POINT CLOUD ENCODING METHOD, POINT CLOUD DECODING METHOD, ENCODER, AND DECODER

[0001]

TECHNICAL FIELD

[0002] This application relates to the field of encoding and decoding technologies, and in particular, to a point cloud (point cloud) encoding method, a point cloud decoding method, an encoder, and a decoder.

BACKGROUND

[0003] With continuous development of 3D sensor (for example, a 3D scanner) technologies, point cloud data collection is more convenient, and collected point cloud data has a larger scale. Therefore, how to effectively encode and decode point cloud data becomes an urgent problem to be resolved.

SUMMARY

[0004] Embodiments of this application provide a point cloud encoding method, a point cloud decoding method, an encoder, and a decoder, to help improve point cloud encoding and decoding performance.

[0005] According to a first aspect, an embodiment of this application provides a point cloud encoding method, including: obtaining description information of a bounding box (Bounding Box) size of a to-be-encoded point cloud and a normal (Normal) axis of a to-be-encoded patch (patch) in the to-be-encoded point cloud, where the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch are used to determine a tangent (Tangent) axis of the to-be-encoded patch and a bitangent (Bi-tangent) axis of the to-be-encoded patch; and encoding a syntax element into a bitstream, where the syntax element includes an index of the normal axis of the to-be-encoded patch and information used to indicate the description information of the bounding

box size of the to-be-encoded point cloud, and the syntax element is used to indicate the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch. In an example, the method may be performed by an encoder. The to-be-encoded point cloud may be any frame of point cloud to be encoded, and the to-be-encoded patch may be any patch in the to-be-encoded point cloud.

[0006] A bounding box of a point cloud refers to a minimum cuboid surrounding the point cloud.

[0007] A bounding box size of the point cloud may also be referred to as side lengths of the bounding box of the point cloud, a three-dimensional space size of the bounding box of the point cloud, or a geometric space size of the bounding box of the point cloud, and may be represented by using lengths of sides, of the bounding box of the point cloud, on three coordinate axes in a reference coordinate system (for example, a world coordinate system).

[0008] Description information of the bounding box size of the point cloud is information used to describe the bounding box size of the point cloud. For example, the description information of the bounding box size of the point cloud may include a size relationship among the side lengths of the bounding box of the point cloud, a coordinate axis on which a longest side of the bounding box of the point cloud is located, or the like.

[0009] Optionally, information used to indicate the description information of the bounding box size of the point cloud may include size information of the bounding box of the point cloud, an index of the coordinate axis on which the longest side of the bounding box of the point cloud is located, an index of the size relationship among the side lengths of the bounding box of the point cloud, or the like. It should be noted that, if the information used to indicate the description information of the bounding box size of the point cloud is the size information of the bounding box of the point cloud, correspondingly, the description information of the bounding box size of the point cloud may be the size relationship among the side lengths of the bounding box of the point cloud, the coordinate axis on which the longest side of the bounding box of the point cloud is located, or the like. In other words, regardless of an encoder side or a decoder side, the size relationship among the side lengths of the bounding box of the point cloud, the coordinate axis on which the longest side of the bounding box of the point cloud is located, or the like may be obtained based on the size information of the bounding box of the point cloud.

[0010] When the description information of the bounding box size of the point cloud includes the size relationship among the side lengths of the bounding box of the point cloud, the information used to indicate the description information of the bounding box size of the point cloud may include the size information of the bounding box of the point cloud or the index of the size relationship among the side lengths of the bounding box of the point cloud.

[0011] When the description information of the bounding box size of the point cloud includes the coordinate axis on which the longest side of the bounding box of the point cloud is located, the information used to indicate the description information of the bounding box size of the point cloud may include the size information of the bounding

box of the point cloud or the index of the coordinate axis on which the longest side of the bounding box of the point cloud is located.

[0012] The index of the normal axis of to-be-encoded patch is patch level (or referred to as patch granularity)–based information. The information used to indicate the description information of the bounding box size of the to-be-encoded point cloud is frame level (or referred to as frame granularity)–based information. A sequence of encoding the foregoing two pieces of information into the bitstream is not limited in this embodiment of this application, and syntax elements at different levels may be separately encoded into the bitstream. For example, frame level (such as point cloud level)–based information is encoded into the bitstream, and patch level–based information is encoded into the bitstream. In other words, the two pieces of information may be encoded into the bitstream at different times.

[0013] The description information of the bounding box size of the point cloud may reflect a posture of the point cloud in three-dimensional space, so as to indirectly reflect postures of most patches in the point cloud. In an example, the posture of the point cloud in the three-dimensional space may be represented by information about whether the point cloud is vertical or horizontal in the three-dimensional space. For example, a point cloud shown in FIG. 6(a) is vertical, and a point cloud shown in FIG. 8(a) is horizontal. Based on this, it may be considered that most patches in the point cloud shown in FIG. 6(a) are vertical, and most patches in the point cloud shown in FIG. 8(a) are horizontal. In addition, when patches in a same posture are mapped to different two-dimensional coordinate systems, postures of projected pictures are different (as shown in FIG. 11). Therefore, determining a tangent axis and a bitangent axis of a to-be-encoded patch in the point cloud based on the description information of the bounding box size of the point cloud and a normal axis of the to-be-encoded patch helps adjust a posture of a projected picture obtained by projecting the patch onto a two-dimensional plane, so that projected pictures of patches are closely arranged in an occupancy map of the point cloud, that is, there are a relatively small quantity of empty pixels in the occupancy map of the point cloud. This facilitates picture/video-based encoding performed on a depth map and a texture map that are determined based on the occupancy map of the point cloud. In other words, point cloud encoding performance can be improved, so as to help improve point cloud decoding performance. For example, when the tangent axis and the bitangent axis of the patch are determined according to the method provided in this embodiment of this application, a posture of a projected picture in the rectangular box in FIG. 8(b) can be set to vertical. In this way, when the encoder performs packing to generate the occupancy map of the point cloud, the projected picture may be vertical, so that the projected pictures of the patches in the point cloud can be closely arranged in the occupancy map of the point cloud.

[0014] In a possible design, the method may further include: determining the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch based on the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch.

[0015] In a possible design, the determining the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch based on the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch may include: determining the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch based on the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch by searching a mapping relationship table, where the mapping relationship table includes a mapping relationship among a plurality of types of description information of bounding box sizes of point clouds, a plurality of types of normal axes of a patch, a plurality of types of tangent axes of the patch, and a plurality of types of bitangent axes of the patch.

[0016] In a possible design, the determining the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch based on the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch may include: determining, based on a mapping relationship between a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets, a target tangent mode set corresponding to the description information of the bounding box size of the to-be-encoded point cloud, where each tangent mode set includes at least two tangent modes, and each tangent mode includes one tangent axis and one bitangent axis; and determining, based on a mapping relationship between a plurality of types of normal axes of a patch and a plurality of tangent modes in the target tangent mode set, a target tangent mode corresponding to the normal axis of the to-be-encoded patch, where a tangent axis included in the determined target tangent mode is the tangent axis of the to-be-encoded patch, and a bitangent axis included in the determined target tangent mode is the bitangent axis of the to-be-encoded patch. For example, the mapping relationship may be predefined, for example, predefined according to a protocol, and may be specifically, by way of example instead of limitation, stored in one or more tables. In this case, this possible design may be implemented through table searching.

[0017] In a possible design, the determining the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch based on the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch may include: determining, based on a mapping relationship among a plurality of types of description information of bounding box sizes of point clouds, a plurality of types of normal axes of a patch, a plurality of types of tangent axes of the patch, and a plurality of types of bitangent axes of the patch, a target tangent axis and a target bitangent axis that correspond to both the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch, where the determined target tangent axis is the tangent axis of the to-be-encoded patch, and the determined target bitangent axis is the bitangent axis of the to-be-encoded patch. For example, the mapping relationship may be predefined, for

example, predefined according to a protocol, and may be specifically, by way of example instead of limitation, stored in one or more tables. In this case, this possible design may be implemented through table searching.

[0018] In a possible design, if the description information of the bounding box size of the to-be-encoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud, when the normal axis of the to-be-encoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch (in this case, a coordinate axis that is perpendicular to both the normal axis and the bitangent axis of the to-be-encoded patch is the tangent axis of the to-be-encoded patch); or when the normal axis of the to-be-encoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch (this is marked as a solution A1). Alternatively, when the normal axis of the to-be-encoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch (in this case, a coordinate axis that is perpendicular to both the normal axis and the tangent axis of the to-be-encoded patch is the bitangent axis of the to-be-encoded patch); or when the normal axis of the to-be-encoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch (this is marked as a solution A2). This helps ensure (or ensures as much as possible) that most of projected pictures obtained by projecting all patches in the to-be-encoded point cloud onto a two-dimensional plane are distributed in a same direction, so that an occupancy map, of the to-be-encoded point cloud, generated by packing these patches has a relatively small size (that is, the patches are arranged more closely), thereby reducing bit overheads of bitstream transmission. That the projected pictures are distributed in a same direction means that long sides (that is, longer sides in widths and heights) of smallest rectangles surrounding the projected pictures are distributed in a same direction. For example, the long sides of these smallest rectangles are all parallel to one coordinate axis in a reference coordinate system (for example, a world coordinate system) in three-dimensional space.

[0019] In a possible design, if the description information of the bounding box size of the to-be-encoded point

horizontal projection or vertical projection.

[0021] For example, the two-dimensional plane is a plane on which a tangent axis of a patch and a bitangent axis of the patch are located. The patch herein is a generalized patch, and includes the to-be-encoded patch. In an example, a horizontal axis of the two-dimensional plane is the tangent axis of the patch, and a vertical axis is the bitangent axis of the patch. Optionally, a horizontal axis of the two-dimensional plane is the bitangent axis of the patch, and a vertical axis is the tangent axis of the patch. It should be noted that, for ease of description, unless otherwise specified, an example in which "a horizontal axis of a two-dimensional plane is a tangent axis of a patch and a vertical axis is a bitangent axis of the patch" is used for description in all technical solutions described in specific implementations of the embodiments of this application.

[0022] For example, the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch are used to project the to-be-encoded patch from a three-dimensional coordinate system to a two-dimensional coordinate system.

[0023] In a possible design, the projection rule for projecting the to-be-encoded point cloud may be a default projection rule, or a preset projection rule (or referred to as a predefined projection rule, which may be, for example, predefined according to a protocol between an encoder side and a decoder side). Alternatively, the projection rule for projecting the to-be-encoded point cloud may be a projection rule indicated by the syntax element obtained from the bitstream through parsing.

[0024] In a possible design, the syntax element may further include information used to indicate the projection rule. The information used to indicate the projection rule is frame level–based information.

[0025] In a possible design, the method may further include: determining, according to a rate-distortion cost criterion, the projection rule for projecting the to-be-encoded point cloud. Specifically, a corresponding mapping relationship among "description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch" is selected based on each of candidate projection rules, so that the tangent axis and the bitangent axis of the to-be-encoded patch are pre-determined based on the mapping relationship, and then bit overheads of bitstream transmission of the to-be-encoded point cloud are pre-determined. Subsequently, a candidate projection rule corresponding to lowest transmission bit overheads (or a candidate projection rule corresponding to transmission bit overheads lower than or equal to preset overheads) is selected as the projection rule for projecting the to-be-encoded point cloud.

[0026] In a possible design, it is assumed that the description information of the bounding box size of the to-be-encoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud. In this case, if the projection rule indicates vertical projection, a specific solution may be the foregoing

solution A1. Alternatively, if the projection rule indicates horizontal projection, a specific solution may be the foregoing solution A2. In this possible design, an example in which "a horizontal axis of a two-dimensional plane is a tangent axis of a patch and a vertical axis is a bitangent axis of the patch" is used for description.

[0027] Alternatively, in a case in which a horizontal axis of a two-dimensional plane is a bitangent axis of a patch and a vertical axis is a tangent axis of the patch, if the description information of the bounding box size of the to-be-encoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud, and the projection rule indicates vertical projection, a specific solution may be the foregoing solution A2. Alternatively, if the projection rule indicates horizontal projection, a specific solution may be the foregoing solution A1.

[0028] In a possible design, it is assumed that the description information of the bounding box size of the to-be-encoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located. In this case, if the projection rule indicates vertical projection, a specific solution may be the foregoing solution B1. Alternatively, if the projection rule indicates horizontal projection, a specific solution may be the foregoing solution B2. In this possible design, an example in which "a horizontal axis of a two-dimensional plane is a tangent axis of a patch and a vertical axis is a bitangent axis of the patch" is used for description.

[0029] Alternatively, in a case in which a horizontal axis of a two-dimensional plane is a bitangent axis of a patch and a vertical axis is a tangent axis of the patch, if the description information of the bounding box size of the to-be-encoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the projection rule indicates vertical projection, a specific solution may be the foregoing solution B2. Alternatively, if the projection rule indicates horizontal projection, a specific solution may be the foregoing solution B1.

[0030] According to a second aspect, an embodiment of this application provides a point cloud decoding method, including: parsing a bitstream to obtain a syntax element, where the syntax element includes an index of a normal axis of a to-be-decoded patch in a to-be-decoded point cloud and information used to indicate description information of a bounding box size of the to-be-decoded point cloud; determining a tangent axis of the to-be-decoded patch and a bitangent axis of the to-be-decoded patch based on the index of the normal axis of the to-be-decoded patch and the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud that are obtained through parsing; and reconstructing geometry (geometry) information of the to-be-decoded point cloud based on tangent axes and bitangent axes of one or more patches in the to-be-decoded point cloud, where the one or more patches include the to-be-decoded patch. The method may be performed by a point cloud decoder. Geometry information of a point cloud refers to coordinates of a point in the point cloud (for example, each point in

the point cloud) in three-dimensional space.

[0031] In a possible design, the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud includes: size information of a bounding box of the to-be-decoded point cloud; or an index of a coordinate axis on which a longest side of a bounding box of the to-be-decoded point cloud is located; or an index of a size relationship among side lengths of a bounding box of the to-be-decoded point cloud.

[0032] The description information of the bounding box size of the to-be-decoded point cloud may include the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, or the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located.

[0033] For example, when the description information of the bounding box size of the to-be-decoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, if the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud includes the size information of the bounding box of the to-be-decoded point cloud, the method may further include: obtaining the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud based on the size information of the bounding box of the to-be-decoded point cloud. Then, optionally, the tangent axis and the bitangent axis of the to-be-decoded patch may be determined according to a possible design provided below.

