accessed data storage media. For example, any one of the plurality of distributed or locally accessed data storage media may be a hard disk drive, a Blu-ray disc, a digital versatile disc (digital versatile disc, DVD), a compact disc read-only memory (compact disc read-only memory, CD-ROM), a flash memory, a volatile or non-volatile memory, or any other suitable digital storage medium configured to store the encoded point cloud data.

[00110] In a possible implementation, the storage apparatus 40 may correspond to a file server or another intermediate storage apparatus that may store the encoded point cloud data generated by the source apparatus 10, and the destination apparatus 20 may stream or download the point cloud data stored in the storage apparatus 40. The file server may be any type of server that can store the encoded point cloud data and send the encoded point cloud data to the destination apparatus 20. In a possible implementation, the file server may include a network server, a file transfer protocol (file transfer protocol, FTP) server, a network attached storage (network attached storage, NAS) apparatus, a local disk drive, and the like. The destination apparatus 20 may obtain the encoded point cloud data by using any standard data connection (including an Internet connection). The any standard data connection may include a wireless channel (for example, a Wi-Fi connection), a wired connection (for example, a digital subscriber line (digital subscriber line, DSL) or a cable modem), or a combination of the wireless channel and the wired connection adapted to obtain the encoded point cloud data stored on the file server. Transmission of the encoded point cloud data from the storage apparatus 40 may be streaming transmission, download transmission, or a combination of the two.

[00111] The point cloud coding system shown in FIG. 1 is only a possible implementation. Moreover, in addition to being applied to the source apparatus 10 for encoding the point cloud data and

the destination apparatus 20 for decoding the encoded point cloud data shown in FIG. 1, the technologies in this application may be further applied to another apparatus that can encode the point cloud and decode the encoded point cloud data. This is not specifically limited in this embodiment of this application.

5 **[00112]** In the point cloud coding system shown in FIG. 1, the source apparatus 10 includes a data source 120, an encoder 100, and an output interface 140. In some embodiments, the output interface 140 may include a modulator/demodulator (modem) and/or a transmitter, where the transmitter may also be referred to as a transmitter. The data source 120 may include a point cloud capturing apparatus (for example, a camera), a point cloud archive containing previously captured
10 point cloud data, a point cloud feed-in interface for receiving point cloud data from a point cloud content provider, and/or a computer graphics system for generating point cloud data, or a combination of these sources of point cloud data.

[00113] The data source 120 may send a point cloud to the encoder 100, and the encoder 100 may encode the received point cloud sent from the data source 120 to obtain encoded point cloud
15 data. The encoder may send the encoded point cloud data to the output interface. In some embodiments, the source apparatus 10 sends the encoded point cloud data directly to the destination apparatus 20 through the output interface 140. In another embodiment, the encoded point cloud data may further be stored on the storage apparatus 40 for the destination apparatus 20 to obtain subsequently for decoding and/or playback.

20 **[00114]** In the embodiment of FIG. 1, the destination apparatus 20 includes an input interface 240, a decoder 200, and a display apparatus 220. In some embodiments, the input interface 240 includes a receiver and/or a modem. The input interface 240 may receive the encoded point cloud data through the link 30 and/or from the storage apparatus 40, and then send the encoded point cloud data to the decoder 200. The decoder 200 may decode the received encoded point cloud data
25 to obtain decoded point cloud data. The decoder may send the decoded point cloud data to the display apparatus 220. The display apparatus 220 may be integrated with the destination apparatus 20 or may be external to the destination apparatus 20. Generally, the display apparatus 220 displays the decoded point cloud data. The display apparatus 220 may be a display apparatus of any one of a plurality of types. For example, the display apparatus 220 may be a liquid crystal display (liquid
30 crystal display, LCD), a plasma display, an organic light-emitting diode (organic light-emitting diode, OLED) display, or another type of display apparatus.

[00115] Although not shown in FIG. 1, in some aspects, the encoder 100 and the decoder 200 may be respectively integrated with an audio encoder and an audio decoder, and may include an appropriate multiplexer-demultiplexer (multiplexer-demultiplexer, MUX-DEMUX) unit or other hardware and software for encoding or decoding both audio and videos in a shared data stream or
5 separate data streams. In some embodiments, if applicable, the MUX-DEMUX unit may comply with the ITU H.223 multiplexer protocol or another protocol such as a user datagram protocol (user datagram protocol, UDP).

[00116] The encoder 100 and the decoder 200 may each be any one of the following circuits: one or more microprocessors, a digital signal processor (digital signal processor, DSP), an
10 application-specific integrated circuit (application-specific integrated circuit, ASIC), a field-programmable gate array (field-programmable gate array, FPGA), discrete logic, hardware, or any combination thereof. If this application is partially implemented by software, the apparatus may store an instruction used for software in a suitable non-volatile computer readable storage medium, and may use one or more processors to execute the instruction in hardware to implement the
15 technologies in this application. Any of the foregoing content (including hardware, software, and a combination of hardware and software) may be considered as one or more processors. Each of the encoder 100 and the decoder 200 may be included in one or more encoders or decoders, and any one of the encoders or the decoders may be integrated as a part of a combined encoder/decoder (codec) in a corresponding apparatus.

[00117] In this application, the encoder 100 may be generally referred to as "signaling" or "sending" some information to another apparatus, for example, the decoder 200. The term "signaling" or "sending" may generally refer to transmission of a syntax element used to decode compressed point cloud data and/or other data. Such transmission may occur in real time or almost
20 real time. Alternatively, such communication may occur after a period of time, for example, may occur when a syntax element in an encoded bitstream is stored in a computer readable storage medium during encoding, and the decoding apparatus may then retrieve the syntax element at any
25 time after the syntax element is stored in the medium.

[00118] FIG. 2 is a schematic block diagram of an encoder 100 according to an embodiment of this application. FIG. 2 is described by using an example of an MPEG (moving picture expert
30 group) point cloud compression (point cloud compression, PCC) encoding framework. Referring to FIG. 2, the encoder 100 may include a point cloud patch information generation module 101, a

point cloud frame in this embodiment of this application. The patch of the point cloud shown in FIG. 4 may be a patch of the current point cloud frame in this embodiment of this application. The occupancy map of the point cloud shown in FIG. 5 may be the occupancy map of the current point cloud frame in this embodiment of this application.

5 **[00122]** After receiving the occupancy map of the current point cloud frame and the packing information of the patch that are sent by the packing module 102, and the first index of each patch and the auxiliary information of each patch that are sent by the point cloud patch information generation module 101, the auxiliary information encoding module 109 may encode the current point cloud frame and each patch included in the current point cloud frame to obtain a bitstream
10 including encoded auxiliary information, and then send the obtained bitstream including the encoded auxiliary information to the multiplexing module 110. The two-dimensional information of each patch and the index information of the reference patch of each patch in the packing information of the patch may also be referred to as the auxiliary information of each patch.

[00123] After receiving the packing information of the patch sent by the packing module 102
15 and the depth map of each patch sent by the point cloud patch information generation module 101, the depth map generation module 103 may generate a depth map of the current point cloud frame based on the packing information of each patch and the depth map of each patch; and then, send the generated depth map of the current point cloud frame to the depth map filling module 105, so as to fill an empty pixel in the depth map of the current point cloud frame to obtain a filled depth
20 map of the current point cloud frame. The depth map filling module 105 may send the obtained filled depth map of the current point cloud frame to the picture-based or video-based encoding module 107, so as to perform picture-based or video-based encoding on the filled depth map of the current point cloud frame to obtain a reconstructed depth map of the current point cloud and a bitstream including an encoded depth map of the current point cloud frame, and may send the
25 obtained reconstructed depth map of the current point cloud frame to the point cloud reconstruction module 113, and send the bitstream including the encoded depth map of the current point cloud frame to the multiplexing module 110.