[0034] For example, when the description information of the bounding box size of the to-be-decoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, if the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud includes the size information of the bounding box of the to-be-decoded point cloud, the method may further include: obtaining, based on the size information of the bounding box of the to-be-decoded point cloud, the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located. Then, optionally, the tangent axis and the bitangent axis of the to-be-decoded patch may be determined according to a possible design provided below.

[0035] In a possible design, the determining a tangent axis of the to-be-decoded patch and a bitangent axis of the to-be-decoded patch based on the index of the normal axis of the to-be-decoded patch and the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud that are obtained through parsing may include: determining, based on a mapping relationship between a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets, a target tangent mode set corresponding to the description information of the bounding box size of the to-be-decoded point cloud, where each tangent mode set includes at least two tangent modes, and each tangent mode includes one tangent axis and one bitangent axis; and determining, based on a mapping relationship between a plurality of types of normal axes of a

patch and a plurality of tangent modes in the target tangent mode set, a target tangent mode corresponding to the normal axis of the to-be-decoded patch, where a tangent axis included in the determined target tangent mode is the tangent axis of the to-be-decoded patch, and a bitangent axis included in the determined target tangent mode is the bitangent axis of the to-be-decoded patch.

[0036] In a possible design, the determining a tangent axis of the to-be-decoded patch and a bitangent axis of the to-be-decoded patch based on the index of the normal axis of the to-be-decoded patch and the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud that are obtained through parsing may include: determining, based on a mapping relationship among a plurality of types of description information of bounding box sizes of point clouds, a plurality of types of normal axes of a patch, a plurality of types of tangent axes of the patch, and a plurality of types of bitangent axes of the patch, a target tangent axis and a target bitangent axis that correspond to both the description information of the bounding box size of the to-be-decoded point cloud and the normal axis of the to-be-decoded patch, where the determined target tangent axis is the tangent axis of the to-be-decoded patch, and the determined target bitangent axis is the bitangent axis of the to-be-decoded patch.

[0037] In a possible design, if the description information of the bounding box size of the to-be-decoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, when the normal axis of the to-be-decoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch; or when the normal axis of the to-be-decoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch (this is marked as a solution C1). Alternatively, when the normal axis of the to-be-decoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch; or when the normal axis of the to-be-decoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch (this is marked as a solution C2).

[0038] In a possible design, if the description information of the bounding box size of the to-be-decoded point

[0042] In a possible design, the description information of the bounding box size of the to-be-decoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud. If the projection rule indicates vertical projection, a specific solution may be the foregoing solution C1. Alternatively, if the projection rule indicates horizontal projection, a specific solution may be the foregoing solution C2.

[0043] In a possible design, the description information of the bounding box size of the to-be-decoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located. If the projection rule indicates vertical projection, a specific solution may be the foregoing solution D1. Alternatively, if the projection rule indicates horizontal projection, a specific solution may be the foregoing solution D2.

[0044] The technical solution provided in any one of the second aspect and the possible designs of the second aspect corresponds to the first aspect or the corresponding point cloud encoding method provided in the first aspect. Therefore, for beneficial effects that can be achieved and explanations of related content, refer to the foregoing descriptions.

[0045] According to a third aspect, an embodiment of this application provides a point cloud encoding method, including: obtaining description information of a bounding box size of a to-be-encoded point cloud group and a normal axis of a to-be-encoded patch in the to-be-encoded point cloud group, where the to-be-encoded point cloud group includes at least two frames of point clouds, and the description information of the bounding box size of the to-be-encoded point cloud group and the normal axis of the to-be-encoded patch are used to determine a tangent axis of the to-be-encoded patch and a bitangent axis of the to-be-encoded patch; and encoding a syntax element into a bitstream, where the syntax element includes an index of the normal axis of the to-be-encoded patch and information used to indicate the description information of the bounding box size of the to-be-encoded point cloud group, and the syntax element is used to indicate the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch. A difference between this technical solution and the technical solution in the first aspect lies in that point cloud encoding is performed based on a point cloud group in this technical solution. Therefore, in addition to the beneficial effects that can be achieved according to the technical solution provided in the first aspect, encoding complexity can be further reduced, and bit overheads of bitstream transmission can be further reduced.

[0046] In a possible design, the method further includes: determining the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch based on the description information of the bounding box size of the to-be-encoded point cloud group and the normal axis of the to-be-encoded patch.

[0047] In a possible design, the obtaining description information of a bounding box size of a to-be-encoded point cloud group may include: using description information of a bounding box size of one frame of point cloud in

the to-be-encoded point cloud group as the description information of the bounding box size of the to-be-encoded point cloud group; or using description information with a highest appearance frequency in description information of bounding box sizes of some or all point clouds in the to-be-encoded point cloud group as the description information of the bounding box size of the to-be-encoded point cloud group.

[0048] In a possible design, the description information of the bounding box size of the to-be-encoded point cloud group may include a coordinate axis on which a longest side of a bounding box of the to-be-encoded point cloud group is located or a size relationship among side lengths of a bounding box of the to-be-encoded point cloud group.

[0049] In a possible design, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud group may include size information of a bounding box of one frame of point cloud in the to-be-encoded point cloud group, or size information with a highest appearance frequency in bounding box sizes of some or all point clouds in the to-be-encoded point cloud group. It may be understood that, in this possible design, the description information of the bounding box size of the to-be-encoded point cloud group may be the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud group is located or the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud group.

[0050] In a possible design, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud group may include an index of a coordinate axis on which a longest side of a bounding box of one frame of point cloud in the to-be-encoded point cloud group is located, or an index of a coordinate axis with a highest appearance frequency in coordinate axes on which longest sides of bounding boxes of some or all point clouds in the to-be-encoded point cloud group are located. It may be understood that, in this possible design, the description information of the bounding box size of the to-be-encoded point cloud group may be the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud group is located.

[0051] In a possible design, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud group may include an index of a size relationship among side lengths of a bounding box of one frame of point cloud in the to-be-encoded point cloud group, or an index of a size relationship with a highest appearance frequency in size relationships among side lengths of bounding boxes of some or all point clouds in the to-be-encoded point cloud group. It may be understood that, in this possible design, the description information of the bounding box size of the to-be-encoded point cloud group may be the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud group.

[0052] Optionally, all possible designs obtained by replacing the frame level–based information in any possible design provided in the first aspect with group of frames (group of frames, GOF) level–based information are applicable

to the third aspect. For example, "bounding box of the point cloud" in any possible design provided in the first aspect is replaced with "bounding box of the point cloud group". For example, "projection rule for projecting the to-be-encoded point cloud" in the possible design provided in the first aspect is replaced with "projection rule for projecting the to-be-encoded point cloud group". Details are not described herein one by one.

[0053] According to a fourth aspect, an embodiment of this application provides a point cloud decoding method, including: parsing a bitstream to obtain a syntax element, where the syntax element includes an index of a normal axis of a to-be-decoded patch in a to-be-decoded point cloud group and information used to indicate description information of a bounding box size of the to-be-decoded point cloud group, and the point cloud group includes at least two frames of point clouds; determining a tangent axis of the to-be-decoded patch and a bitangent axis of the to-be-decoded patch based on the index of the normal axis of the to-be-decoded patch and the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud group that are obtained through parsing; and reconstructing geometry information of a to-be-decoded point cloud in the to-be-decoded point cloud group based on tangent axes and bitangent axes of one or more patches in the to-be-decoded point cloud, where the one or more patches include the to-be-decoded patch.

[0054] In a possible design, the description information of the bounding box size of the to-be-decoded point cloud group may include a coordinate axis on which a longest side of a bounding box of the to-be-decoded point cloud group is located or a size relationship among side lengths of a bounding box of the to-be-decoded point cloud group.

[0055] In a possible design, the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud group may include size information of a bounding box of one frame of point cloud in the to-be-decoded point cloud group, or size information with a highest appearance frequency in bounding box sizes of some or all point clouds in the to-be-decoded point cloud group.

[0056] In a possible design, the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud group may include an index of a coordinate axis on which a longest side of a bounding box of one frame of point cloud in the to-be-decoded point cloud group is located, or an index of a coordinate axis with a highest appearance frequency in coordinate axes on which longest sides of bounding boxes of some or all point clouds in the to-be-decoded point cloud group are located.

[0057] In a possible design, the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud group may include an index of a size relationship among side lengths of a bounding box of one frame of point cloud in the to-be-decoded point cloud group, or an index of a size relationship with a highest appearance frequency in size relationships among side lengths of bounding boxes of some or all point clouds in the to-be-decoded point cloud group.

patch may be a generalized patch, and in this case, the identifier is GOF level–based information) in a to-be-encoded point cloud group in the one or more point cloud groups based on description information of a bounding box size of the point cloud group, that is, used to indicate whether to encode the patch in the to-be-encoded point cloud group according to the point cloud encoding method provided in the third aspect. When the identifier is used to indicate to determine the tangent axis and the bitangent axis of the to-be-encoded patch in the to-be-encoded point cloud group based on the description information of the bounding box size of the point cloud group, the encoder performs encoding according to any point cloud encoding method provided in the third aspect.

[0071] According to a ninth aspect, an embodiment of this application provides a point cloud data decoding device. The device may include a memory and a decoder.

[0072] The memory is configured to store point cloud data in a form of a bitstream, and the point cloud data includes one or more frames of point clouds.

[0073] The decoder is configured to decode the bitstream to obtain an identifier. The identifier is used to indicate whether to determine a tangent axis and a bitangent axis of a patch in a to-be-decoded point cloud in the one or more frames of point clouds based on description information of a bounding box size of the point cloud, that is, used to indicate whether to decode the patch in the to-be-decoded point cloud according to the point cloud decoding method provided in the second aspect. When the identifier is used to indicate to determine the tangent axis and the bitangent axis of the to-be-decoded patch in the to-be-decoded point cloud based on the description information of the bounding box size of the point cloud, the decoder performs decoding according to any point cloud decoding method provided in the second aspect.

[0074] Alternatively, the point cloud data in the ninth aspect includes one or more point cloud groups, and each point cloud group includes one or more frames of point clouds. The decoder is configured to decode the bitstream to obtain an identifier. The identifier is used to indicate whether to determine a tangent axis and a bitangent axis of a patch (the patch may be a generalized patch, and in this case, the identifier is GOF level–based information) in a to-be-decoded point cloud group in the one or more point cloud groups based on description information of a bounding box size of the point cloud group, that is, used to indicate whether to decode the patch in the to-be-decoded point cloud group according to the point cloud decoding method provided in the fourth aspect. When the identifier is used to indicate to determine the tangent axis and the bitangent axis of the to-be-decoded patch in the to-be-decoded point cloud group based on the description information of the bounding box size of the point cloud group, the decoder performs decoding according to any point cloud decoding method provided in the fourth aspect.

[0075] According to a tenth aspect, an embodiment of this application provides an encoding device, including

and/or a transmitter. The data source 120 may include a point cloud capture apparatus (for example, a camera), a point cloud archive including previously captured point cloud data, a point cloud feed-in interface configured to receive point cloud data from a point cloud content provider, and/or a computer graphics system configured to generate point cloud data, or a combination of these sources of point cloud data.

[00109] The encoder 100 may encode the point cloud data from the data source 120. In some examples, the source apparatus 10 directly sends the encoded point cloud data to the destination apparatus 20 through the output interface 140. In another example, the encoded point cloud data may be alternatively stored in the storage apparatus 40, so that the destination apparatus 20 subsequently accesses the encoded point cloud data for decoding and/or play.

[00110] In the example in FIG. 1, the destination apparatus 20 includes the input interface 240, the decoder 200, and a display apparatus 220. In some examples, the input interface 240 includes a receiver and/or a modem. The input interface 240 may receive the encoded point cloud data over the link 30 and/or from the storage apparatus 40. The display apparatus 220 may be integrated with the destination apparatus 20 or may be located outside the destination apparatus 20. Usually, the display apparatus 220 displays decoded point cloud data. There may be a plurality of types of display apparatuses 220, for example, a liquid crystal display (liquid crystal display, LCD), a plasma display, an organic light-emitting diode (organic light-emitting diode, OLED) display, or another type of display apparatus.

[00111] 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, to process encoding of audio and a video in a combined data stream or a separate data stream. In some examples, if appropriate, the MUX-DEMUX unit can comply with an ITU H.223 multiplexer protocol or another protocol such as a user datagram protocol (user datagram protocol, UDP).

[00112] The encoder 100 and the decoder 200 each may be implemented, for example, as any one of a plurality of circuits: one or more microprocessors, a digital signal processor (digital signal processor, DSP), an 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 implemented partially through software, the apparatus may store, in an appropriate non-volatile computer-readable storage medium, an instruction used for the software, and may use one or more processors to execute the instruction in hardware, to implement the technology in this application. Any one of the foregoing content (including hardware, software, a combination of hardware and software, and the like) may be considered as one or more processors. The encoder 100 and the decoder 200 each may be included in one or more encoders or decoders, and the encoder or the decoder may be integrated as a part of a combined encoder/decoder (codec) in a corresponding apparatus.

with relatively great heights (that is, a side on which the y-axis is located) are vertically arranged and some patches with relatively great heights are horizontally arranged (for example, patches in a rectangular box). This causes a large amount of empty space in the occupancy map of the point cloud, such as a region in which empty pixels are located in FIG. 8(b). In addition, this leads to a relatively large size of the occupancy map of the point cloud, and is unfavorable for subsequent video compression encoding.

[00145] Moreover, as shown in FIG. 6(a) to FIG. 6(c), if the tangent axis and the bitangent axis of each patch are obtained based on Table 2, an occupancy map shown in FIG. 6(c) can be obtained based on patches shown in FIG. 6(b).

[00146] The following describes a point cloud encoding method and a point cloud decoding method that are provided in the embodiments of this application.

[00147] FIG. 9 is a schematic flowchart of a point cloud encoding method according to an embodiment of this application. For example, with reference to the point cloud coding system shown in FIG. 1, each step in this embodiment may be performed by the source apparatus 10 in the point cloud coding system, and more specifically, may be performed by the encoder 100 in the source apparatus 10. The method shown in FIG. 9 may include the following steps.

[00148] S101: Obtain description information of a bounding box size of a to-be-encoded point cloud and a normal axis of a to-be-encoded patch in the to-be-encoded point cloud. The to-be-encoded point cloud may be any frame of to-be-encoded point cloud. The to-be-encoded patch may be any patch in the to-be-encoded point cloud.