[00124] The point cloud occupancy map downsampling module 111 may perform downsampling processing on the received occupancy map of the current point cloud frame sent by
30 the packing module 102, to obtain a low-resolution occupancy map of the current point cloud frame. Then, the point cloud occupancy map downsampling module 111 may further send the low-

resolution occupancy map of the current point cloud frame to the occupancy map encoding module 108 and the point cloud occupancy map filling module 112. The occupancy map encoding module 108 may encode the received low-resolution occupancy map of the current point cloud frame to obtain a bitstream including an encoded low-resolution occupancy map of the current point cloud frame, and the occupancy map encoding module 108 may further send the bitstream including the encoded low-resolution occupancy map of the current point cloud frame to the multiplexing module 110. The point cloud occupancy map filling module 112 fills an original-resolution occupancy map of the current point cloud frame based on the received low-resolution occupancy map of the current point cloud frame, to obtain a filled occupancy map of the current point cloud frame, where the filled occupancy map of the current point cloud frame has an original resolution.

[00125] The point cloud reconstruction module 113 may reconstruct a geometry of the current point cloud frame based on the received filled occupancy map of the current point cloud frame sent by the point cloud occupancy map filling module 112, the reconstructed depth map of the current point cloud frame sent by the picture-based or video-based encoding module 107, the packing information of the patch, and the auxiliary information of the patch, so as to output a reconstructed point cloud. In addition, the point cloud reconstruction module 113 may further output a correspondence between a reconstructed point in the reconstructed point cloud and a patch, and a packing location of the reconstructed point in the reconstructed point cloud. The point cloud reconstruction module 113 may send the reconstructed point cloud and the correspondence between a reconstructed point in the reconstructed point cloud and a patch to the point cloud filtering module 114, and the point cloud reconstruction module 113 may further send the packing location of the reconstructed point in the reconstructed point cloud to the texture generation module 104.

[00126] After receiving the reconstructed point cloud and the correspondence between a reconstructed point in the reconstructed point cloud and a patch that are sent by the point cloud reconstruction module 113, the point cloud filtering module 114 may filter the reconstructed point cloud. Specifically, defects such as an obvious noise point and a seam in the reconstructed point cloud may be removed to obtain a filtered reconstructed point cloud, which may also be referred to as a smoothed reconstructed point cloud. Alternatively, the point cloud filtering module 114 may perform smoothing processing on the reconstructed point cloud.

[00127] After receiving the smoothed reconstructed point cloud sent by the point cloud filtering

module 114, the packing location of the reconstructed point in the reconstructed point cloud sent by the point cloud reconstruction module 113, and the current point cloud frame sent by the data source 120, the texture map generation module 104 may generate a texture map of the current point cloud frame based on the smoothed reconstructed point cloud, the packing location of the reconstructed point in the reconstructed point cloud, and the current point cloud frame, and may send the generated texture map of the current point cloud frame to the texture map filling module 106, so as to fill an empty pixel in the texture map of the current point cloud frame to obtain a filled texture map of the current point cloud frame. The texture map filling module 106 may send the obtained filled texture map of the current point cloud frame to the picture-based or video-based encoding module 107, so as to perform picture-based or video-based encoding on the filled texture map of the current point cloud frame to obtain a bitstream including a reconstructed texture map of the current point cloud frame. The picture-based or video-based encoding module 107 may further send the obtained bitstream including the reconstructed texture map of the current point cloud frame to the multiplexing module 110.

[00128] Based on the foregoing description, the picture-based or video-based encoding module 107, the occupancy map encoding module 108, and the auxiliary information encoding module 109 may send the obtained bitstreams to the multiplexing module 110, and the multiplexing module 110 may combine these received bitstreams into a combined bitstream, and send the combined bitstream to an output interface 140. The output interface 140 may send the combined bitstream to a decoder 200.

[00129] It should be understood that the encoder 100 shown in FIG. 2 is merely an embodiment of this application. In a specific implementation, the encoder 100 may include more or fewer modules than the modules shown in FIG. 2. This is not specifically limited in this embodiment of this application.

[00130] FIG. 6 is a schematic block diagram of a decoder 200 according to an embodiment of this application. FIG. 6 is described by using an example of an MPEG PCC decoding framework. Referring to FIG. 6, the decoder 200 may include a demultiplexing module 201, a picture-based or video-based decoding module 202, an occupancy map decoding module 203, an auxiliary information decoding module 204, a point cloud occupancy map filling module 205, a point cloud geometry information reconstruction module 206, a point cloud filtering module 207, and a point cloud texture information reconstruction module 208.

[00131] The demultiplexing module 201 may receive, through an input interface 204, a combined bitstream sent by an output interface 140 of an encoder 100, and send the combined bitstream to a corresponding decoding module. Specifically, the demultiplexing module 201 sends a bitstream including an encoded texture map of a current point cloud frame and a bitstream including an encoded depth map of the current point cloud frame to the picture-based or video-based decoding module 202, sends a bitstream including an encoded low-resolution occupancy map of the current point cloud frame to the occupancy map decoding module 203, and sends a bitstream including encoded auxiliary information to the auxiliary information decoding module 204.

[00132] The picture-based or video-based decoding module 202 may decode the received bitstream including the encoded texture map of the current point cloud frame and the bitstream including the encoded depth map of the current point cloud frame to obtain reconstructed texture map information of the current point cloud frame and reconstructed depth map information of the current point cloud frame, and may send the reconstructed texture map information of the current point cloud frame to the point cloud texture information reconstruction module 208, and send the reconstructed depth map information of the current point cloud frame to the point cloud geometry information reconstruction module 206. The occupancy map decoding module 203 may decode the received bitstream including the encoded low-resolution occupancy map of the current point cloud frame to obtain reconstructed low-resolution occupancy map information of the current point cloud frame, and send the reconstructed low-resolution occupancy map information of the current point cloud frame to the point cloud filling module 205. The point cloud occupancy map filling module 205 may obtain reconstructed original-resolution occupancy map information of the current point cloud frame based on the reconstructed low-resolution occupancy map information of the current point cloud frame, and then send the reconstructed original-resolution occupancy map information of the current point cloud frame to the point cloud geometry information reconstruction module 206. For ease of description, the reconstructed original-resolution occupancy map information of the current point cloud frame is subsequently collectively referred to as reconstructed occupancy map information of the current point cloud frame.

[00133] The auxiliary information decoding module 204 may decode the received bitstream including the encoded auxiliary information to obtain auxiliary information, and may send the auxiliary information to the point cloud geometry information reconstruction module 206. A specific decoding method

is described in a subsequent embodiment.

[00134] The point cloud geometry information reconstruction module 206 may reconstruct a geometry of the current point cloud frame based on the received reconstructed depth map information of the current point cloud frame sent by the picture-based or video-based decoding module 202, the reconstructed occupancy map information of the current point cloud frame sent by the point cloud occupancy map filling module 205, and the auxiliary information sent by the auxiliary information decoding module 204, so as to obtain a reconstructed point cloud. The reconstructed point cloud is similar to the reconstructed point cloud obtained by a point cloud reconstruction module 113 in the encoder 100. For a specific reconstruction process, refer to a reconstruction process of the point cloud reconstruction module 112 in the encoder 100. Details are not described herein again. The point cloud geometry information reconstruction module 206 may further send the reconstructed point cloud to the point cloud filtering module 207. The point cloud filtering module 207 may filter the reconstructed point cloud based on the received reconstructed point cloud to obtain a smoothed reconstructed point cloud. For a specific filtering process, refer to a filtering process of a point cloud filtering module 114 in the encoder 100. Details are not described herein again. The point cloud filtering module 207 may send the smoothed reconstructed point cloud to the point cloud texture information reconstruction module 208. After receiving the smoothed reconstructed point cloud sent by the point cloud filtering module 207 and the reconstructed texture map information of the current point cloud frame sent by the picture-based or video-based decoding module 202, the point cloud texture information reconstruction module 208 may reconstruct texture information of the reconstructed point cloud to obtain the reconstructed point cloud with reconstructed texture information.

[00135] It should be understood that the decoder 200 shown in FIG. 6 is merely an example. In specific implementation, the decoder 200 may include more or fewer modules than those shown in FIG. 6. This is not limited in this embodiment of this application.

[00136] For ease of understanding, the following first describes technical terms involved in the embodiments of this application.

[00137] In an example, a current point cloud group may be a group of frames (group of frames, GOF), and one group of frames may include 32 frames of point clouds, in other words, the current point cloud group may include 32 frames of point clouds. Certainly, a quantity of frames of point clouds included in the current point cloud group may alternatively be another value, which is not limited in this embodiment of this application. In an example, one group of frames may be further

three-dimensional information of the to-be-encoded patch. In a third possible case, when the to-be-encoded patch is a first-type patch, two-dimensional information of a reference patch of the to-be-encoded patch is different from two-dimensional information of the to-be-encoded patch, and three-dimensional information of the reference patch of the to-be-encoded patch is different from three-dimensional information of the to-be-encoded patch.

[00141] When patches included in all point clouds in a current point cloud group are arranged in the manner shown in FIG. 8, a reference patch of a to-be-encoded patch may be a patch at a same location in a reference frame of a current point cloud frame in which the to-be-decoded patch is located. For example, if the to-be-decoded patch is at the third location in the current point cloud frame, the third patch in the reference frame of the current point cloud frame is the reference patch of the to-be-decoded patch.

[00142] The rotation transformation information may be rotation angle information, coordinate axis transformation information, or image transformation information. The rotation angle information includes a specific rotation angle value or rotation angle index. For example, if a rotation angle value of the to-be-encoded patch is 0, it indicates that the to-be-encoded patch does not rotate. If the rotation angle value of the to-be-encoded patch is 20, it indicates that the to-be-encoded patch rotates by 20°. If the rotation angle value of the to-be-encoded patch is 80, it indicates that the to-be-encoded patch rotates by 80°. For another example, if a rotation angle index of the to-be-encoded patch is 0, it indicates that the to-be-encoded patch does not rotate. If the rotation angle index of the to-be-encoded patch is 1, it indicates that the to-be-encoded patch rotates by 15°. If the rotation angle index of the to-be-encoded patch is 2, it indicates that the to-be-encoded patch rotates by 30°. If the rotation angle index of the to-be-encoded patch is 3, it indicates that the to-be-encoded patch rotates by 45°. The rotation angle information may alternatively be represented in another form, which is not specifically limited herein. For example, a matrix form may alternatively be used for description. Especially, when acceleration processing is performed in a GPU (Graphic Processing Unit, graphic processing unit), a processing speed is increased by using the matrix form.

[00143] It should be noted that rotation of the to-be-encoded patch may be clockwise rotation, or may be counterclockwise rotation.

[00144] If the rotation transformation information is the coordinate axis swap information, the coordinate axis swap information may be represented as a coordinate axis swap flag. For example,

into the bitstream in the differential encoding scheme based on the two-dimensional information and the three-dimensional information of the first third-type patch means encoding a difference between the two-dimensional information of the to-be-encoded patch and the two-dimensional information of the first third-type patch, and a difference between the three-dimensional information of the to-be-encoded patch and the three-dimensional information of the first third-type patch into the bitstream.

[00162] In this embodiment of this application, the auxiliary information of the to-be-encoded patch is first obtained, and then the auxiliary information and the first index of the to-be-encoded patch are encoded into the bitstream. Values of the first index may be the first value, the second value, and the third value. Different values indicate different types of patches. Therefore, different types of patches can be distinguished by using the first index. In this way, a quantity of first-type patches does not need to be written into the bitstream, and bit overheads of the bitstream are reduced. In addition, for different types of patches, content included in auxiliary information encoded into the bitstream may be different, and for the first-type patch and the second-type patch, only a portion of auxiliary information is encoded into the bitstream. This can simplify a format of information encoded into the bitstream, reduce the bit overheads of the bitstream, and improve encoding efficiency.

[00163] Next, a point cloud decoding method corresponding to the point cloud encoding method based on the foregoing embodiment shown in FIG. 9 is described. It should be noted that, with reference to the point cloud coding system shown in FIG. 1 and the schematic block diagram of the decoder 200 shown in FIG. 6, any point cloud decoding method in the following may be performed by the decoder 200 in the point cloud coding system, and more specifically, may be performed by the auxiliary information decoding module 204 in the decoder 200. Referring to FIG. 11, the decoding method includes the following steps.

[00164] S1101. Parse a first index of a to-be-decoded patch from a bitstream.

[00165] First indexes of all patches in a current point cloud frame may be separately packed and encoded into the bitstream, or may be packed together and encoded into the bitstream. Therefore, for a scheme in which the first indexes are separately packed and encoded into the bitstream, if the to-be-decoded patch is the first patch in the current point cloud frame, the first index of the to-be-decoded patch may be parsed from the bitstream. Certainly, for a non-first patch, the first index of the to-be-decoded patch may alternatively be parsed from the bitstream. In other

11, 10, and 00 respectively. This is not limited in this embodiment of this application.

[00180] Based on the foregoing description, first-type patches, second-type patches, and third-type patches in each frame of point cloud in the current point cloud group may be arranged in the manner shown in FIG. 8. In this case, if the to-be-decoded patch is the first patch in the current point cloud frame, after the first index of the to-be-decoded patch is parsed from the bitstream, it may be determined, based on the value of the first index, whether the current point cloud frame is the first frame of point cloud in the current point cloud group. In other words, when the to-be-decoded patch is the first patch in the current point cloud frame, and the first index is the third value, it may be determined that the current point cloud frame is the first frame of point cloud in the current point cloud group.

[00181] However, in some cases, first-type patches, second-type patches, and third-type patches in each frame of point cloud in the current point cloud group are not arranged in the manner shown in FIG. 8, in other words, a first index of the first patch in any frame of point cloud in the current point cloud group may be the first value, the second value, or the third value. In this case, when the to-be-decoded patch is the first patch in the current point cloud frame, it cannot be determined, based on the first index parsed from the bitstream, whether the current point cloud frame is the first frame of point cloud in the current point cloud group. In this case, first indexes of a plurality of patches included in the current point cloud frame may be determined. In a possible implementation, the plurality of patches are all patches included in the current point cloud frame. If all the first indexes of the plurality of patches are the third value, it may be determined that the current point cloud frame is the first frame of point cloud in the current point cloud group.

[00182] When the first index is the third value, if auxiliary information of the first third-type patch is encoded in a fixed-length encoding scheme, two-dimensional information and three-dimensional information of a non-first third-type patch are encoded in a differential encoding scheme, and other auxiliary information is encoded in the fixed-length encoding scheme, in this step, for the non-first third-type patch, the two-dimensional information and the three-dimensional information of the to-be-decoded patch may be parsed from the bitstream in the differential decoding scheme, and the rotation transformation information and the normal coordinate axis information of the to-be-decoded patch are parsed from the bitstream in the fixed-length decoding scheme. For the non-first third-type patch, a manner of parsing the two-dimensional information and the three-dimensional information of the to-be-decoded patch from the bitstream in the

patch, only a portion of auxiliary information is encoded into the bitstream. This can simplify a format of information encoded into the bitstream, reduce the bit overheads of the bitstream, and improve encoding efficiency.

5 [00203] Next, a point cloud decoding method corresponding to the point cloud encoding method based on the embodiment shown in FIG. 12 is described. It should be noted that, with reference to the point cloud coding system shown in FIG. 1 and the schematic block diagram of the decoder 200 shown in FIG. 6, any point cloud decoding method in the following may be performed by the decoder 200 in the point cloud coding system, and more specifically, may be performed by the auxiliary information decoding module 204 in the decoder 200. Referring to FIG.
10 13, the decoding method includes the following steps.

[00204] S1301. Parse a first index of a to-be-decoded patch from a bitstream.

[00205] It should be noted that for content of S1301, refer to content of S1101, and details are not described herein again.

[00206] S1302. Parse a second index of the to-be-decoded patch from the bitstream when the
15 first index is a first value.

[00207] It should be noted that the second index is described in S1201. Therefore, details are not described herein again.

[00208] S1303. Use auxiliary information of a reference patch of the to-be-decoded patch as auxiliary information of the to-be-decoded patch when the second index is a fourth value; or parse
20 auxiliary information of the to-be-decoded patch from the bitstream when the second index is a fifth value, where the auxiliary information includes three-dimensional information of the to-be-decoded patch.