[00149] A bounding box of a point cloud refers to a minimum cuboid surrounding the point cloud. For ease of description, in this embodiment of this application, each side of the bounding box of the point cloud is parallel to or perpendicular to a coordinate axis such as the x-axis, the y-axis, or the z-axis of a world coordinate system. FIG. 10 is a schematic diagram of a location of a bounding box of a point cloud in a world coordinate system according to an embodiment of this application.

[00150] A bounding box size of the point cloud may also be referred to as side lengths of the bounding box of the point cloud, a three-dimensional space size of the bounding box of the point cloud, or a geometric space size of the bounding box of the point cloud. For example, Bx, By, and Bz may be used to represent the bounding box size of the point cloud. Bx refers to a size of a side, of the bounding box of the point cloud, on the x-axis (or parallel to the x-axis), By refers to a size of a side, of the bounding box of the point cloud, on the y-axis (or parallel to the y-axis), and Bz refers to a size of a side, of the bounding box of the point cloud, on the z-axis (or parallel to the z-axis). For example, it is assumed that the to-be-encoded patch is the i^{th} point in the to-be-encoded point cloud, i = 0, 1, ..., or N–1, and N is a quantity of points in the to-be-encoded point cloud. In this case, a method for obtaining the bounding box size of

axis of the to-be-encoded patch.

[00156] Optionally, the encoder may predefine, for example, according to a protocol, a mapping relationship among a plurality of types of description information of bounding box sizes of point clouds (or indexes of the plurality of types of description information), a plurality of types of normal axes of a patch (or indexes of the plurality of types of normal axes), a plurality of types of tangent axes of the patch (or indexes of the plurality of types of tangent axes), and a plurality of types of bitangent axes of the patch (or indexes of the plurality of types of bitangent axes). Then, after obtaining the description information of the bounding box size of the to-be-encoded point cloud (or an index of the description information) and the normal axis of the to-be-encoded patch (or an index of the normal axis of the to-be-encoded patch), the encoder obtains the tangent axis of the to-be-encoded patch (or an index of the tangent axis of the to-be-encoded patch) and the bitangent axis of the to-be-encoded patch (or an index of the bitangent axis of the to-be-encoded patch) based on the foregoing mapping relationship.

[00157] A specific representation form of the mapping relationship is not limited in this embodiment of this application. For example, the mapping relationship may be represented in a form of a table, a formula, or logical determining (for example, an if else operation or a switch operation) based on a condition. An example in which the mapping relationship is specifically represented in a form of a table is mainly used below for description. Based on this, when performing S102, the encoder may obtain the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch by searching the table. It may be understood that the foregoing mapping relationship is specifically represented in one or more tables. This is not limited in this embodiment of this application. For ease of description, in this embodiment of this application, an example in which these tables are specifically represented in one table is used for description. This is uniformly described herein, and is not described below again.

[00158] If the description information of the bounding box size of the point cloud includes the size relationship for the bounding box size of the point cloud, possible description information of the bounding box size of the point cloud and an index of the possible description information may be shown in Table 3.

Table 3

Size relationship for a bounding box size of a point cloud	Bx ≥ By ≥ Bz	Bx > Bz > By	By > Bx > Bz	By > Bz ≥ Bx	Bz ≥ Bx > By	Bz > By > Bx
Index of the size relationship for the bounding box size of the point cloud	0	1	2	3	4	5

[00159] Bx ≥ By ≥ Bz may include four cases in total: Bx > By > Bz, Bx = By > Bz, Bx > By = Bz, and Bx =

By = Bz. It may be considered that in Table 3, an example in which "Bx = By > Bz, Bx > By = Bz, and Bx = By = Bz" each share the index "0" with "Bx > By > Bz" is used for description. Alternatively, "Bx = By > Bz" and "By > Bx > Bz" may share the index "2". In this case, a size relationship corresponding to the index "2" may be replaced with "By ≥ Bx > Bz". Alternatively, "Bx > By = Bz" and "Bx > Bz > By" may share the index "1". In this case, a size relationship corresponding to the index "1" may be replaced with "Bx > Bz ≥ By". Alternatively, "Bx = By = Bz" may share an index with any size relationship in Table 3. For example, if "Bx = By = Bz" and "Bz > By > Bx" share the index "5", a size relationship corresponding to the index "5" may be replaced with "Bz ≥ By ≥ Bx". Other examples are not enumerated one by one.

[00160] By > Bz ≥ Bx may include two cases in total: By > Bz > Bx and By > Bz = Bx. It may be considered that in Table 3, an example in which "By > Bz = Bx" and "By > Bz > Bx" share the index 3 is used for description. Alternatively, "By > Bz = Bx" and "By > Bx > Bz" may share the index "2". In this case, a size relationship corresponding to the index "2" may be replaced with "By > Bx ≥ Bz".

[00161] Bz ≥ Bx > By may include Bz > Bx > By and Bz = Bx > By. It may be considered that in Table 3, an example in which "Bz = Bx > By" and "Bz > Bx > By" share the index "4" is used for description. Alternatively, "Bz = Bx > By" and "Bx > Bz > By" may share the index "1". In this case, a size relationship corresponding to the index "1" may be replaced with "Bx ≥ Bz > By".

[00162] It should be noted that any alternative solution described above may be combined with Table 3 to form a new table used to indicate "possible description information of the bounding box size of the point cloud and an index of the possible description information". In addition, in principle, in a case of no conflict, any two or more of the foregoing alternative solutions may be combined with Table 3 to form a new table used to indicate "possible description information of the bounding box size of the point cloud and an index of the possible description information". In addition, an index of each size relationship provided in Table 3 is merely an example, and does not constitute a limitation on the index of the size relationship for the bounding box size of the point cloud in this embodiment of this application. All the following specific examples are described by using "the possible description information of the bounding box size of the point cloud and the index of the possible description information" in Table 3 as an example. This is uniformly described herein, and is not described below again.

[00163] S103: Encode a syntax element into a bitstream, where the syntax element includes the index of the normal axis of the to-be-encoded patch and information used to indicate the description information of the bounding box size of the to-be-encoded point cloud, and the syntax element is used to indicate the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch. In other words, this embodiment of this application supports a technical solution of implicitly indicating the tangent axis of the to-be-encoded patch and the bitangent axis

of the to-be-encoded patch by using the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud and the index of the normal axis of the to-be-encoded patch.

[00164] In an example, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud is frame level–based information. Therefore, with reference to the bitstream structure shown in FIG. 3, if the to-be-encoded point cloud is the first frame of point cloud in a GOF, in S103, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud may be encoded into a field 1103 in the bitstream. Based on this, the index of the normal axis of the to-be-encoded patch may be encoded into a field 1104 in the bitstream.

[00165] It may be understood that, because the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud and the index of the normal axis of the to-be-encoded patch are information of different levels (one is frame level–based information, and the other is patch level–based information), the two pieces of information may be encoded into the bitstream at different times. Certainly, this application is not limited thereto.

[00166] For example, with reference to the encoder shown in FIG. 2, S101 and S102 may be specifically performed by the patch information generation module 101 in the encoder. S103 may be performed by the auxiliary information encoding module 108 in the encoder.

[00167] A sequence of performing S102 and S103 is not limited in this embodiment of this application. For example, S102 may be performed before S103, or S103 may be performed before S102, or S102 and S103 may be performed at the same time.

[00168] Optionally, after S102 is performed and before S103 is performed, the method may further include: projecting the to-be-encoded patch from a three-dimensional coordinate system to a two-dimensional coordinate system based on the tangent axis and the bitangent axis of the to-be-encoded patch. For subsequent steps to be performed by the encoder, refer to the foregoing description of the encoder shown in FIG. 2, but this is not limited.

[00169] For descriptions of beneficial effects of this embodiment, refer to the foregoing summary. Details are not described herein again.

[00170] Optionally, if the description information of the bounding box size of the point cloud includes a size relationship among side lengths of the bounding box of the point cloud, a mapping relationship among description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch may be specifically the following solution 1 or solution 2. Whether the solution 1 or the solution 2 is specifically used may be predefined (for example, predefined according to a protocol), or may be notified by the encoder to the decoder by encoding indication information into the bitstream. Specific content of the indication

information is not limited in this embodiment of this application. For example, the indication information may be identifier information of the solution 1 or the solution 2, or may be a mapping rule in the following manner 3. Certainly, this embodiment of this application is not limited thereto.

[00171] Optionally, if the description information of the bounding box size of the point cloud includes the coordinate axis on which the longest side of the bounding box of the point cloud is located, a mapping relationship among description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch may be specifically the following solution 3 or solution 4. Whether the solution 3 or the solution 4 is specifically used may be predefined (for example, predefined according to a protocol), or may be notified by the encoder to the decoder by encoding indication information into the bitstream. Specific content of the indication information is not limited in this embodiment of this application. For example, the indication information may be identifier information of the solution 3 or the solution 4, or may be a mapping rule in the following manner 3. Certainly, this embodiment of this application is not limited thereto.

[00172] Solution 1:

[00173] When a normal axis of a patch is different from a coordinate axis on which a longest side of a bounding box of a point cloud including the patch is located, the coordinate axis on which the longest side of the bounding box of the point cloud is located is a bitangent axis of the patch. In this case, a coordinate axis perpendicular to both the normal axis of the patch and the bitangent axis of the patch is a tangent axis of the patch.

[00174] When a normal axis of a patch is the same as a coordinate axis on which a longest side of a bounding box of a point cloud including the patch is located, a coordinate axis on which a second longest side of the bounding box of the point cloud is located is a bitangent axis of the patch, and a coordinate axis on which a shortest side of the bounding box of the point cloud is located is a tangent axis of the patch.

[00175] Based on the solution 1, a "mapping relationship among indexes of a plurality of types of description information of bounding box sizes of point clouds, indexes of a plurality of types of normal axes of a patch, indexes of a plurality of types of tangent axes of the patch, and indexes of a plurality of types of bitangent axes of the patch" provided in this embodiment of this application may be shown in Table 4.

patch is 0, and an index of a bitangent axis of the patch is 2. With reference to Table 1 and Table 3, it can be learned that this example is specifically as follows: When Bz ≥ Bx > By, if the normal axis of the patch is the y-axis, the tangent axis of the patch is the x-axis, and the bitangent axis of the patch is the z-axis.

[00178] A principle of another example is similar to that described herein, and no more examples are enumerated.

[00179] Solution 2:

[00180] When a normal axis of a patch is different from a coordinate axis on which a longest side of a bounding box of a point cloud including the patch is located, the coordinate axis on which the longest side of the bounding box of the point cloud is located is a tangent axis of the patch. In this case, a coordinate axis perpendicular to both the normal axis of the patch and the tangent axis of the patch is a bitangent axis of the patch.

[00181] When a normal axis of a patch is the same as a coordinate axis on which a longest side of a bounding box of a point cloud including the patch is located, a coordinate axis on which a second longest side of the bounding box of the point cloud is located is a tangent axis of the patch, and a coordinate axis on which a shortest side of the bounding box of the point cloud is located is a bitangent axis of the patch.

[00182] Based on the solution 2, a "mapping relationship among indexes of a plurality of types of description information of bounding box sizes of point clouds, indexes of a plurality of types of normal axes of a patch, indexes of a plurality of types of tangent axes of the patch, and indexes of a plurality of types of bitangent axes of the patch" provided in this embodiment of this application may be shown in Table 5.

Table 5

Index of a size relationship for a bounding box size of a point cloud	Index of a normal axis of a patch	Index of a tangent axis of the patch	Index of a bitangent axis of the patch
0	0	1	2
	1	0	2
	2	0	1
1	0	2	1
	1	0	2
	2	0	1
2	0	1	2
	1	0	2

of the point cloud is located may be the bitangent axis of the patch, and the coordinate axis on which the shortest side of the bounding box of the point cloud is located is the tangent axis of the patch, or the coordinate axis on which the shortest side of the bounding box of the point cloud is located may be the bitangent axis of the patch, and the coordinate axis on which the second longest side of the bounding box of the point cloud is located is the tangent axis of the patch.

[00187] Based on the solution 3, a "mapping relationship among indexes of a plurality of types of description information of bounding box sizes of point clouds, indexes of a plurality of types of normal axes of a patch, indexes of a plurality of types of tangent axes of the patch, and indexes of a plurality of types of bitangent axes of the patch" provided in this embodiment of this application may be shown in Table 6.

Table 6

Index of a coordinate axis on which a longest side of a bounding box of a point cloud is located	Index of a normal axis of a patch	Index of a tangent axis of the patch	Index of a bitangent axis of the patch
0	0	1	2
	1	2	0
	2	1	0
1	0	2	1
	1	0	2
	2	0	1
2	0	1	2
	1	0	2
	2	0	1

[00188] For example, referring to Table 6, it can be learned that when an index of a coordinate axis on which a longest side of a bounding box of a point cloud is located is 0, if an index of a normal axis of a patch is 2, an index of a tangent axis of the patch is 1, and an index of a bitangent axis of the patch is 0. With reference to Table 1, it can be learned that this example is specifically as follows: When the coordinate axis on which the longest side of the bounding box of the point cloud is located is the x-axis, if the normal axis of the patch is the z-axis, the tangent axis of the patch is the y-axis, and the bitangent axis of the patch is the x-axis. A principle of another example is similar to that described herein, and no more examples are enumerated.

[00189] Table 6 shows merely an example of the "mapping relationship among indexes of a plurality of types of description information of bounding box sizes of point clouds, indexes of a plurality of types of normal axes of a patch, indexes of a plurality of types of tangent axes of the patch, and indexes of a plurality of types of bitangent axes of the patch" provided based on the solution 3. Alternatively, when the coordinate axis on which the longest side of the bounding box of the point cloud is located is the x-axis, and the coordinate axis on which the longest side of the bounding box of the point cloud is located is the same as the normal axis of the patch, the z-axis is the tangent axis of the patch, and the y-axis is the bitangent axis of the patch. Alternatively, when the coordinate axis on which the longest side of the bounding box of the point cloud is located is the y-axis, and the coordinate axis on which the longest side of the bounding box of the point cloud is located is the same as the normal axis of the patch, the z-axis is the tangent axis of the patch, and the x-axis is the bitangent axis of the patch. Alternatively, when the coordinate axis on which the longest side of the bounding box of the point cloud is located is the z-axis, and the coordinate axis on which the longest side of the bounding box of the point cloud is located is the same as the normal axis of the patch, the y-axis is the tangent axis of the patch, and the x-axis is the bitangent axis of the patch.

[00190] It should be noted that during specific implementation, whether the mapping relationship among an index of a coordinate axis on which a longest side of a bounding box of a point cloud is located, an index of a normal axis of a patch, an index of a tangent axis of the patch, and an index of a bitangent axis of the patch is Table 6 or a new table including a mapping relationship among these indexes that corresponds to an alternative solution of Table 6 may be predefined, for example, predefined according to a protocol.

[00191] Solution 4:

[00192] When a normal axis of a patch is different from a coordinate axis on which a longest side of a bounding box of a point cloud including the patch is located, the coordinate axis on which the longest side of the bounding box of the point cloud is located is a tangent axis of the patch. In this case, a coordinate axis perpendicular to both the normal axis of the patch and the tangent axis of the patch is a bitangent axis of the patch.

[00193] When a normal axis of a patch is the same as a coordinate axis on which a longest side of a bounding box of a point cloud including the patch is located, one of a coordinate axis on which a second longest side of the bounding box of the point cloud is located and a coordinate axis on which a shortest side of the bounding box of the point cloud is located is a bitangent axis of the patch, and the other is a tangent axis of the patch. Specifically, when the normal axis of the patch is the same as the coordinate axis on which the longest side of the bounding box of the point cloud including the patch is located, the coordinate axis on which the second longest side of the bounding box of the point cloud is located may be the tangent axis of the patch, and the coordinate axis on which the shortest side of the bounding box of the point cloud is located is the bitangent axis of the patch, or the coordinate axis on which the

shortest side of the bounding box of the point cloud is located may be the tangent axis of the patch, and the coordinate axis on which the second longest side of the bounding box of the point cloud is located is the bitangent axis of the patch.

[00194] Based on the solution 4, a "mapping relationship among indexes of a plurality of types of description information of bounding box sizes of point clouds, indexes of a plurality of types of normal axes of a patch, indexes of a plurality of types of tangent axes of the patch, and indexes of a plurality of types of bitangent axes of the patch" provided in this embodiment of this application may be shown in Table 7.

Table 7

Index of a coordinate axis on which a longest side of a bounding box of a point cloud is located	Index of a normal axis of a patch	Index of a tangent axis of the patch	Index of a bitangent axis of the patch
0	0	2	1
	1	0	2
	2	0	1
1	0	1	2
	1	2	0
	2	1	0
2	0	2	1
	1	2	0
	2	1	0

[00195] For example, referring to Table 7, it can be learned that when an index of a coordinate axis on which a longest side of a bounding box of a point cloud is located is 0, if an index of a normal axis of a patch is 2, an index of a tangent axis of the patch is 0, and an index of a bitangent axis of the patch is 1. With reference to Table 1, it can be learned that this example is specifically as follows: When the coordinate axis on which the longest side of the bounding box of the point cloud is located is the x-axis, if the normal axis of the patch is the z-axis, the tangent axis of the patch is the x-axis, and the bitangent axis of the patch is the y-axis. A principle of another example is similar to that described herein, and no more examples are enumerated.

[00196] Table 7 shows merely an example of the "mapping relationship among indexes of a plurality of types of

description information of bounding box sizes of point clouds, indexes of a plurality of types of normal axes of a patch, indexes of a plurality of types of tangent axes of the patch, and indexes of a plurality of types of bitangent axes of the patch" provided based on the solution 4. Alternatively, when the coordinate axis on which the longest side of the bounding box of the point cloud is located is the x-axis, and the coordinate axis on which the longest side of the bounding box of the point cloud is located is the same as the normal axis of the patch, the y-axis is the tangent axis of the patch, and the z-axis is the bitangent axis of the patch. Alternatively, when the coordinate axis on which the longest side of the bounding box of the point cloud is located is the y-axis, and the coordinate axis on which the longest side of the bounding box of the point cloud is located is the same as the normal axis of the patch, the x-axis is the tangent axis of the patch, and the z-axis is the bitangent axis of the patch. Alternatively, when the coordinate axis on which the longest side of the bounding box of the point cloud is located is the z-axis, and the coordinate axis on which the longest side of the bounding box of the point cloud is located is the same as the normal axis of the patch, the x-axis is the tangent axis of the patch, and the y-axis is the bitangent axis of the patch.

[00197] It should be noted that during specific implementation, whether the mapping relationship among an index of a coordinate axis on which a longest side of a bounding box of a point cloud is located, an index of a normal axis of a patch, an index of a tangent axis of the patch, and an index of a bitangent axis of the patch is Table 7 or a new table including a mapping relationship among these indexes that corresponds to an alternative solution of Table 7 may be predefined, for example, predefined according to a protocol.

[00198] Optionally, S102 may be implemented in one of the following manners.

[00199] Manner 1: S102 may include the following step S102-A:

[00200] S102-A: Determine, based on a mapping relationship among a plurality of types of description information of bounding box sizes of point clouds, a plurality of types of normal axes of a patch, a plurality of types of tangent axes of the patch, and a plurality of types of bitangent axes of the patch, a target tangent axis and a target bitangent axis that correspond to both the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch, where the determined target tangent axis is the tangent axis of the to-be-encoded patch, and the determined target bitangent axis is the bitangent axis of the to-be-encoded patch.

[00201] The manner 1 may be replaced with the following step S102-B:

[00202] S102-B: Determine, based on a mapping relationship among indexes of a plurality of types of description information of bounding box sizes of point clouds, indexes of a plurality of types of normal axes of a patch, indexes of a plurality of types of tangent axes of the patch, and indexes of a plurality of types of bitangent axes of the patch, an index of a target tangent axis and an index of a target bitangent axis that correspond to both the index of the description information of the bounding box size of the to-be-encoded point cloud and the index of the normal axis of

the to-be-encoded patch. The determined index of the target tangent axis is the index of the tangent axis of the to-be-encoded patch, and the determined index of the target bitangent axis is the index of the bitangent axis of the to-be-encoded patch.

[00203] Specifically, when the description information of the bounding box size of the point cloud includes the size relationship among the side lengths of the bounding box of the point cloud, the mapping relationship may be shown in Table 4 or Table 5. When the description information of the bounding box size of the point cloud includes the coordinate axis on which the longest side of the bounding box of the point cloud is located, the mapping relationship may be shown in Table 6 or Table 7.

[00204] In an example, referring to any one of Table 4 to Table 7, an index of each type of description information of a bounding box size of a point cloud corresponds to three combinations of "an index of a tangent axis and an index of a bitangent axis", and each combination of "an index of a tangent axis and an index of a bitangent axis" corresponds to an index of one normal axis. For example, referring to Table 4, it can be learned that if the index of the description information of the bounding box size of the to-be-encoded point cloud is 0, and the index of the normal axis of the patch is 0, the index of the tangent axis of the patch is 2, and the index of the bitangent axis is 1. To be specific, if the description information of the bounding box size of the to-be-encoded point cloud is $Bx \geq By \geq Bz$, and the normal axis of the patch is the x-axis, the tangent axis of the patch is the z-axis, and the bitangent axis is the y-axis. A principle of another example is similar to that described herein, and no more examples are enumerated.

[00205] Manner 2: S102 may include the following steps S102-C1 and S102-C2:

[00206] S102-C1: Determine, based on a mapping relationship between a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets, a target tangent mode set corresponding to the description information of the bounding box size of the to-be-encoded point cloud, where each tangent mode set includes at least two tangent modes, and each tangent mode includes one tangent axis and one bitangent axis.

[00207] S102-C2: Determine, based on a mapping relationship between a plurality of types of normal axes of a patch and a plurality of tangent modes in the target tangent mode set, a target tangent mode corresponding to the normal axis of the to-be-encoded patch, where a tangent axis included in the determined target tangent mode is the tangent axis of the to-be-encoded patch, and a bitangent axis included in the determined target tangent mode is the bitangent axis of the to-be-encoded patch.

[00208] The description information of the bounding box size of the point cloud may be in a one-to-one correspondence with the tangent mode sets. The point cloud herein is a generalized point cloud. The plurality of types of normal axes of the patch may be in a one-to-one correspondence with the plurality of tangent modes in the target

tangent mode set. The patch herein is a generalized patch. Because the normal axis of the patch may be the x-axis, the y-axis, or the z-axis, there may be three types of normal axes of the patch. In other words, each tangent mode set may include three tangent modes.

[00209] The manner 2 may be replaced with the following steps S102-D1 and S102-D2:

[00210] S102-D1: Determine, based on a mapping relationship between indexes of a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets, a target tangent mode set corresponding to the index of the description information of the bounding box size of the to-be-encoded point cloud, where each tangent mode set includes at least two tangent modes, and each tangent mode includes an index of one tangent axis and an index of one bitangent axis.

[00211] S102-D2: Determine, based on a mapping relationship between indexes of a plurality of types of normal axes of a patch and indexes of a plurality of tangent modes in the target tangent mode set, a target tangent mode corresponding to the index of the normal axis of the to-be-encoded patch, where an index of a tangent axis included in the determined target tangent mode is the index of the tangent axis of the to-be-encoded patch, and an index of a bitangent axis included in the determined target tangent mode is the index of the bitangent axis of the to-be-encoded patch.

[00212] Specifically, when the description information of the bounding box size of the point cloud includes the size relationship among the side lengths of the bounding box of the point cloud, the mapping relationship between indexes of a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets and the mapping relationship between indexes of a plurality of types of normal axes of a patch and indexes of a plurality of tangent modes in the target tangent mode set may be shown in Table 4 or Table 5. When the description information of the bounding box size of the point cloud includes the coordinate axis on which the longest side of the bounding box of the point cloud is located, the two mapping relationships may be shown in Table 6 or Table 7.

[00213] In an example, referring to any one of Table 4 to Table 7, a combination of "an index of a tangent axis of a patch and an index of a bitangent axis of the patch" included in each row of the last two columns of the table represents one tangent mode. Each tangent mode corresponds to an index of one normal axis. Three tangent modes corresponding to an index of each type of description information of a bounding box size of a point cloud represent a tangent mode set corresponding to the description information.

[00214] For example, referring to Table 4, if the index of the description information of the bounding box size of the to-be-encoded point cloud is 0, the target tangent mode set corresponding to the index of the description information of the bounding box size of the to-be-encoded point cloud includes the following tangent modes: a tangent mode including "an index 2 of a

tangent axis of a patch and an index 1 of a bitangent axis of the patch", a tangent mode including "an index 2 of a tangent axis of a patch and an index 0 of a bitangent axis of the patch", and a tangent mode including "an index 1 of a tangent axis of a patch and an index 0 of a bitangent axis of the patch". In this case, if the index of the normal axis of the to-be-encoded patch is 0, the tangent mode corresponding to the to-be-encoded patch is the tangent mode including "an index 2 of a tangent axis of a patch and an index 1 of a bitangent axis of the patch". A principle of another example is similar to that described herein, and no more examples are enumerated.

[00215] Manner 3: S102 may include the following step S102-E:

[00216] S102-E: Determine the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch according to a projection rule (or referred to as a projection rule for projecting the to-be-encoded point cloud) based on the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch, where the projection rule refers to distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-encoded point cloud onto the two-dimensional plane. The two-dimensional plane is a plane on which the tangent axis and the bitangent axis of the to-be-encoded patch are located.

[00217] It may be understood that, for a specific implementation of determining the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch based on the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch in the manner 3, refer to the manner 1 or the manner 2.

[00218] Optionally, the projection rule may include vertical projection or horizontal projection. The vertical projection refers to a rule in which projected pictures are vertically distributed when most patches in a point cloud are projected onto a two-dimensional plane. The horizontal projection refers to a rule in which projected pictures are horizontally distributed when most patches in a point cloud are projected onto a two-dimensional plane. It may be understood that, during specific implementation, the encoder may not need to first determine a specific quantity of the "most patches" herein before determining whether the projection rule for projecting the to-be-encoded point cloud indicates horizontal projection or vertical projection. For example, the projection rule for projecting the to-be-encoded point cloud may be predefined, for example, predefined according to a protocol. For another example, the projection rule for projecting the to-be-encoded point cloud may be obtained according to a rate-distortion cost criterion. Certainly, this application is not limited thereto. For example, the projection rule for projecting the to-be-encoded point cloud is determined from a candidate projection rule set according to the rate-distortion cost criterion. The candidate projection rule set may include at least two preset projection rules, for example, may include horizontal projection and vertical projection.

[00219] Optionally, if the projection rule for projecting the to-be-encoded point cloud is not predefined, after obtaining the projection rule for projecting the to-be-encoded point cloud, the encoder may encode, into the bitstream, information used to indicate the projection rule, to notify the decoder of the projection rule. It may be understood that the information used to indicate the projection rule is frame level–based information. Therefore, with reference to FIG. 3, if the to-be-encoded point cloud is the first frame of point cloud in a GOF, the information used to indicate the projection rule may be encoded into the field 1103 in the bitstream.

[00220] FIG. 11(a) to FIG. 11(c) are a schematic diagram of projection of a patch from three-dimensional space to a two-dimensional plane according to an embodiment of this application. In FIG. 11, an origin of coordinates is denoted as O. It is assumed that a letter A shown in FIG. 11(a) is a patch in the three-dimensional space, and a normal axis of the patch is the z-axis. In addition, it is assumed that on the two-dimensional plane, a tangent direction of the patch is a horizontal axis (that is, a U-axis), and a bitangent direction of the patch is a vertical axis (that is, a V-axis). In this case, when a tangent axis of the patch is the x-axis and a bitangent axis of the patch is the y-axis, that is, when the U-axis is the x-axis and the V-axis is the y-axis, after the patch shown in FIG. 11(a) is projected onto the two-dimensional plane, a projected picture shown in FIG. 11(b) is obtained. When a tangent axis of the patch is the y-axis and a bitangent axis of the patch is the x-axis, that is, when the U-axis is the y-axis and the V-axis is the x-axis, after the patch shown in FIG. 11(a) is projected onto the two-dimensional plane, a projected picture shown in FIG. 11(c) is obtained. It may be understood that the projected picture shown in FIG. 11(b) is vertically distributed, and the projected picture shown in FIG. 11(c) is horizontally distributed.