[00209] It should be noted that when the second index is the fourth value, it may indicate that the three-dimensional information of the to-be-decoded patch is not encoded into the bitstream. In
25 other words, the three-dimensional information of the to-be-decoded patch is the same as three-dimensional information of the reference patch of the to-be-decoded patch. In this case, the auxiliary information of the reference patch of the to-be-decoded patch may be used as the auxiliary information of the to-be-decoded patch. When the second index is the fifth value, it may indicate that the three-dimensional information of the to-be-decoded patch is encoded into the
30 bitstream, and the auxiliary information of the to-be-decoded patch includes the three-dimensional information. In this case, the auxiliary information of the to-be-decoded patch is parsed from the

further be used to indicate whether the two-dimensional information and the three-dimensional information of the to-be-encoded patch are both encoded into the bitstream. In other words, when the first index is the first value, the fourth index of the to-be-decoded patch may be parsed from the bitstream. When the fourth index is an eighth value, it may indicate that the two-dimensional information and the three-dimensional information of the to-be-decoded patch are the same as two-dimensional information and three-dimensional information of the reference patch of the to-be-decoded patch, and are not encoded into the bitstream. Therefore, the two-dimensional information and the three-dimensional information of the reference patch of the to-be-decoded patch may be used as the two-dimensional information and the three-dimensional information of the to-be-decoded patch. When the fourth index is a ninth value, it may indicate that the two-dimensional information and the three-dimensional information of the to-be-decoded patch are different from the two-dimensional information and the three-dimensional information of the reference patch of the to-be-decoded patch, and both are encoded into the bitstream. Therefore, the two-dimensional information and the three-dimensional information of the to-be-decoded patch may be parsed from the bitstream. A specific decoding scheme may be a decoding method matching the encoding method, and details are not described herein.

[00212] In addition, a manner of using an index (`override_3d_shift_tangent_axis`) used to indicate whether `3d_shift_tangent_axis` is encoded into the bitstream, an index (`override_3d_shift_bitangent_axis`) used to indicate whether `3d_shift_bitangent_axis` is encoded into the bitstream, and an index (`override_3d_shift_normal_axis`) used to indicate whether `3d_shift_normal_axis` is encoded into the bitstream to indicate whether the three-dimensional information of the to-be-decoded patch is encoded into the bitstream and a manner of using an index (`override_2d_shift_u`) used to indicate whether `2d_shift_u` is encoded into the bitstream, an index (`override_2d_shift_v`) used to indicate whether `2d_shift_v` is encoded into the bitstream, an index (`override_2d_size_u`) used to indicate whether `2d_size_u` is encoded into the bitstream, and an index (`override_2d_size_v`) used to indicate whether `2d_size_v` is encoded into the bitstream to indicate whether the two-dimensional information of the to-be-decoded patch is encoded into the bitstream are similar to those for the second index, the third index, and the fourth index. Details are not described herein again.

[00213] S1304. Parse auxiliary information of the to-be-decoded patch from the bitstream when the first index is a second value, where the auxiliary information includes two-dimensional

information and three-dimensional information of the to-be-decoded patch, and index information of a reference patch of the to-be-decoded patch.

[00214] It should be noted that for content of S1304, refer to content of S1103, and details are not described herein again.

5 **[00215] S1305.** Parse auxiliary information of the to-be-decoded patch from the bitstream when the first index is a third value, where the auxiliary information includes two-dimensional information, three-dimensional information, rotation transformation information, and normal coordinate axis information of the to-be-decoded patch.

[00216] It should be noted that for content of S1305, refer to content of S1104, and details are
10 not described herein again.

[00217] S1306. Reconstruct the to-be-decoded patch based on the auxiliary information of the to-be-decoded patch.

[00218] It should be noted that for content of S1306, refer to content of S1105, and details are not described herein again.

15 **[00219]** In this embodiment of this application, values of the first index may be the first value, the second value, and the third value. Different values indicate different types of patches. Therefore, different types of patches can be distinguished by using the first index. In this way, a quantity of first-type patches does not need to be parsed from the bitstream, and bit overheads of the bitstream are reduced. In addition, when the first index is the first value, the second index of the to-be-
20 decoded patch is parsed from the bitstream. When the second index is the fourth value, it indicates that three-dimensional information of the to-be-decoded patch is not encoded into the bitstream. In other words, the three-dimensional information of the to-be-decoded patch is the same as the three-dimensional information of the reference patch of the to-be-decoded patch. In this case, the three-dimensional information of the reference patch of the to-be-decoded patch may be used as
25 the three-dimensional information of the to-be-decoded patch, and the three-dimensional information of the to-be-decoded patch does not need to be parsed from the bitstream. Therefore, this can simplify a format of parsing the bitstream, reduce bit overheads of the bitstream, and improve decoding efficiency.

[00220] FIG. 14 is a schematic structural diagram of a first point cloud encoding apparatus
30 according to an embodiment of this application. As shown in FIG. 14, an encoding apparatus 1400 may include:

packing module 102 in FIG. 2, and the auxiliary information encoding module 1402 may correspond to the auxiliary information encoding module 109 in FIG. 2. In other words, a function of the patch information obtaining module 1401 may be implemented by the point cloud patch information generation module 101 and the packing module 102 in FIG. 2, and a function of the auxiliary information encoding module 1402 may be implemented by the auxiliary information encoding module 109 in FIG. 2. In an example, the point cloud patch information generation module 101 is configured to obtain the three-dimensional information, the normal coordinate axis information, the first index, and the like of the to-be-encoded patch. The packing module 102 is configured to obtain the rotation transformation information of the to-be-encoded patch, the index information of the reference patch, the two-dimensional information, and the like. Certainly, this application is not limited thereto. For other details, refer to a conventional technology or the foregoing explanation of the principle of the encoder shown in FIG. 2. Details are not described herein again.

[00226] FIG. 15 is a schematic structural diagram of a first point cloud decoding apparatus according to an embodiment of this application. As shown in FIG. 15, the decoding apparatus 1500 may include:

an auxiliary information decoding module 1501, configured to parse a first index of a to-be-decoded patch from a bitstream, where

the auxiliary information decoding module 1501 is further configured to: parse auxiliary information of the to-be-decoded patch from the bitstream when the first index is a first value, where the auxiliary information includes three-dimensional information of the to-be-decoded patch; or parse auxiliary information of the to-be-decoded patch from the bitstream when the first index is a second value, where the auxiliary information includes two-dimensional information and three-dimensional information of the to-be-decoded patch, and index information of a reference patch of the to-be-decoded patch; or parse auxiliary information of the to-be-decoded patch from the bitstream when the first index is a third value, where the auxiliary information includes two-dimensional information, three-dimensional information, rotation transformation information, and normal coordinate axis information of the to-be-decoded patch; and

a reconstruction module 1502, configured to reconstruct the to-be-decoded patch based on the auxiliary information of the to-be-decoded patch.

[00232] The reference patch of the to-be-decoded patch is included in a reference frame of the current point cloud frame.

[00233] It should be noted that the auxiliary information decoding module 1501 is configured to execute related content of steps S1101 to S1104 in the embodiment shown in FIG. 11, and the reconstruction module 1502 is configured to execute related content of step S1105 in the embodiment shown in FIG. 11. As an example, the auxiliary information decoding module 1501 in FIG. 15 corresponds to the auxiliary information decoding module 204 in FIG. 6, and the reconstruction module 1502 in FIG. 15 corresponds to the point cloud geometry information reconstruction module 206 in FIG. 6. In other words, a function of the auxiliary information decoding module 1501 may be implemented by the auxiliary information decoding module 204 in FIG. 6, and a function of the reconstruction module 1502 may be implemented by the point cloud geometry information reconstruction module 206 in FIG. 6. Certainly, this application is not limited thereto. For other details, refer to a conventional technology or the foregoing explanation of the principle of the decoder shown in FIG. 6. Details are not described herein again.

[00234] FIG. 16 is a schematic structural diagram of a second point cloud encoding apparatus according to an embodiment of this application. As shown in FIG. 16, the encoding apparatus 1600 may include:

a point cloud patch (patch) information obtaining module 1601, configured to obtain auxiliary information of a to-be-encoded patch; and

an auxiliary information encoding module 1602, configured to encode the auxiliary information of the to-be-encoded patch and a first index of the to-be-encoded patch into a bitstream, where

the first index is a first value, indicating that the to-be-encoded patch is a first-type patch, and information encoded into the bitstream further includes a second index, where the second index is a fourth value, indicating that three-dimensional information of the to-be-encoded patch is not encoded into the bitstream, or the second index is a fifth value, indicating that three-dimensional information of the to-be-encoded patch is encoded into the bitstream, and the auxiliary information of the to-be-encoded patch includes the three-dimensional information; or

the first index is a second value, indicating that the to-be-encoded patch is a second-type patch, and the auxiliary information of the to-be-encoded patch includes two-dimensional information, three-dimensional information, and index information of a reference patch of the to-

be-encoded patch; or

the first index is a third value, indicating that the to-be-encoded patch is a third-type patch, and the auxiliary information of the to-be-encoded patch includes two-dimensional information, three-dimensional information, rotation transformation information, and normal coordinate axis information.

[00235] It should be noted that the patch information obtaining module 1601 is configured to execute related content of step S1201 in the embodiment shown in FIG. 12, and the auxiliary information encoding module 1602 is configured to execute related content of step S1202 in the embodiment shown in FIG. 12. In an example, the patch information obtaining module 1601 may correspond to a combination of the point cloud patch information generation module 101 and the packing module 102 in FIG. 2, and the auxiliary information encoding module 1602 may correspond to the auxiliary information encoding module 109 in FIG. 2. In other words, a function of the patch information obtaining module 1601 may be implemented by the point cloud patch information generation module 101 and the packing module 102 in FIG. 2, and a function of the auxiliary information encoding module 1602 may be implemented by the auxiliary information encoding module 109 in FIG. 2. In an example, the point cloud patch information generation module 101 is configured to obtain the three-dimensional information, the normal coordinate axis information, the first index, the second index, and the like of the to-be-encoded patch. The packing module 102 is configured to obtain the rotation transformation information of the to-be-encoded patch, the index information of the reference patch, the two-dimensional information, and the like. Certainly, this application is not limited thereto. For other details, refer to a conventional technology or the foregoing explanation of the principle of the encoder shown in FIG. 2. Details are not described herein again.

[00236] FIG. 17 is a schematic structural diagram of a second point cloud decoding apparatus according to an embodiment of this application. As shown in FIG. 17, the decoding apparatus 1700 may include:

an auxiliary information decoding module 1701, configured to parse a first index of a to-be-decoded patch from a bitstream, where

the auxiliary information decoding module 1701 is further configured to: parse a second index of the to-be-decoded patch from the bitstream when the first index is a first value, and use auxiliary information of a reference patch of the to-be-decoded patch as auxiliary

information of the to-be-decoded patch when the second index is a fourth value or parse auxiliary information of the to-be-decoded patch from the bitstream when the second index is a fifth value, where the auxiliary information includes three-dimensional information of the to-be-decoded patch; or parse auxiliary information of the to-be-decoded patch from the bitstream when the first index is a second value, where the auxiliary information includes two-dimensional information and three-dimensional information of the to-be-decoded patch, and index information of a reference patch of the to-be-decoded patch; or parse auxiliary information of the to-be-decoded patch from the bitstream when the first index is a third value, where the auxiliary information includes two-dimensional information, three-dimensional information, rotation transformation information, and normal coordinate axis information of the to-be-decoded patch; and

a reconstruction module 1702, configured to reconstruct the to-be-decoded patch based on the auxiliary information of the to-be-decoded patch.

[00237] It should be noted that the auxiliary information decoding module 1701 is configured to execute related content of steps S1301 to S1305 in the embodiment shown in FIG. 13, and the reconstruction module 1702 is configured to execute related content of step S1306 in the embodiment shown in FIG. 13. As an example, the auxiliary information decoding module 1701 in FIG. 17 corresponds to the auxiliary information decoding module 204 in FIG. 6, and the reconstruction module 1702 in FIG. 17 corresponds to the point cloud geometry information reconstruction module 206 in FIG. 6. In other words, a function of the auxiliary information decoding module 1701 may be implemented by the auxiliary information decoding module 204 in FIG. 6, and a function of the reconstruction module 1702 may be implemented by the point cloud geometry information reconstruction module 206 in FIG. 6. Certainly, this application is not limited thereto. For other details, refer to a conventional technology or the foregoing explanation of the principle of the decoder shown in FIG. 6. Details are not described herein again.

[00238] FIG. 18 is a schematic block diagram of an implementation of a coding apparatus 1800 according to an embodiment of this application. The coding apparatus 1800 may include a processor 1801, a memory 1802, and a bus system 1803. The processor 1801 is connected to the memory 1802 by using the bus system 1803, the memory 1802 is configured to store instructions, and the processor 1801 is configured to execute the instructions stored in the memory 1802, so as to perform various point cloud encoding or decoding methods described in this application.

To avoid repetition, details are not described herein again.

[00239] In this embodiment of this application, the processor 1801 may be a central processing unit (central processing unit, CPU), or the processor 1801 may be another general-purpose processor, a DSP, an ASIC, an FPGA or another programmable logic device, a discrete gate or a transistor logic device, a discrete hardware component, or the like. The general purpose processor may be a microprocessor, or the processor may be any conventional processor or the like.

[00240] The memory 1802 may include a ROM device or a RAM device. Any another suitable type of storage device may also be used as the memory 1802. The memory 1802 may include code and data 18021 accessed by the processor 1801 by using the bus system 1803. The memory 1802 may further include an operating system 18023 and an application program 18022. The application program 18022 includes at least one program that allows the processor 1801 to perform the point cloud encoding or decoding method described in this application (in particular, the point cloud codec method described in this application). For example, the application program 18022 may include applications 1 to N, which further include a point cloud encoding or decoding application (referred to as a point cloud coding application) performing the point cloud encoding or decoding method described in this application.

[00241] The bus system 1803 may further include a power bus, a control bus, a status signal bus, and the like, in addition to a data bus. However, for clear description, various types of buses in the figure are marked as the bus system 1803.

[00242] Optionally, the coding apparatus 1800 may further include one or more output devices, such as a display 1804. In an example, the display 1804 may be a touch-sensitive display that combines the display with a touch-sensitive unit operable to sense a touch input. The display 1804 may be connected to the processor 1801 by using the bus 1803.

[00243] It should be noted that the coding apparatus 1800 may perform the point cloud encoding method in this application, or may perform the point cloud decoding method in this application.

[00244] A person skilled in the art can appreciate that functions described with reference to various illustrative logical blocks, modules, and algorithm steps disclosed in this specification may be implemented by hardware, software, firmware, or any combination thereof. If the functions are implemented by software, the functions described in various illustrative logical blocks, modules, and steps may be stored in or transmitted by a computer readable medium as one or more instructions or code, and executed by a hardware-based processing unit. The computer readable