[00221] In an example, if the description information of the bounding box size of the point cloud includes the size relationship among the side lengths of the bounding box of the point cloud, when the projection rule for projecting the to-be-encoded point cloud indicates vertical projection, a mapping relationship among description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch may be the foregoing solution 1. In this case, the encoder may obtain the tangent axis and the bitangent axis of the to-be-encoded patch by searching Table 4. When the projection rule for projecting the to-be-encoded point cloud indicates horizontal projection, a mapping relationship among description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch may be the foregoing solution 2. In this case, the encoder may obtain the tangent axis and the bitangent axis of the to-be-encoded patch by searching Table 5.

[00222] In an example, if the description information of the bounding box size of the point cloud includes the coordinate axis on which the longest side of the bounding box of the point cloud is located, when the projection rule for projecting the to-be-encoded point cloud indicates vertical projection, a mapping relationship among description

information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch may be the foregoing solution 3. In this case, the encoder may obtain the tangent axis and the bitangent axis of the to-be-encoded patch by searching Table 6. When the projection rule for projecting the to-be-encoded point cloud indicates horizontal projection, a mapping relationship among description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch may be the foregoing solution 4. In this case, the encoder may obtain the tangent axis and the bitangent axis of the to-be-encoded patch by searching Table 7.

[00223] An example in which the projection rule includes vertical projection and horizontal projection is used above for description. Further, the projection rule may include another projection rule. In this case, the encoder may predefine (for example, according to a protocol) a correspondence between each projection rule and a "mapping relationship among description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch". Therefore, after a specific projection rule for projecting the to-be-encoded point cloud is determined, the "mapping relationship among description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch" used for determining the tangent axis and the bitangent axis of the to-be-encoded patch may be obtained.

[00224] The following describes specific implementations of the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud. For example, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud may include any one of the following information 1 to 7.

[00225] Information 1 is size information of a bounding box of the to-be-encoded point cloud. The size information of the bounding box of the to-be-encoded point cloud may include the bounding box size Bx, By, and Bz of the to-be-encoded point cloud. For example, if Bx = 10 centimeters (cm), By = 8 cm, and Bz = 5 cm, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud may include: Bx = 10 cm, By = 8 cm, and Bz = 5 cm.

[00226] Information 2 is an index of a coordinate axis on which a longest side of a bounding box of the to-be-encoded point cloud is located. For example, if Bx = 10 cm, By = 8 cm, and Bz = 5 cm, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud may include an index "0" of a coordinate axis (that is, the x-axis) on which a longest side (that is, Bx) of the bounding box of the to-be-encoded point cloud is located.

[00227] Information 3 is an index of a size relationship among side lengths of a bounding box of the to-be-encoded point cloud. For example, if Bx = 10 cm, By = 8 cm, and Bz = 5 cm, referring to Table 2, it can be learned that the

information used to indicate the description information of the bounding box size of the to-be-encoded point cloud may include an index "0" of a size relationship (that is, Bx > By > Bz) among the side lengths of the bounding box of the to-be-encoded point cloud.

[00228] Information 4 is an index of a coordinate axis on which a longest side of a bounding box of the to-be-encoded point cloud is located and an index of a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud is located.

[00229] Information 5 is an index of a coordinate axis on which a longest side of a bounding box of the to-be-encoded point cloud is located and an index of a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located.

[00230] Information 6 is an index of a coordinate axis on which a second longest side of a bounding box of the to-be-encoded point cloud is located and an index of a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located.

[00231] Information 7 is an index of a coordinate axis on which a longest side of a bounding box of the to-be-encoded point cloud is located, an index of a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud is located, and an index of a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located.

[00232] When the description information of the bounding box size of the to-be-encoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud may be implemented by using any one of the foregoing information 1 and information 3 to information 7. It may be understood that the decoder may obtain a size relationship among Bx, By, and Bz by using any one of the information 1 and the information 4 to the information 7, or may obtain a size relationship among Bx, By, and Bz by using the information 3 with reference to Table 2.

[00233] When the description information of the bounding box size of the to-be-encoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud may be implemented by using the foregoing information 1 or information 2.

[00234] It may be understood that, during specific implementation, which one of the foregoing information 1 to 7 is included in the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud may be predefined (for example, predefined according to a protocol). Certainly, this application is not limited thereto. For example, if it is pre-agreed on that the foregoing information 4 is used as the information used

to indicate the description information of the bounding box size of the to-be-encoded point cloud, an optional implementation may be that the bitstream includes a field 1 and a field 2, the field 1 is used to indicate the index of the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the field 2 is used to indicate the index of the coordinate axis on which the second longest side of the bounding box of the to-be-encoded point cloud is located. In addition, locations of the two fields in the bitstream and a quantity of bits occupied by each field are pre-agreed on by the encoder and the decoder. In this case, if Bx = 10 cm, By = 8 cm, and Bz = 5 cm, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud includes the field 1 carrying an index 0 of the coordinate axis on which the longest side (that is, Bx) of the bounding box of the to-be-encoded point cloud is located and the field 2 carrying an index 1 of the coordinate axis on which the second longest side (that is, By) of the bounding box of the to-be-encoded point cloud is located. Specific examples of the information 5 to information 7 are similar to that described herein, and are not enumerated one by one herein.

[00235] FIG. 12 is a schematic flowchart of a point cloud decoding method according to an embodiment of this application. The point cloud encoding method corresponds to the point cloud decoding method. Therefore, for explanations of related content in this embodiment, refer to the foregoing embodiment of the point cloud encoding method. For example, with reference to the point cloud coding system shown in FIG. 1, this embodiment may be specifically performed by the destination apparatus 20 in the point cloud coding system, and more specifically, may be performed by the decoder 200 in the destination apparatus 20. The method shown in FIG. 12 may include the following steps.

[00236] S201: Parse a bitstream to obtain a syntax element. The syntax element includes an index of a normal axis of a to-be-decoded patch in a to-be-decoded point cloud and information used to indicate description information of a bounding box size of the to-be-decoded point cloud.

[00237] The to-be-decoded point cloud may be a point cloud transmitted by an encoder to the decoder after the encoder encodes the foregoing to-be-encoded point cloud. Referring to FIG. 3, if the to-be-decoded point cloud is the first frame of point cloud in a GOF, S201 may specifically include: parsing a field 1102 to obtain the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud; and parsing a field 1103 to obtain the index of the normal axis of the to-be-decoded patch. Because the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud is frame level–based information, and the index of the normal axis of the to-be-decoded patch is patch level–based information, the decoder may parse the two pieces of information at different times.

[00238] The description information of the bounding box size of the to-be-decoded point cloud may include a size relationship among side lengths of a bounding box of the to-be-decoded point cloud, a coordinate axis on which a

longest side of a bounding box of the to-be-decoded point cloud is located, or the like. During specific implementation, whether the description information of the bounding box size of the to-be-decoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud or the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located may be predefined (for example, predefined according to a protocol), or may be determined by parsing indication information carried in the bitstream. It may be understood that the indication information is frame level–based information.

[00239] Optionally, the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud may include one of the following information. Information 8 is size information of the bounding box of the to-be-decoded point cloud. Information 9 is an index of the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located. Information 10 is an index of the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud. Information 11 is an index of the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located and an index of a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located. Information 12 is an index of the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located and an index of a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located. Information 13 is an index of a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located and an index of a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located. Information 14 is an index of the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, an index of a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located, and an index of a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located.

[00240] Specifically, when the description information of the bounding box size of the to-be-decoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud may include any one of the information 8 and information 10 to information 14. When the description information of the bounding box size of the to-be-decoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud may include either of the information 8 and information 9.

[00241] Optionally, the decoder may determine the description information of the bounding box size of the to-be-decoded point cloud (or the index of the description information) based on specific information that is used to indicate the description information of the bounding box size of the to-be-decoded point cloud and that is carried in a

preset field (such as the field 1102) in the bitstream that is predefined (for example, predefined according to a protocol).

[00242] S202: Determine a tangent axis of the to-be-decoded patch and a bitangent axis of the to-be-decoded patch based on the index of the normal axis of the to-be-decoded patch and the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud that are obtained through parsing.

[00243] Optionally, the decoder may predefine, for example, according to a protocol, a mapping relationship among a plurality of types of description information of bounding box sizes of point clouds (or indexes of the plurality of types of description information), a plurality of types of normal axes of a patch (or indexes of the plurality of types of normal axes), a plurality of types of tangent axes of the patch (or indexes of the plurality of types of tangent axes), and a plurality of types of bitangent axes of the patch (or indexes of the plurality of types of bitangent axes). Then, after the index of the normal axis of the to-be-decoded patch and the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud are obtained by parsing the bitstream, the tangent axis of the to-be-decoded patch (or an index of the tangent axis of the to-be-decoded patch) and the bitangent axis of the to-be-decoded patch (or an index of the bitangent axis of the to-be-decoded patch) are obtained according to the mapping relationship.

[00244] If the decoder predefines the mapping relationship in a form of a table (certainly, this application is not limited thereto), the table may be a mapping relationship shown in any one of Table 4 to Table 7. Based on this, the decoder may obtain the tangent axis of the to-be-decoded patch and the bitangent axis of the to-be-decoded patch by searching the table.

[00245] S203: Reconstruct geometry information of the to-be-decoded point cloud based on tangent axes and bitangent axes of one or more patches in the to-be-decoded point cloud, where the one or more patches include the to-be-decoded patch.

[00246] The point cloud decoding method corresponds to the point cloud encoding method provided above. Therefore, for beneficial effects that can be achieved according to the point cloud decoding method, refer to the foregoing analysis of the beneficial effects that can be achieved according to the point cloud encoding method. Details are not described herein again.

[00247] Optionally, S202 may be implemented in one of the following manners.

[00248] Manner 1: S202 may include the following step S202-A:

[00249] S202-A: Determine, based on a mapping relationship among a plurality of types of description information of bounding box sizes of point clouds, a plurality of types of normal axes of a patch, a plurality of types of tangent axes of the patch, and a plurality of types of bitangent axes of the patch, a target tangent axis and a target bitangent axis that correspond to both the description information of the bounding box size of the to-be-decoded point

cloud and the normal axis of the to-be-decoded patch, where the determined target tangent axis is the tangent axis of the to-be-decoded patch, and the determined target bitangent axis is the bitangent axis of the to-be-decoded patch.

[00250] The manner 1 may be replaced with the following step S202-B:

[00251] S202-B: Determine, based on a mapping relationship among indexes of a plurality of types of description information of bounding box sizes of point clouds, indexes of a plurality of types of normal axes of a patch, indexes of a plurality of types of tangent axes of the patch, and indexes of a plurality of types of bitangent axes of the patch, an index of a target tangent axis and an index of a target bitangent axis that correspond to both the index of the description information of the bounding box size of the to-be-decoded point cloud and the index of the normal axis of the to-be-decoded patch. The determined index of the target tangent axis is the index of the tangent axis of the to-be-decoded patch, and the determined index of the target bitangent axis is the index of the bitangent axis of the to-be-decoded patch.

[00252] Specifically, when the description information of the bounding box size of the point cloud includes the size relationship among the side lengths of the bounding box of the point cloud, the mapping relationship may be shown in Table 4 or Table 5. When the description information of the bounding box size of the point cloud includes the coordinate axis on which the longest side of the bounding box of the point cloud is located, the mapping relationship may be shown in Table 6 or Table 7.

[00253] In an example, referring to any one of Table 4 to Table 7, an index of each type of description information of a bounding box size of a point cloud corresponds to three combinations of "an index of a tangent axis and an index of a bitangent axis", and each combination of "an index of a tangent axis and an index of a bitangent axis" corresponds to an index of one normal axis. For example, referring to Table 4, it can be learned that if the index of the description information of the bounding box size of the to-be-decoded point cloud is 0, and the index of the normal axis of the patch is 0, the index of the tangent axis of the patch is 2, and the index of the bitangent axis is 1. To be specific, the tangent axis of the patch is the z-axis, and the bitangent axis of the patch is the y-axis. A principle of another example is similar to that described herein, and no more examples are enumerated.

[00254] Manner 2: S202 may include the following steps S202-C1 and S202-C2:

[00255] S202-C1: Determine, based on a mapping relationship between a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets, a target tangent mode set corresponding to the description information of the bounding box size of the to-be-decoded point cloud, where each tangent mode set includes at least two tangent modes, and each tangent mode includes one tangent axis and one bitangent axis.

[00256] S202-C2: Determine, based on a mapping relationship between a plurality of types of normal axes of a

patch and a plurality of tangent modes in the target tangent mode set, a target tangent mode corresponding to the normal axis of the to-be-decoded patch, where a tangent axis included in the determined target tangent mode is the tangent axis of the to-be-decoded patch, and a bitangent axis included in the determined target tangent mode is the bitangent axis of the to-be-decoded patch.

[00257] The manner 2 may be replaced with the following steps S202-D1 and S202-D2:

[00258] S202-D1: Determine, based on a mapping relationship between indexes of a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets, a target tangent mode set corresponding to the index of the description information of the bounding box size of the to-be-decoded point cloud, where each tangent mode set includes at least two tangent modes, and each tangent mode includes an index of one tangent axis and an index of one bitangent axis.

[00259] S202-D2: Determine, based on a mapping relationship between indexes of a plurality of types of normal axes of a patch and a plurality of tangent modes in the target tangent mode set, a target tangent mode corresponding to the index of the normal axis of the to-be-decoded patch, where an index of a tangent axis included in the determined target tangent mode is the index of the tangent axis of the to-be-decoded patch, and an index of a bitangent axis included in the determined target tangent mode is the index of the bitangent axis of the to-be-decoded patch.

[00260] For specific implementations and related descriptions of the mapping relationship between indexes of a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets and the mapping relationship between indexes of a plurality of types of normal axes of a patch and a plurality of tangent modes in the target tangent mode set, refer to the foregoing descriptions.

[00261] For example, referring to Table 4, if the index of the description information of the bounding box size of the to-be-decoded point cloud is 0, the target tangent mode set corresponding to the index of the description information of the bounding box size of the to-be-decoded point cloud includes the following tangent modes: a tangent mode including "an index 2 of a tangent axis of a patch and an index 1 of a bitangent axis of the patch", a tangent mode including "an index 2 of a tangent axis of a patch and an index 0 of a bitangent axis of the patch", and a tangent mode including "an index 1 of a tangent axis of a patch and an index 0 of a bitangent axis of the patch". In this case, if the index of the normal axis of the to-be-decoded patch is 0, the tangent mode corresponding to the to-be-decoded patch is the tangent mode including "an index 2 of a tangent axis of a patch and an index 1 of a bitangent axis of the patch". A principle of another example is similar to that described herein, and no more examples are enumerated.

[00262] Manner 3: S202 may include the following step S202-E:

[00263] S202-E: Determine the tangent axis of the to-be-decoded patch and the bitangent axis of the to-be-decoded patch according to a projection rule (or referred to as a projection rule for projecting the to-be-decoded point

cloud) based on the description information of the bounding box size of the to-be-decoded point cloud and the normal axis of the to-be-decoded patch, where the projection rule refers to distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-decoded point cloud onto the two-dimensional plane. The two-dimensional plane is a plane on which the tangent axis and the bitangent axis of the to-be-decoded patch are located.

[00264] Optionally, the projection rule may include vertical projection or horizontal projection.

[00265] In an example, the projection rule for projecting the to-be-decoded point cloud may be predefined, for example, predefined according to a protocol.

[00266] In an example, the projection rule for projecting the to-be-decoded point cloud may be obtained by the decoder by parsing the bitstream. The syntax element obtained by parsing the bitstream includes information used to indicate the projection rule for projecting the to-be-decoded point cloud. The information used to indicate the projection rule for projecting the to-be-decoded point cloud is frame level–based information. A specific type of the information used to indicate the projection rule for projecting the to-be-decoded point cloud is not limited in this embodiment of this application. For example, the information may be an index of the projection rule. For example, if the projection rule indicates vertical projection, the index of the projection rule may be 0. If the projection rule indicates horizontal projection, the index of the projection rule may be 1. Certainly, this application is not limited thereto.

[00267] In an example, if the description information of the bounding box size of the point cloud includes the size relationship among the side lengths of the bounding box of the point cloud, when the projection rule for projecting the to-be-decoded point cloud indicates vertical projection, a mapping relationship among description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch may be the foregoing solution 1. In this case, the decoder may obtain the tangent axis and the bitangent axis of the to-be-decoded patch by searching Table 4. When the projection rule for projecting the to-be-decoded point cloud indicates horizontal projection, a mapping relationship among description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch may be the foregoing solution 2. In this case, the decoder may obtain the tangent axis and the bitangent axis of the to-be-decoded patch by searching Table 5.

[00268] In an example, if the description information of the bounding box size of the point cloud includes the coordinate axis on which the longest side of the bounding box of the point cloud is located, when the projection rule for projecting the to-be-decoded point cloud indicates vertical projection, a mapping relationship among description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a

bitangent axis of the patch may be the foregoing solution 3. In this case, the decoder may obtain the tangent axis and the bitangent axis of the to-be-decoded patch by searching Table 6. When the projection rule for projecting the to-be-decoded point cloud indicates horizontal projection, a mapping relationship among description information of a bounding box size of a point cloud, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch may be the foregoing solution 4. In this case, the decoder may obtain the tangent axis and the bitangent axis of the to-be-decoded patch by searching Table 7.

[00269] It may be understood that, when the description information of the bounding box size of the to-be-decoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, and the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud includes the index of the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, or when the description information of the bounding box size of the to-be-decoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, and the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud includes the index of the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, optionally, S202 may be implemented by using any one of the manner 1 to the manner 3 provided above or an alternative manner of the manner.

[00270] It may be understood that, when the description information of the bounding box size of the to-be-decoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, if the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud includes the size information of the bounding box of the to-be-decoded point cloud, the method may further include: obtaining the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud based on the size information of the bounding box of the to-be-decoded point cloud. Then, optionally, S202 may be implemented by using any one of the manner 1 to the manner 3 provided above or an alternative manner of the manner.

[00271] It may be understood that, when the description information of the bounding box size of the to-be-decoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, if the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud includes the size information of the bounding box of the to-be-decoded point cloud, the method may further include: obtaining, based on the size information of the bounding box of the to-be-decoded point cloud, the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located. Then, optionally, S202 may be implemented by using any one of the manner 1 to the manner 3 provided above or an

alternative manner of the manner.

[00272] FIG. 13 is a schematic flowchart of another point cloud encoding method according to an embodiment of this application. For explanations of related content in this embodiment, refer to the foregoing descriptions. The method shown in FIG. 13 may include the following steps.

[00273] S301: Obtain description information of a bounding box size of a to-be-encoded point cloud group and a normal axis of a to-be-encoded patch in the to-be-encoded point cloud group, where the to-be-encoded point cloud group (that is, a GOF) includes at least two frames of point clouds. The to-be-encoded point cloud group may be any point cloud group that has an encoding requirement.

[00274] A specific implementation of using specific point clouds as a point cloud group is not limited in this embodiment of this application. For example, reference may be made to the prior art. For example, 32 consecutive frames of point clouds may be used as a point cloud group.

[00275] Description information of a bounding box size of a point cloud group may include a size relationship among side lengths of a bounding box of the point cloud group, a coordinate axis on which a longest side of a bounding box of the point cloud group is located, or the like.

[00276] Optionally, the description information of the bounding box size of the point cloud group may be description information of a bounding box size of one frame of point cloud (for example, the first frame of point cloud) in the point cloud group.

[00277] Optionally, the description information of the bounding box size of the point cloud group may be obtained by collecting statistics on description information of bounding box sizes of some or all point clouds in the point cloud group. For example, description information with a highest appearance frequency in the description information of the bounding box sizes of the some or all point clouds in the point cloud group may be used as the description information of the bounding box size of the point cloud group. Details are as follows:

[00278] When the description information of the bounding box size of the point cloud group includes the size relationship among the side lengths of the bounding box of the point cloud group, the description information of the bounding box size of the point cloud group may be a size relationship with a highest appearance frequency in size relationships among side lengths of bounding boxes of some or all point clouds in the point cloud group. For example, referring to Table 2, a size relationship among side lengths of a bounding box of each point cloud may be one of the six possible cases shown in Table 2. If it is learned, by collecting statistics on the size relationship among the side lengths of the bounding box of each point cloud in the point cloud group, that $Bx \geq By \geq Bz$ has a highest appearance frequency in the six possible cases, $Bx \geq By \geq Bz$ is used as a size relationship among side lengths of a bounding box of the to-be-encoded point cloud group.

into a bitstream, with reference to the bitstream structure shown in FIG. 3, the encoder may encode the information into a field 1102.

[00285] For example, a mapping relationship obtained after the "description information of the bounding box size of the point cloud" in the foregoing solution 1 to solution 4 is replaced with the "description information of the bounding box size of the point cloud group" may be used as a "mapping relationship among description information of a bounding box size of a point cloud group, a normal axis of a patch, a tangent axis of the patch, and a bitangent axis of the patch" in this embodiment.

[00286] S303: Encode a syntax element into a bitstream, where the syntax element includes an index of the normal axis of the to-be-encoded patch and information used to indicate the description information of the bounding box size of the to-be-encoded point cloud group, and the syntax element is used to indicate the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch.

[00287] The information used to indicate the description information of the bounding box size of the to-be-encoded point cloud group is GOF level–based information. Therefore, if the information is to be encoded into the bitstream, with reference to the bitstream structure shown in FIG. 3, the encoder may encode the information into the field 1102.

[00288] Optionally, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud group may include one of the following: size information of a bounding box of the to-be-encoded point cloud group; an index of a coordinate axis on which a longest side of a bounding box of the to-be-encoded point cloud group is located; an index of a size relationship among side lengths of a bounding box of the to-be-encoded point cloud group; an index of a coordinate axis on which a longest side of a bounding box of the to-be-encoded point cloud group is located and an index of a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud group is located; an index of a coordinate axis on which a longest side of a bounding box of the to-be-encoded point cloud group is located and an index of a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud group is located; an index of a coordinate axis on which a second longest side of a bounding box of the to-be-encoded point cloud group is located and an index of a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud group is located; or an index of a coordinate axis on which a longest side of a bounding box of the to-be-encoded point cloud group is located, an index of a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud group is located, and an index of a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud group is located. The size information of the bounding box of the to-be-encoded point cloud group may be size information of a bounding box of one frame of point cloud in the to-be-encoded point cloud group, or may be size

information with a highest appearance frequency in size information of bounding boxes of some or all point clouds in the to-be-encoded point cloud group. A principle of another method for determining the coordinate axis on which the second longest side of the bounding box of the to-be-encoded point cloud group is located and the coordinate axis on which the shortest side of the bounding box of the to-be-encoded point cloud group is located is similar to that described herein, and details are not described herein again.

[00289] A sequence of performing S302 and S303 is not limited in this embodiment of this application. For example, S302 may be performed before S303, or S303 may be performed before S302, or S302 and S303 may be performed at the same time.

[00290] Optionally, after S302 is performed and before S303 is performed, the method may further include: projecting the to-be-encoded patch from a three-dimensional coordinate system to a two-dimensional coordinate system based on the tangent axis and the bitangent axis of the to-be-encoded patch. For subsequent steps to be performed by the encoder, refer to the foregoing description of the encoder shown in FIG. 2, but this is not limited.

[00291] For beneficial effects of the point cloud encoding method provided in this embodiment, refer to the beneficial effects of the point cloud encoding method provided above. In addition, it may be understood that, because encoding is performed based on the point cloud group in this application, compared with those in a technical solution of performing encoding based on a point cloud, encoding complexity can be reduced, and bit overheads of bitstream transmission can be reduced.

[00292] FIG. 14 is a schematic flowchart of a point cloud decoding method according to an embodiment of this application. For explanations of related content in this embodiment, refer to the foregoing descriptions. The method shown in FIG. 14 may include the following steps.

[00293] S401: Parse a bitstream to obtain a syntax element, where the syntax element includes an index of a normal axis of a to-be-decoded patch in a to-be-decoded point cloud group and information used to indicate description information of a bounding box size of the to-be-decoded point cloud group, and the point cloud group includes at least two frames of point clouds.

[00294] S402: Determine a tangent axis of the to-be-decoded patch and a bitangent axis of the to-be-decoded patch based on the index of the normal axis of the to-be-decoded patch and the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud group that are obtained through parsing.

[00295] S403: Reconstruct geometry information of a to-be-decoded point cloud in the to-be-decoded point cloud group based on tangent axes and bitangent axes of one or more patches in the to-be-decoded point cloud, where the one or more patches include the to-be-decoded patch.

[00296] Optionally, the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud group includes size information of a bounding box of the to-be-decoded point cloud group, an index of a coordinate axis on which a longest side of a bounding box of the to-be-decoded point cloud group is located, an index of a size relationship among side lengths of a bounding box of the to-be-decoded point cloud group, or the like.

[00297] It should be noted that, for explanations of related content, specific implementations of related steps, and the like in this embodiment, directly refer to the foregoing descriptions. Alternatively, the explanations and the implementations may be obtained through inference according to the method provided above. Details are not described herein.

[00298] The point cloud decoding method provided in this embodiment corresponds to the point cloud encoding method shown in FIG. 13. Therefore, for beneficial effects that can be achieved according to the point cloud decoding method, refer to the foregoing description. Details are not described herein again.

[00299] It should be noted that a method for determining a tangent axis and a bitangent axis of a patch in the embodiments of this application is included in the embodiments of the point cloud encoding method and the point cloud decoding method provided above. Therefore, a separate embodiment is not provided.

[00300] The foregoing mainly describes the solutions provided in the embodiments of this application from a perspective of the method. To implement the foregoing functions, the encoder and the decoder each include a corresponding hardware structure and/or software module for performing each function. A person skilled in the art should be easily aware that, in combination with the examples of units and algorithm steps described in the embodiments disclosed in this specification, this application can be implemented by hardware or a combination of hardware and computer software. Whether a function is performed by hardware or hardware driven by computer software depends on particular applications and design constraints of the technical solutions. A person skilled in the art may use different methods to implement the described functions for each particular application, but it should not be considered that the implementation goes beyond the scope of this application.

[00301] In the embodiments of this application, the encoder and the decoder may be divided into function modules based on the foregoing method examples. For example, each function module may be obtained through division based on each corresponding function, or two or more functions may be integrated into one processing module. The integrated module may be implemented in a form of hardware, or may be implemented in a form of a software function module. It should be noted that, in the embodiments of this application, division into modules is an example, and is merely logical function division. During actual implementation, there may be another division manner.

[00302] FIG. 15 is a schematic block diagram of an encoder 150 according to an embodiment of this application.

The encoder 150 may include a patch information generation module 1501 and an auxiliary information encoding module 1502. In an example, the patch information generation module 1501 may correspond to the patch information generation module 101 in FIG. 2, and the auxiliary information encoding module 1502 may correspond to the auxiliary information encoding module 108 in FIG. 2. Certainly, this application is not limited thereto.

[00303] The following describes a feasible implementation of performing encoding by the encoder 150 based on a point cloud.

[00304] In a feasible implementation, the patch information generation module 1501 is configured to obtain description information of a bounding box size of a to-be-encoded point cloud and a normal axis of a to-be-encoded patch in the to-be-encoded point cloud. The description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch are used to determine a tangent axis of the to-be-encoded patch and a bitangent axis of the to-be-encoded patch. The auxiliary information encoding module 1502 is configured to encode a syntax element into a bitstream, where the syntax element includes an index of the normal axis of the to-be-encoded patch and information used to indicate the description information of the bounding box size of the to-be-encoded point cloud, and the syntax element is used to indicate the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch. For example, the patch information generation module 1501 may be configured to perform S101 in FIG. 9 and/or another step described in the embodiments of this application, and the auxiliary information encoding module 1502 may be configured to perform S103 in FIG. 9 and/or another step described in the embodiments of this application.

[00305] In a feasible implementation, the patch information generation module 1501 may be further configured to determine the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch based on the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch. For example, the patch information generation module 1501 may be configured to perform S102 in FIG. 9 and/or another step described in the embodiments of this application.

[00306] In a feasible implementation, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud includes: size information of a bounding box of the to-be-encoded point cloud; an index of a coordinate axis on which a longest side of a bounding box of the to-be-encoded point cloud is located; or an index of a size relationship among side lengths of a bounding box of the to-be-encoded point cloud.

[00307] In a feasible implementation, the patch information generation module 1501 may be specifically configured to: determine, based on a mapping relationship between a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets, a target tangent mode set corresponding to the description information of the bounding box size of the to-be-encoded point cloud, where each tangent mode set

includes at least two tangent modes, and each tangent mode includes one tangent axis and one bitangent axis; and determine, based on a mapping relationship between a plurality of types of normal axes of a patch and a plurality of tangent modes in the target tangent mode set, a target tangent mode corresponding to the normal axis of the to-be-encoded patch, where a tangent axis included in the determined target tangent mode is the tangent axis of the to-be-encoded patch, and a bitangent axis included in the determined target tangent mode is the bitangent axis of the to-be-encoded patch.