CLAIMS

1. A point cloud encoding method, wherein the method comprises:
obtaining auxiliary information of a to-be-encoded point cloud patch; and
encoding the auxiliary information of the to-be-encoded patch and a first index of the to-be-
5 encoded patch into a bitstream, wherein
the first index is a first value, indicating that the to-be-encoded patch is a first-type patch, and
the auxiliary information of the to-be-encoded patch comprises three-dimensional information; or
the first index is a second value, indicating that the to-be-encoded patch is a second-type
patch, and the auxiliary information of the to-be-encoded patch comprises two-dimensional
10 information, three-dimensional information, and index information of a reference patch of the to-
be-encoded patch; or
the first index is a third value, indicating that the to-be-encoded patch is a third-type patch,
and the auxiliary information of the to-be-encoded patch comprises two-dimensional information,
three-dimensional information, rotation transformation information, and normal axis information.
15 2. The method according to claim 1, wherein the first value, the second value, and the third
value are binary numbers 10, 11, and 00 respectively; or
the first value, the second value, and the third value are binary numbers 11, 10, and 00
respectively.
3. The method according to claim 1 or 2, wherein when the first index of the to-be-encoded
20 patch is the third value, and the to-be-encoded patch is the first patch in a current point cloud frame
to which the to-be-encoded patch belongs, the current point cloud frame is the first point cloud
frame.
4. The method according to any one of claims 1 to 3, wherein the reference patch of the to-
be-encoded patch is comprised in a reference frame of the current point cloud frame.
25 5. The method according to any one of claims 1 to 4, wherein the first-type patch is a global
matched patch in a current group, the second-type patch is a local matched patch in the current
group, and the third-type patch is an unmatched patch in the current group.
6. A point cloud decoding method, wherein the method comprises:
parsing a first index of a to-be-decoded point cloud patch from a bitstream;
30 parsing auxiliary information of the to-be-decoded patch from the bitstream when the first

index is a first value, wherein the auxiliary information comprises three-dimensional information of the to-be-decoded patch; or

parsing auxiliary information of the to-be-decoded patch from the bitstream when the first index is a second value, wherein the auxiliary information comprises two-dimensional information and three-dimensional information of the to-be-decoded patch, and index information of a reference patch of the to-be-decoded patch; or

parsing auxiliary information of the to-be-decoded patch from the bitstream when the first index is a third value, wherein the auxiliary information comprises two-dimensional information, three-dimensional information, rotation transformation information, and normal axis information of the to-be-decoded patch; and

reconstructing the to-be-decoded patch based on the auxiliary information of the to-be-decoded patch.

7. The method according to claim 6, wherein the first value, the second value, and the third value are binary numbers 10, 11, and 00 respectively; or

the first value, the second value, and the third value are binary numbers 11, 10, and 00 respectively.

8. The method according to claim 6 or 7, wherein the method further comprises:

when the to-be-decoded patch is the first patch, and the first index is the third value, determining that a current point cloud frame to which the to-be-decoded patch belongs is the first point cloud frame.

9. The method according to any one of claims 6 to 8, wherein the parsing a first index of a to-be-decoded patch from a bitstream comprises:

parsing the first index of the to-be-decoded patch from the bitstream when the to-be-decoded patch is the first patch in the current point cloud frame; or

parsing a plurality of first indexes of a plurality of patches comprised in the current point cloud frame from the bitstream when the to-be-decoded patch is the first patch in the current point cloud frame, wherein the plurality of parsed first indexes comprise the first index of the to-be-decoded patch.

10. The method according to any one of claims 6 to 9, wherein when the first index is the first value, the method further comprises:

obtaining the two-dimensional information, the rotation transformation information, and the

normal axis information of the to-be-decoded patch based on auxiliary information of the reference patch of the to-be-decoded patch; and

the reconstructing the to-be-decoded patch based on the auxiliary information of the to-be-decoded patch comprises:

5 reconstructing the to-be-decoded patch based on the two-dimensional information, the three-dimensional information, the normal axis information, and the rotation transformation information of the to-be-decoded patch.

11. The method according to any one of claims 6 to 9, wherein when the first index is the second value, the method further comprises:

10 obtaining the rotation transformation information and the normal axis information of the to-be-decoded patch based on the index information of the reference patch of the to-be-decoded patch; and

the reconstructing the to-be-decoded patch based on the auxiliary information of the to-be-decoded patch comprises:

15 reconstructing the to-be-decoded patch based on the two-dimensional information, the three-dimensional information, the normal axis information, and the rotation transformation information of the to-be-decoded patch.

12. The method according to any one of claims 6 to 11, wherein the reference patch of the to-be-decoded patch is comprised in a reference frame of the current point cloud frame.

20 13. A point cloud encoding method, wherein the method comprises:

obtaining auxiliary information of a to-be-encoded point cloud patch; and

encoding the auxiliary information of the to-be-encoded patch and a first index of the to-be-encoded patch into a bitstream, wherein

the first index is a first value, indicating that the to-be-encoded patch is a first-type patch, and
25 information encoded into the bitstream further comprises a second index, wherein the second index is a fourth value, indicating that three-dimensional information of the to-be-encoded patch is not encoded into the bitstream, or the second index is a fifth value, indicating that three-dimensional information of the to-be-encoded patch is encoded into the bitstream, and the auxiliary information of the to-be-encoded patch comprises the three-dimensional information; or

30 the first index is a second value, indicating that the to-be-encoded patch is a second-type patch, and the auxiliary information of the to-be-encoded patch comprises two-dimensional

information, three-dimensional information, and index information of a reference patch of the to-be-encoded patch; or

the first index is a third value, indicating that the to-be-encoded patch is a third-type patch, and the auxiliary information of the to-be-encoded patch comprises two-dimensional information, three-dimensional information, rotation transformation information, and normal axis information.

14. A point cloud decoding method, wherein the method comprises:

parsing a first index of a to-be-decoded point cloud patch from a bitstream;

parsing a second index of the to-be-decoded patch from the bitstream when the first index is a first value; and

using auxiliary information of a reference patch of the to-be-decoded patch as auxiliary information of the to-be-decoded patch when the second index is a fourth value; or parsing auxiliary information of the to-be-decoded patch from the bitstream when the second index is a fifth value, wherein the auxiliary information comprises three-dimensional information of the to-be-decoded patch; or

parsing auxiliary information of the to-be-decoded patch from the bitstream when the first index is a second value, wherein the auxiliary information comprises two-dimensional information and three-dimensional information of the to-be-decoded patch, and index information of a reference patch of the to-be-decoded patch; or

parsing auxiliary information of the to-be-decoded patch from the bitstream when the first index is a third value, wherein the auxiliary information comprises two-dimensional information, three-dimensional information, rotation transformation information, and normal axis information of the to-be-decoded patch; and

reconstructing the to-be-decoded patch based on the auxiliary information of the to-be-decoded patch.

15. A point cloud encoding apparatus, wherein the apparatus comprises:

a point cloud patch information obtaining module, configured to obtain auxiliary information of a to-be-encoded patch; and

an auxiliary information encoding module, configured to encode the auxiliary information of the to-be-encoded patch and a first index of the to-be-encoded patch into a bitstream, wherein

the first index is a first value, indicating that the to-be-encoded patch is a first-type patch, and the auxiliary information of the to-be-encoded patch comprises three-dimensional information; or

the first index is a second value, indicating that the to-be-encoded patch is a second-type patch, and the auxiliary information of the to-be-encoded patch comprises two-dimensional information, three-dimensional information, and index information of a reference patch of the to-be-encoded patch; or

5 the first index is a third value, indicating that the to-be-encoded patch is a third-type patch, and the auxiliary information of the to-be-encoded patch comprises two-dimensional information, three-dimensional information, rotation transformation information, and normal axis information.

16. The apparatus according to claim 15, wherein the first value, the second value, and the third value are binary numbers 10, 11, and 00 respectively; or

10 the first value, the second value, and the third value are binary numbers 11, 10, and 00 respectively.

17. The apparatus according to claim 15 or 16, wherein when the first index of the to-be-encoded patch is the third value, and the to-be-encoded patch is the first patch in a current point cloud frame to which the to-be-encoded patch belongs, the current point cloud frame is the first
15 point cloud frame.

18. The apparatus according to any one of claims 15 to 17, wherein the reference patch of the to-be-encoded patch is comprised in a reference frame of the current point cloud frame.

19. The apparatus according to any one of claims 15 to 18, wherein the first-type patch is a global matched patch in a current group, the second-type patch is a local matched patch in the
20 current group, and the third-type patch is an unmatched patch in the current group.