[00308] In a feasible implementation, the patch information generation module 1501 may be specifically configured to determine, based on a mapping relationship among a plurality of types of description information of bounding box sizes of point clouds, a plurality of types of normal axes of a patch, a plurality of types of tangent axes of the patch, and a plurality of types of bitangent axes of the patch, a target tangent axis and a target bitangent axis that correspond to both the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch, where the determined target tangent axis is the tangent axis of the to-be-encoded patch, and the determined target bitangent axis is the bitangent axis of the to-be-encoded patch.

[00309] In a feasible implementation, the patch information generation module 1501 may be specifically configured to determine the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch based on the description information of the bounding box size of the to-be-encoded point cloud and the normal axis of the to-be-encoded patch according to a projection rule for projecting the to-be-encoded point cloud, where the projection rule refers to distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-encoded point cloud onto the two-dimensional plane.

[00310] In a feasible implementation, the patch information generation module 1501 may be further configured to determine, according to a rate-distortion cost criterion, the projection rule for projecting the to-be-encoded point cloud. Optionally, the syntax element further includes information used to indicate the projection rule for projecting the to-be-encoded point cloud.

[00311] In a feasible implementation, the projection rule for projecting the to-be-encoded point cloud is preset.

[00312] In a feasible implementation, if a projection rule indicates vertical projection, the description information of the bounding box size of the to-be-encoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud, and the normal axis of the to-be-encoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch; and if a projection rule indicates vertical projection, the description information of the bounding box size of the to-be-encoded point cloud includes the size relationship among the side

lengths of the bounding box of the to-be-encoded point cloud, and the normal axis of the to-be-encoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch.

[00313] Alternatively, if a projection rule indicates horizontal projection, the description information of the bounding box size of the to-be-encoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud, and the normal axis of the to-be-encoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch; and if a projection rule indicates horizontal projection, the description information of the bounding box size of the to-be-encoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud, and the normal axis of the to-be-encoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch.

[00314] The projection rule refers to distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-encoded point cloud onto the two-dimensional plane, and the two-dimensional plane is a plane on which the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch are located.

[00315] In a feasible implementation, if a projection rule indicates vertical projection, the description information of the bounding box size of the to-be-encoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the normal axis of the to-be-encoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch; and if a projection rule indicates vertical projection, the description information of the bounding box size of the to-be-encoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the normal axis of the to-be-encoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, one of a coordinate axis on which a second longest side of the bounding box of the to-be-encoded

point cloud is located and a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch, and the other is the tangent axis of the to-be-encoded patch.

[00316] Alternatively, if a projection rule indicates horizontal projection, the description information of the bounding box size of the to-be-encoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the normal axis of the to-be-encoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch; and if a projection rule indicates horizontal projection, the description information of the bounding box size of the to-be-encoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the normal axis of the to-be-encoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, one of a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud is located and a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch, and the other is the bitangent axis of the to-be-encoded patch.

[00317] The projection rule refers to distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-encoded point cloud onto the two-dimensional plane, and the two-dimensional plane is a plane on which the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch are located.

[00318] The following describes a feasible implementation of performing encoding by the encoder 150 based on a point cloud group.

[00319] In a feasible implementation, the patch information generation module 1501 is configured to: obtain description information of a bounding box size of a to-be-encoded point cloud group and a normal axis of a to-be-encoded patch in the to-be-encoded point cloud group, where the to-be-encoded point cloud group includes at least two frames of point clouds; and determine a tangent axis of the to-be-encoded patch and a bitangent axis of the to-be-encoded patch based on the description information of the bounding box size of the to-be-encoded point cloud group and the normal axis of the to-be-encoded patch. The auxiliary information encoding module 1502 is configured to encode a syntax element into a bitstream, where the syntax element includes an index of the normal axis of the to-be-encoded patch and information used to indicate the description information of the bounding box size of the to-be-encoded point cloud group, and the syntax element is used to indicate the tangent axis of the to-be-encoded patch and

the bitangent axis of the to-be-encoded patch. For example, the patch information generation module 1501 may be configured to perform S301 and S302 in FIG. 13 and/or another step described in the embodiments of this application, and the auxiliary information encoding module 1502 may be configured to perform S303 in FIG. 13 and/or another step described in the embodiments of this application.

[00320] In a feasible implementation, the patch information generation module 1501 may be specifically configured to: use description information of a bounding box size of one frame of point cloud in the to-be-encoded point cloud group as the description information of the bounding box size of the to-be-encoded point cloud group; or use description information with a highest appearance frequency in description information of bounding box sizes of some or all point clouds in the to-be-encoded point cloud group as the description information of the bounding box size of the to-be-encoded point cloud group.

[00321] In a feasible implementation, the information used to indicate the description information of the bounding box size of the to-be-encoded point cloud group may include size information of a bounding box of one frame of point cloud in the to-be-encoded point cloud group, or size information with a highest appearance frequency in bounding box sizes of some or all point clouds in the to-be-encoded point cloud group; an index of a coordinate axis on which a longest side of a bounding box of one frame of point cloud in the to-be-encoded point cloud group is located, or an index of a coordinate axis with a highest appearance frequency in coordinate axes on which longest sides of bounding boxes of some or all point clouds in the to-be-encoded point cloud group are located; or an index of a size relationship among side lengths of a bounding box of one frame of point cloud in the to-be-encoded point cloud group, or an index of a size relationship with a highest appearance frequency in size relationships among side lengths of bounding boxes of some or all point clouds in the to-be-encoded point cloud group.

[00322] Optionally, all technical solutions obtained after frame level–based information in any feasible implementation in which the encoder 150 performs encoding based on a point cloud is replaced with GOF level–based information are applicable to a solution in which encoding is performed based on a point cloud group.

[00323] FIG. 16 is a schematic block diagram of a decoder 160 according to an embodiment of this application. The decoder 160 may include an auxiliary information decoding module 1601 and a point cloud geometry information reconstruction module 1602. In an example, the auxiliary information decoding module 1601 may correspond to the auxiliary information decoding module 204 in FIG. 4, and the point cloud geometry information reconstruction module 1602 may correspond to the point cloud geometry information reconstruction module 205 in FIG. 4. Certainly, this application is not limited thereto.

[00324] The following describes a feasible implementation of performing decoding by the point cloud decoder 160 based on a point cloud.

[00325] In a feasible implementation, the auxiliary information decoding module 1601 is configured to: parse a bitstream to obtain a syntax element, where the syntax element includes an index of a normal axis of a to-be-decoded patch in a to-be-decoded point cloud and information used to indicate description information of a bounding box size of the to-be-decoded point cloud; and determine a tangent axis of the to-be-decoded patch and a bitangent axis of the to-be-decoded patch based on the index of the normal axis of the to-be-decoded patch and the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud that are obtained through parsing. The point cloud geometry information reconstruction module 1602 is configured to reconstruct geometry information of the to-be-decoded point cloud based on tangent axes and bitangent axes of one or more patches in the to-be-decoded point cloud, where the one or more patches include the to-be-decoded patch. For example, the auxiliary information decoding module 1601 may be configured to perform S201 and S202 in FIG. 12 and/or another step described in the embodiments of this application. The point cloud geometry information reconstruction module 1602 may be configured to perform S203 in FIG. 12 and/or another step described in the embodiments of this application.

[00326] In a feasible implementation, the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud may include size information of a bounding box of the to-be-decoded point cloud; an index of a coordinate axis on which a longest side of a bounding box of the to-be-decoded point cloud is located; or an index of a size relationship among side lengths of a bounding box of the to-be-decoded point cloud.

[00327] In a feasible implementation, the auxiliary information decoding module 1601 may be specifically configured to: determine, based on a mapping relationship between a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets, a target tangent mode set corresponding to the description information of the bounding box size of the to-be-decoded point cloud, where each tangent mode set includes at least two tangent modes, and each tangent mode includes one tangent axis and one bitangent axis; and determine, based on a mapping relationship between a plurality of types of normal axes of a patch and a plurality of tangent modes in the target tangent mode set, a target tangent mode corresponding to the normal axis of the to-be-decoded patch, where a tangent axis included in the determined target tangent mode is the tangent axis of the to-be-decoded patch, and a bitangent axis included in the determined target tangent mode is the bitangent axis of the to-be-decoded patch.

[00328] In a feasible implementation, the auxiliary information decoding module 1601 may be specifically configured to determine, based on a mapping relationship among a plurality of types of description information of

bounding box sizes of point clouds, a plurality of types of normal axes of a patch, a plurality of types of tangent axes of the patch, and a plurality of types of bitangent axes of the patch, a target tangent axis and a target bitangent axis that correspond to both the description information of the bounding box size of the to-be-decoded point cloud and the normal axis of the to-be-decoded patch, where the determined target tangent axis is the tangent axis of the to-be-decoded patch, and the determined target bitangent axis is the bitangent axis of the to-be-decoded patch.

[00329] In a feasible implementation, the auxiliary information decoding module 1601 may be specifically configured to determine the tangent axis of the to-be-decoded patch and the bitangent axis of the to-be-decoded patch based on the description information of the bounding box size of the to-be-decoded point cloud and the normal axis of the to-be-decoded patch according to a projection rule for projecting the to-be-decoded point cloud, where the projection rule refers to distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-decoded point cloud onto the two-dimensional plane.

[00330] In a feasible implementation, the projection rule is preset.

[00331] In a feasible implementation, the syntax element further includes information used to indicate the projection rule.

[00332] In a feasible implementation, if a projection rule indicates vertical projection, the description information of the bounding box size of the to-be-decoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, and the normal axis of the to-be-decoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch; and if a projection rule indicates vertical projection, the description information of the bounding box size of the to-be-decoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, and the normal axis of the to-be-decoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch.

[00333] Alternatively, if a projection rule indicates horizontal projection, the description information of the bounding box size of the to-be-decoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, and the normal axis of the to-be-decoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-

be-decoded patch; and if a projection rule indicates horizontal projection, the description information of the bounding box size of the to-be-decoded point cloud includes the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, and the normal axis of the to-be-decoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch.

[00334] The projection rule refers to distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-decoded point cloud onto the two-dimensional plane, and the two-dimensional plane is a plane on which the tangent axis of the to-be-decoded patch and the bitangent axis of the to-be-decoded patch are located.

[00335] In a feasible implementation, if a projection rule indicates vertical projection, the description information of the bounding box size of the to-be-decoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, and the normal axis of the to-be-decoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch; and if a projection rule indicates vertical projection, the description information of the bounding box size of the to-be-decoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, and the normal axis of the to-be-decoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, one of a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located and a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch, and the other is the tangent axis of the to-be-decoded patch.

[00336] Alternatively, if a projection rule indicates horizontal projection, the description information of the bounding box size of the to-be-decoded point cloud includes the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, and the normal axis of the to-be-decoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch; and if a projection rule indicates horizontal projection, the description information of the bounding box size of the to-be-decoded point cloud includes the coordinate axis on which the

longest side of the bounding box of the to-be-decoded point cloud is located, and the normal axis of the to-be-decoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, one of a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located and a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch, and the other is the bitangent axis of the to-be-decoded patch.

[00337] The projection rule refers to distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-decoded point cloud onto the two-dimensional plane, and the two-dimensional plane is a plane on which the tangent axis of the to-be-decoded patch and the bitangent axis of the to-be-decoded patch are located.

[00338] The following describes a feasible implementation of performing decoding by the decoder 150 based on a point cloud group.

[00339] In a feasible implementation, the auxiliary information decoding module 1601 is configured to: parse a bitstream to obtain a syntax element, where the syntax element includes an index of a normal axis of a to-be-decoded patch in a to-be-decoded point cloud group and information used to indicate description information of a bounding box size of the to-be-decoded point cloud group, and the point cloud group includes at least two frames of point clouds; and determine a tangent axis of the to-be-decoded patch and a bitangent axis of the to-be-decoded patch based on the index of the normal axis of the to-be-decoded patch and the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud group that are obtained through parsing. The point cloud geometry information reconstruction module 1602 is configured to reconstruct geometry information of a to-be-decoded point cloud in the to-be-decoded point cloud group based on tangent axes and bitangent axes of one or more patches in the to-be-decoded point cloud, where the one or more patches include the to-be-decoded patch. For example, the auxiliary information decoding module 1601 may be configured to perform S401 and S402 in FIG. 14 and/or another step described in the embodiments of this application. The point cloud geometry information reconstruction module 1602 may be configured to perform S403 in FIG. 14 and/or another step described in the embodiments of this application.

[00340] In a feasible implementation, the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud group may include size information of a bounding box of the to-be-decoded point cloud group; an index of a coordinate axis on which a longest side of a bounding box of the to-be-decoded point cloud group is located; or an index of a size relationship among side lengths of a bounding box of the to-be-decoded point cloud group.

[00341] In a feasible implementation, the information used to indicate the description information of the bounding box size of the to-be-decoded point cloud group includes size information of a bounding box of one frame of point cloud in the to-be-decoded point cloud group, or size information with a highest appearance frequency in bounding box sizes of some or all point clouds in the to-be-decoded point cloud group; an index of a coordinate axis on which a longest side of a bounding box of one frame of point cloud in the to-be-decoded point cloud group is located, or an index of a coordinate axis with a highest appearance frequency in coordinate axes on which longest sides of bounding boxes of some or all point clouds in the to-be-decoded point cloud group are located; or an index of a size relationship among side lengths of a bounding box of one frame of point cloud in the to-be-decoded point cloud group, or an index of a size relationship with a highest appearance frequency in size relationships among side lengths of bounding boxes of some or all point clouds in the to-be-decoded point cloud group.

[00342] It may be understood that the modules in the encoder/decoder in the embodiments of this application are function bodies for implementing various execution steps included in the corresponding point cloud encoding/decoding method in this application, that is, function bodies that can completely implement steps in the corresponding point cloud encoding/decoding method in this application and extensions and variations of these steps. For details, refer to the foregoing description. For brevity, details are not described in this specification.

[00343] FIG. 17 is a schematic block diagram of an implementation of an encoding device or a decoding device (which are briefly referred to as a coding device 1700 or a point cloud coding device 1700) according to an embodiment of this application. The coding device 1700 may include a processor 1710, a memory 1730, and a bus system 1750. The processor 1710 is connected to the memory 1730 through the bus system 1750. The memory 1730 is configured to store an instruction. The processor 1710 is configured to execute the instruction stored in the memory 1730, to perform various point cloud encoding or decoding methods described in this application. To avoid repetition, details are not described herein again.

[00344] In this embodiment of this application, the processor 1710 may be a central processing unit (central processing unit, CPU), or the processor 1710 may be another general-purpose processor, a DSP, an ASIC, an FPGA, another programmable logic device, a discrete gate, 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.

[00345] The memory 1730 may include a ROM device or a RAM device. Any other proper type of storage device may be alternatively used as the memory 1730. The memory 1730 may include code and data 1731 that are accessed by the processor 1710 through the bus 1750. The memory 1730 may further include an operating system 1733 and an application 1735. The application 1735 includes at least one program that enables the processor 1710 to perform the

CLAIMS

1. An encoding apparatus comprising:

a processor; and

a memory coupled to the processor and configured to store instructions that, when executed by the processor, cause the encoding apparatus to be configured to:

obtain description information of a bounding box size of a to-be-encoded point cloud;

obtain a normal axis of a to-be-encoded patch in the to-be-encoded point cloud; and

encode a syntax element into a bitstream,

wherein the syntax element comprises an index of the normal axis and information indicating the description information of the bounding box size,

wherein the syntax element indicates a first tangent axis of the to-be-encoded patch and a first bitangent axis of the to-be-encoded patch,

wherein the to-be-encoded point cloud comprises one or more patches, and

wherein the one or more patches comprise the to-be-encoded patch.

2. The encoding apparatus of claim 1, wherein the information comprises at least one of size information of a bounding box of the to-be-encoded point cloud, a first index of a coordinate axis of a longest side of the bounding box or a second index of a size relationship of a plurality of side lengths of the bounding box.

3. The encoding apparatus of claim 1, wherein the instructions further cause the encoding apparatus to be configured to determine, based on the description information and the normal axis, the first tangent axis of the to-be-encoded patch and the first bitangent axis of the to-be-encoded patch.

4. The encoding apparatus of claim 3, wherein the instructions further cause the encoding apparatus to be configured to:

project a patch in the to-be-encoded point cloud onto a two-dimensional plane to obtain a projected picture, wherein the two-dimensional plane is a plane on which the first tangent axis and the first bitangent axis are located; and

determine the first tangent axis and the first bitangent axis according to a projection rule based on the description information and the normal axis, wherein the projection rule refers to a distribution of the projected picture on the two-dimensional plane.

5. The encoding apparatus of claim 4, wherein the projection rule is a preset projection rule or the projection rule is based on a rate-distortion cost criterion.

6. The encoding apparatus of claim 5, wherein the syntax element further comprises information indicating the projection rule when the projection rule is based on the rate-distortion cost criterion.

7. The encoding apparatus of claim 3, wherein the instructions further cause the encoding apparatus to be configured to:

determine a target tangent mode set corresponding to the description information based on a first mapping

relationship between a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets, wherein each of the tangent mode sets comprises at least two tangent modes, and wherein each of the tangent modes comprises one tangent axis and one bitangent axis; and

determine a target tangent mode corresponding to the normal axis based on a second mapping relationship between a plurality of types of normal axes of a patch and a plurality of tangent modes in the target tangent mode set, wherein a tangent axis of the target tangent mode is the first tangent axis, and wherein a third bitangent axis of the target tangent mode is the first bitangent axis.

8. The encoding apparatus of claim 3, wherein the instructions further cause the encoding apparatus to be configured to determine, based on a third mapping relationship among a plurality of types of description information of bounding box sizes of point clouds, a plurality of types of normal axes of a patch, a plurality of types of tangent axes of the patch, and a plurality of types of bitangent axes of the patch, wherein a target tangent axis and a target bitangent axis correspond to both the description information and the normal axis, wherein the target tangent axis is the first tangent axis, and wherein the target bitangent axis is the first bitangent axis.

9. The encoding apparatus of claim 1, wherein when a projection rule indicates a vertical projection, the description information of the bounding box size of the to-be-encoded point cloud comprises a size relationship among a plurality of side lengths of a bounding box of the to-be-encoded point cloud, the normal axis of the to-be-encoded patch is different from a coordinate axis on which a longest side of the bounding box of the to-be-encoded point cloud is located, and the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch, or the description information of the bounding box size of the to-be-encoded point cloud comprises the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud, and the normal axis of the to-be-encoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch,

wherein when the projection rule indicates a horizontal projection, the description information of the bounding box size of the to-be-encoded point cloud comprises the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud, the normal axis of the to-be-encoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch, or the description information of the bounding box size of the to-be-encoded point cloud comprises the size relationship among the side lengths of the bounding box of the to-be-encoded point cloud, and the normal axis of the to-be-encoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch, and

wherein the projection rule refers to a distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-encoded point cloud onto the two-dimensional plane, and the two-dimensional plane is a plane on which the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-

encoded patch are located.

10. The encoding apparatus of claim 1, wherein when a projection rule indicates a vertical projection, the description information of the bounding box size of the to-be-encoded point cloud comprises a coordinate axis on which a longest side of a bounding box of the to-be-encoded point cloud is located, and the normal axis of the to-be-encoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch, or the description information of the bounding box size of the to-be-encoded point cloud comprises the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the normal axis of the to-be-encoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, one of a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud is located or a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch, and another of the coordinate axis on which the second longest side of the bounding box of the to-be-encoded point cloud is located the a coordinate axis on which the shortest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch,

wherein when the projection rule indicates a horizontal projection, the description information of the bounding box size of the to-be-encoded point cloud comprises the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the normal axis of the to-be-encoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch, or the description information of the bounding box size of the to-be-encoded point cloud comprises the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, and the normal axis of the to-be-encoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-encoded point cloud is located, one of a coordinate axis on which a second longest side of the bounding box of the to-be-encoded point cloud is located or a coordinate axis on which a shortest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-encoded patch, and another of the coordinate axis on which the second longest side of the bounding box of the to-be-encoded point cloud is located or the coordinate axis on which the shortest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-encoded patch, and

wherein the projection rule refers to a distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-encoded point cloud onto the two-dimensional plane, and the two-dimensional plane is a plane on which the tangent axis of the to-be-encoded patch and the bitangent axis of the to-be-encoded patch are located.

11. A decoding apparatus comprising:

a processor; and

a memory coupled to the processor and configured to store instructions that, when executed by the processor, cause the decoding apparatus to be configured to:

parse a bitstream to obtain a syntax element, wherein the syntax element comprises an index of a normal axis of a to-be-decoded patch in a to-be-decoded point cloud and information indicating description information of a bounding box size of the to-be-decoded point cloud;

determine a first tangent axis of the to-be-decoded patch and a first bitangent axis of the to-be-decoded patch based on the index and the information indicating the description information of the bounding box size; and

reconstruct geometry information of the to-be-decoded point cloud based on a plurality of tangent axes and a plurality of bitangent axes of one or more patches in the to-be-decoded point cloud,

wherein the to-be-decoded point cloud comprises one or more patches, and wherein the one or more patches comprise the to-be-decoded patch.

12. The decoding apparatus of claim 11, wherein the information comprises one of the following size information of a bounding box of the to-be-decoded point cloud, a second index of a coordinate axis of a longest side of the bounding box, or a third index of a size relationship of a plurality of side lengths of the bounding box.

13. The decoding apparatus of claim 11, wherein the instructions further cause the decoding apparatus to be configured to:

project a patch in a to-be-encoded point cloud onto a two-dimensional plane to obtain a projected picture, wherein the two-dimensional plane is a plane on which the first tangent axis and the first bitangent axis are located; and

determine the first tangent axis and the first bitangent axis according to a projection rule based on the index of the normal axis and the information, wherein the projection rule refers to a distribution of the projected picture on the two-dimensional plane.

14. The decoding apparatus of claim 13, wherein the projection rule is a preset projection rule, or the syntax element further comprises information indicating the projection rule.

15. The decoding apparatus of claim 11, wherein the instructions further cause the decoding apparatus to be configured to:

determine a target tangent mode set corresponding to the description information based on a first mapping relationship between a plurality of types of description information of bounding box sizes of point clouds and a plurality of tangent mode sets, wherein each of the tangent mode sets comprises at least two tangent modes, and wherein each of the tangent modes comprises a second tangent axis and a second bitangent axis; and

determine a target tangent mode corresponding to the normal axis based on a second mapping relationship between a plurality of types of normal axes of a patch and a plurality of tangent modes in the target tangent mode set, wherein a third tangent axis of the target tangent mode is the first tangent axis, and wherein a third bitangent axis of the target tangent mode is the first bitangent axis.

16. The decoding apparatus of claim 11, wherein the instructions further cause the decoding apparatus to be configured to determine, based on a third mapping relationship among a plurality of types of description information of bounding box sizes of point clouds, a plurality of types of normal axes of a patch, a plurality of types of tangent axes of the patch, and a plurality of types of bitangent axes of the patch, wherein a target tangent axis and a target bitangent axis correspond to both the description information and the normal axis, wherein the target tangent axis is the first tangent axis, and wherein the target bitangent axis is the first bitangent axis.

17. The decoding apparatus of claim 11, wherein when a projection rule indicates a vertical projection, the

description information of the bounding box size of the to-be-decoded point cloud comprises a size relationship among a plurality aside lengths of a bounding box of the to-be-decoded point cloud, the normal axis of the to-be-decoded patch is different from a coordinate axis on which a longest side of the bounding box of the to-be-decoded point cloud is located, and the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch, or the description information of the bounding box size of the to-be-decoded point cloud comprises the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, the normal axis of the to-be-decoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch,

wherein when the projection rule indicates a horizontal projection, the description information of the bounding box size of the to-be-decoded point cloud comprises the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, the normal axis of the to-be-decoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, and the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch or the description information of the bounding box size of the to-be-decoded point cloud comprises the size relationship among the side lengths of the bounding box of the to-be-decoded point cloud, the normal axis of the to-be-decoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch, and a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch, and

wherein the projection rule refers to a distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-decoded point cloud onto the two-dimensional plane, and the two-dimensional plane is a plane on which the tangent axis of the to-be-decoded patch and the bitangent axis of the to-be-decoded patch are located.

18. The decoding apparatus of claim 11, wherein when a projection rule indicates a vertical projection, the description information of the bounding box size of the to-be-decoded point cloud comprises a coordinate axis on which a longest side of a bounding box of the to-be-decoded point cloud is located, and the normal axis of the to-be-decoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, and the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch, or the description information of the bounding box size of the to-be-decoded point cloud comprises the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, and the normal axis of the to-be-decoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, one of a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located or a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located is the bitangent axis of the to-be-decoded patch, and another of the coordinate axis on which the second longest side of the bounding box of the to-be-encoded point cloud is located the a coordinate axis on which the shortest side of the bounding box of the to-be-encoded point cloud is located is the tangent axis of the to-be-decoded patch,

wherein when the projection rule indicates a horizontal projection, the description information of the bounding box size of the to-be-decoded point cloud comprises the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, and the normal axis of the to-be-decoded patch is different from the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, and the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch, or the description information of the bounding box size of the to-be-decoded point cloud comprises the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, and the normal axis of the to-be-decoded patch is the same as the coordinate axis on which the longest side of the bounding box of the to-be-decoded point cloud is located, one of a coordinate axis on which a second longest side of the bounding box of the to-be-decoded point cloud is located and a coordinate axis on which a shortest side of the bounding box of the to-be-decoded point cloud is located is the tangent axis of the to-be-decoded patch, and another of the coordinate axis on which the second longest side of the bounding box of the to-be-encoded point cloud is located or the coordinate axis on which the shortest side of the bounding box of the to-be-encoded point cloud is located is the bitangent axis of the to-be-decoded patch, and

wherein the projection rule refers to a distribution, on a two-dimensional plane, of a projected picture obtained by projecting a patch in the to-be-decoded point cloud onto the two-dimensional plane, and the two-dimensional plane is a plane on which the tangent axis of the to-be-decoded patch and the bitangent axis of the to-be-decoded patch are located.

19. A computer program product comprising computer-executable instructions stored on a non-transitory computer-readable medium that, when executed by a processor, cause an encoding apparatus to:

obtain description information of a bounding box size of a to-be-encoded point cloud;

obtain a normal axis of a to-be-encoded patch in the to-be-encoded point cloud; and

encode a syntax element into a bitstream,

wherein the syntax element comprises an index of the normal axis and information indicating the description information of the bounding box size, and

wherein the syntax element indicates a tangent axis of the to-be-encoded patch and a bitangent axis of the to-be-encoded patch,

wherein the to-be-encoded point cloud comprises one or more patches, and

wherein the one or more patches comprise the to-be-encoded patch.

20. A computer program product comprising computer-executable instructions stored on a non-transitory computer-readable medium that, when executed by a processor, cause a decoding apparatus to:

parse a bitstream to obtain a syntax element, wherein the syntax element comprises an index of a normal axis of a to-be-decoded patch in a to-be-decoded point cloud and information indicating description information of a bounding box size of the to-be-decoded point cloud;

determine a tangent axis of the to-be-decoded patch and a bitangent axis of the to-be-decoded patch based on the index and the information indicating description information of the bounding box size; and

reconstruct geometry information of the to-be-decoded point cloud based on a plurality of tangent axes and a plurality of bitangent axes of one or more patches in the to-be-decoded point cloud,

wherein the to-be-decoded point cloud comprises one or more patches, and

wherein the one or more patches comprise the to-be-decoded patch.

21. The encoding apparatus of claim 1, wherein the bounding box size of the to-be-encoded point cloud depends on bounding box sizes of patches in the to-be-encoded point cloud, or wherein the description information of the bounding box size describes the one or more patches in the to-be-encoded point cloud.

22. The decoding apparatus of claim 11, wherein the bounding box size of the to-be-decoded point cloud depends on bounding box sizes of patches in the to-be-decoded point cloud, or wherein the description information of the bounding box size describes the one or more patches in the to-be-decoded point cloud.

23. The computer program product of claim 19, wherein the bounding box size of the to-be-encoded point cloud depends on bounding box sizes of patches in the to-be-encoded point cloud, or wherein the description information of the bounding box size describes the one or more patches in the to-be-encoded point cloud.

24. The computer program product of claim 20, wherein the bounding box size of the to-be-decoded point cloud depends on bounding box sizes of patches in the to-be-decoded point cloud, or wherein the description information of the bounding box size describes the one or more patches in the to-be-decoded point cloud.