20. A point cloud decoding apparatus, wherein the apparatus comprises:

an auxiliary information decoding module, configured to parse a first index of a to-be-decoded point cloud patch from a bitstream, wherein

the auxiliary information decoding module is further configured to: parse auxiliary
25 information of the to-be-decoded patch from the bitstream when the first index is a first value, wherein the auxiliary information comprises three-dimensional information of the to-be-decoded patch; or parse auxiliary information of the to-be-decoded patch from the bitstream when the first index is a second value, wherein the auxiliary information comprises two-dimensional information and three-dimensional information of the to-be-decoded patch, and index information of a
30 reference patch of the to-be-decoded patch; or parse auxiliary information of the to-be-decoded patch from the bitstream when the first index is a third value, wherein the auxiliary information

comprises two-dimensional information, three-dimensional information, rotation transformation information, and normal axis information of the to-be-decoded patch; and

a reconstruction module, configured to reconstruct the to-be-decoded patch based on the auxiliary information of the to-be-decoded patch.

5 21. The apparatus according to claim 20, wherein the first value, the second value, and the third value are binary numbers 10, 11, and 00 respectively; or

the first value, the second value, and the third value are binary numbers 11, 10, and 00 respectively.

22. The apparatus according to claim 20 or 21, wherein the auxiliary information decoding
10 module is further configured to:

when the to-be-decoded patch is the first patch, and the first index is the third value, determine that a current point cloud frame to which the to-be-decoded patch belongs is the first point cloud frame.

23. The apparatus according to any one of claims 20 to 22, wherein the auxiliary information
15 decoding module is further configured to:

parse the first index of the to-be-decoded patch from the bitstream when the to-be-decoded patch is the first patch in the current point cloud frame; or parse a plurality of first indexes of a plurality of patches comprised in the current point cloud frame from the bitstream when the to-be-decoded patch is the first patch in the current point cloud frame, wherein the plurality of parsed
20 first indexes comprise the first index of the to-be-decoded patch.

24. The apparatus according to any one of claims 20 to 23, wherein when the first index is the first value, the auxiliary information decoding module is further configured to:

obtain the two-dimensional information, the rotation transformation information, and the normal axis information of the to-be-decoded patch based on auxiliary information of the reference
25 patch of the to-be-decoded patch; and

the reconstruction module is further configured to:

reconstruct the to-be-decoded patch based on the two-dimensional information, the three-dimensional information, the normal axis information, and the rotation transformation information of the to-be-decoded patch.

25 25. The apparatus according to any one of claims 20 to 23, wherein when the first index is the second value, the auxiliary information decoding module is further configured to:

obtain the rotation transformation information and the normal axis information of the to-be-decoded patch based on the index information of the reference patch of the to-be-decoded patch;
and

the reconstruction module is further configured to:

5 reconstruct the to-be-decoded patch based on the two-dimensional information, the three-dimensional information, the normal axis information, and the rotation transformation information of the to-be-decoded patch.

26. The apparatus according to any one of claims 20 to 25, wherein the reference patch of the to-be-decoded patch is comprised in a reference frame of the current point cloud frame.

10 27. A point cloud encoding apparatus, wherein the apparatus comprises:

a point cloud patch information obtaining module, configured to obtain auxiliary information of a to-be-encoded patch; and

an auxiliary information encoding module, configured to encode the auxiliary information of the to-be-encoded patch and a first index of the to-be-encoded patch into a bitstream, wherein

15 the first index is a first value, indicating that the to-be-encoded patch is a first-type patch, and information encoded into the bitstream further comprises a second index, wherein the second index is a fourth value, indicating that three-dimensional information of the to-be-encoded patch is not encoded into the bitstream, or the second index is a fifth value, indicating that three-dimensional information of the to-be-encoded patch is encoded into the bitstream, and the auxiliary information
20 of the to-be-encoded patch comprises the three-dimensional information; or

the first index is a second value, indicating that the to-be-encoded patch is a second-type patch, and the auxiliary information of the to-be-encoded patch comprises two-dimensional information, three-dimensional information, and index information of a reference patch of the to-be-encoded patch; or

25 the first index is a third value, indicating that the to-be-encoded patch is a third-type patch, and the auxiliary information of the to-be-encoded patch comprises two-dimensional information, three-dimensional information, rotation transformation information, and normal axis information.

28. A point cloud decoding apparatus, wherein the apparatus comprises:

an auxiliary information decoding module, configured to parse a first index of a to-be-
30 decoded point cloud patch from a bitstream, wherein

the auxiliary information decoding module is further configured to: parse a second index of

the to-be-decoded patch from the bitstream when the first index is a first value, and use auxiliary information of a reference patch of the to-be-decoded patch as auxiliary information of the to-be-decoded patch when the second index is a fourth value, or parse auxiliary information of the to-be-decoded patch from the bitstream when the second index is a fifth value, wherein the auxiliary
5 information comprises three-dimensional information of the to-be-decoded patch; or parse auxiliary information of the to-be-decoded patch from the bitstream when the first index is a second value, wherein the auxiliary information comprises two-dimensional information and three-dimensional information of the to-be-decoded patch, and index information of a reference patch of the to-be-decoded patch; or parse auxiliary information of the to-be-decoded patch from
10 the bitstream when the first index is a third value, wherein the auxiliary information comprises two-dimensional information, three-dimensional information, rotation transformation information, and normal axis information of the to-be-decoded patch; and

a reconstruction module, configured to reconstruct the to-be-decoded patch based on the auxiliary information of the to-be-decoded patch.

15 29. A point cloud encoding method, wherein the method comprises:

obtaining auxiliary information of a to-be-encoded point cloud patch; and

encoding the auxiliary information of the to-be-encoded patch and a syntax element of the to-be-encoded patch into a bitstream, wherein the syntax element comprises a first syntax element, wherein:

20 when the first syntax element indicates that the to-be-encoded patch has a reference patch, the syntax element encoded into the bitstream further comprises a second syntax element, a value of the second syntax element is true, indicating that two-dimensional information of the to-be-encoded patch is encoded into the bitstream but three-dimensional information of the to-be-encoded patch is not encoded into the bitstream, and the auxiliary information of the to-be-encoded
25 patch comprises the two-dimensional information; or

the syntax element encoded into the bitstream further comprises a second syntax element and a third syntax element, a value of the second syntax element is false and a value of the third syntax element is true, indicating that two-dimensional information of the to-be-encoded patch is not encoded into the bitstream but three-dimensional information of the to-be-encoded patch is
30 encoded into the bitstream, and the auxiliary information of the to-be-encoded patch comprises the three-dimensional information; or

the syntax element encoded into the bitstream further comprises a second syntax element and a third syntax element, a value of the second syntax element is false and a value of the third syntax element is false, indicating that two-dimensional information of the to-be-encoded patch is not encoded into the bitstream and three-dimensional information of the to-be-encoded patch is not
5 encoded into the bitstream.

30. The method according to claim 29, wherein when the first syntax element indicates that the to-be-encoded patch does not have a reference patch, the auxiliary information of the to-be-encoded patch comprises the two-dimensional information, the three-dimensional information, rotation transformation information, and normal axis information.

10 31. The method according to claim 29 or 30, wherein when the first syntax element indicates that the to-be-encoded patch does not have a reference patch, and the to-be-encoded patch is the first patch in a current point cloud frame to which the to-be-encoded patch belongs, the current point cloud frame is the first point cloud frame.

32. The method according to any one of claims 29 to 31, wherein the reference patch of the
15 to-be-encoded patch is comprised in a reference frame of the current point cloud frame.

33. The method according to claim 32, wherein a location of the to-be-encoded patch in the current point cloud frame is the same as a location of the reference patch of the to-be-encoded patch in the reference frame of the current point cloud frame.

34. A point cloud decoding method, wherein the method comprises:
20 parsing a first syntax element of a to-be-decoded point cloud patch from a bitstream;
parsing a second syntax element of the to-be-decoded patch from the bitstream or parsing a second syntax element and a third syntax element of the to-be-decoded patch from the bitstream when the first syntax element indicates that the to-be-decoded patch has a reference patch;

when a value of the second syntax element is true, parsing two-dimensional information of
25 the to-be-decoded patch from the bitstream, and obtaining three-dimensional information of the to-be-decoded patch based on three-dimensional information of the reference patch of the to-be-decoded patch as; or

when a value of the second syntax element is false and a value of the third syntax element is true, parsing three-dimensional information of the to-be-decoded patch from the bitstream, and
30 obtaining two-dimensional information of the to-be-decoded patch based on two-dimensional information of the reference patch of the to-be-decoded patch; or

when a value of the second syntax element is false and a value of the third syntax element is false, obtaining two-dimensional information of the to-be-decoded patch based on two-dimensional information of the reference patch of the to-be-decoded patch, and obtaining three-dimensional information of the to-be-decoded patch based on three-dimensional information of the reference patch of the to-be-decoded patch; and

reconstructing the to-be-decoded patch based on auxiliary information of the to-be-decoded patch, wherein the auxiliary information of the to-be-decoded patch comprises the two-dimensional information of the to-be-decoded patch and the three-dimensional information of the to-be-decoded patch.

35. The method according to claim 34, wherein the method further comprises:

parsing the auxiliary information of the to-be-decoded patch from the bitstream when the first syntax element indicates that the to-be-decoded patch does not have a reference patch, wherein the auxiliary information of the to-be-decoded patch comprises the two-dimensional information, the three-dimensional information, rotation transformation information, and normal axis information.

36. The method according to claim 34 or 35, wherein the method further comprises:

when the to-be-decoded patch is the first patch, and the first syntax element indicates that the to-be-decoded patch does not have a reference patch, determining that a current point cloud frame to which the to-be-decoded patch belongs is the first point cloud frame.

37. The method according to any one of claims 34 to 36, wherein the parsing a first syntax element of a to-be-decoded point cloud patch from a bitstream comprises:

parsing the first syntax element of the to-be-decoded patch from the bitstream when the to-be-decoded patch is the first patch in the current point cloud frame; or

parsing a plurality of first syntax elements of a plurality of patches comprised in the current point cloud frame from the bitstream when the to-be-decoded patch is the first patch in the current point cloud frame, wherein the plurality of parsed first syntax elements comprise the first syntax element of the to-be-decoded patch.

38. The method according to any one of claims 34 to 37, wherein the reference patch of the to-be-decoded patch is comprised in a reference frame of the current point cloud frame.

39. The method according to claim 38, wherein a location of the to-be-decoded patch in the current point cloud frame is the same as a location of the reference patch of the to-be-decoded patch in the reference frame of the current point cloud frame.

40. A point cloud encoding apparatus, wherein the apparatus comprises:

a point cloud patch information obtaining module, configured to obtain auxiliary information of a to-be-encoded patch; and

an auxiliary information encoding module, configured to encode the auxiliary information of the to-be-encoded patch and a syntax element of the to-be-encoded patch into a bitstream, wherein the syntax element comprises a first syntax element, wherein:

when the first syntax element indicates that the to-be-encoded patch has a reference patch,

the syntax element encoded into the bitstream further comprises a second syntax element, a value of the second syntax element is true, indicating that two-dimensional information of the to-be-encoded patch is encoded into the bitstream but three-dimensional information of the to-be-encoded patch is not encoded into the bitstream, and the auxiliary information of the to-be-encoded patch comprises the two-dimensional information; or

the syntax element encoded into the bitstream further comprises a second syntax element and a third syntax element, a value of the second syntax element is false and a value of the third syntax element is true, indicating that two-dimensional information of the to-be-encoded patch is not encoded into the bitstream but three-dimensional information of the to-be-encoded patch is encoded into the bitstream, and the auxiliary information of the to-be-encoded patch comprises the three-dimensional information; or

the syntax element encoded into the bitstream further comprises a second syntax element and a third syntax element, a value of the second syntax element is false and a value of the third syntax element is false, indicating that two-dimensional information of the to-be-encoded patch is not encoded into the bitstream and three-dimensional information of the to-be-encoded patch is not encoded into the bitstream.

41. The apparatus according to claim 40, wherein when the first syntax element indicates that the to-be-encoded patch does not have a reference patch, the auxiliary information of the to-be-encoded patch comprises the two-dimensional information, the three-dimensional information, rotation transformation information, and normal axis information.

42. The apparatus according to claim 40 or 41, wherein when the first syntax element indicates that the to-be-encoded patch does not have a reference patch, and the to-be-encoded patch is the first patch in a current point cloud frame to which the to-be-encoded patch belongs, the current point cloud frame is the first point cloud frame.

43. The apparatus according to any one of claims 40 to 42, wherein the reference patch of the to-be-encoded patch is comprised in a reference frame of the current point cloud frame.

44. The apparatus according to claim 43, wherein a location of the to-be-encoded patch in the current point cloud frame is the same as a location of the reference patch of the to-be-encoded patch in the reference frame of the current point cloud frame.

45. A point cloud decoding apparatus, wherein the apparatus comprises:

an auxiliary information decoding module, configured to parse a first syntax element of a to-be-decoded point cloud patch from a bitstream, wherein

the auxiliary information decoding module is further configured to: parse a second syntax element of the to-be-decoded patch from the bitstream or parse a second syntax element and a third syntax element of the to-be-decoded patch from the bitstream when the first syntax element indicates that the to-be-decoded patch has a reference patch;

when a value of the second syntax element is true, parse two-dimensional information of the to-be-decoded patch from the bitstream, and obtain three-dimensional information of the to-be-decoded patch based on three-dimensional information of the reference patch of the to-be-decoded patch; or

when a value of the second syntax element is false and a value of the third syntax element is true, parse three-dimensional information of the to-be-decoded patch from the bitstream, and obtain two-dimensional information of the to-be-decoded patch based on two-dimensional information of the reference patch of the to-be-decoded patch ; or

when a value of the second syntax element is false and a value of the third syntax element is false, obtain two-dimensional information of the to-be-decoded patch based on two-dimensional information of the reference patch of the to-be-decoded patch, and obtain three-dimensional information of the to-be-decoded patch based on three-dimensional information of the reference patch of the to-be-decoded patch; and

a reconstruction module, configured to reconstruct the to-be-decoded patch based on auxiliary information of the to-be-decoded patch, wherein the auxiliary information of the to-be-decoded patch comprises the two-dimensional information of the to-be-decoded patch and the three-dimensional information of the to-be-decoded patch.

46. The apparatus according to claim 45, wherein the auxiliary information decoding module is further configured to:

parse the auxiliary information of the to-be-decoded patch from the bitstream when the first syntax element indicates that the to-be-decoded patch does not have a reference patch, wherein the auxiliary information of the to-be-decoded patch comprises the two-dimensional information, the three-dimensional information, rotation transformation information, and normal axis information.

5 47. The apparatus according to claim 45 or 46, wherein the auxiliary information decoding module is further configured to:

when the to-be-decoded patch is the first patch, and the first syntax element indicates that the to-be-decoded patch does not have a reference patch, determine that a current point cloud frame to which the to-be-decoded patch belongs is the first point cloud frame.

10 48. The apparatus according to any one of claims 45 to 47, wherein the auxiliary information decoding module is further configured to:

parse the first syntax element of the to-be-decoded patch from the bitstream when the to-be-decoded patch is the first patch in the current point cloud frame; or

15 parse a plurality of first syntax elements of a plurality of patches comprised in the current point cloud frame from the bitstream when the to-be-decoded patch is the first patch in the current point cloud frame, wherein the plurality of parsed first syntax elements comprise the first syntax element of the to-be-decoded patch.

49. The apparatus according to any one of claims 45 to 48, wherein the reference patch of the to-be-decoded patch is comprised in a reference frame of the current point cloud frame.

20 50. The apparatus according to claim 49, wherein a location of the to-be-decoded patch in the current point cloud frame is the same as a location of the reference patch of the to-be-decoded patch in the reference frame of the current point cloud frame.

25 51. A computer readable storage medium, comprising program code, wherein when the program code is run on a computer, the computer is enabled to perform the point cloud encoding method according to any one of claims 1 to 5, claim 13, or claims 29 to 33.

30 52. A computer readable storage medium, comprising program code, wherein when the program code is run on a computer, the computer is enabled to perform the point cloud decoding method according to any one of claims 6 to 12, claim 14, or claims 34 to 39.