three-dimensional data, a massive amount of data of a point cloud necessitates compression of the amount of three-dimensional data by encoding for accumulation and transmission, as in the case of a two-dimensional moving picture (examples include Moving Picture Experts Group-4 Advanced Video Coding (MPEG-4 AVC) and High Efficiency Video Coding (HEVC) standardized by MPEG).

[0004]

Meanwhile, point cloud compression is partially supported by, for example, an open-source library (Point Cloud Library) for point cloud-related processing.

[0005]

Furthermore, a technique for searching for and displaying a facility located in the surroundings of the vehicle by using three-dimensional map data is known (for example, see Patent Literature (PTL) 1).

Citation List

Patent Literature

[0006]

PTL 1: International Publication WO 2014/020663

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0007]

There has been a demand for improving coding efficiency in encoding and decoding three-dimensional data.

[0008]

Embodiments of the present disclosure provide a three-dimensional data encoding method, a three-dimensional data decoding method, a three-dimensional data encoding device, or a three-dimensional data decoding device that is capable of improving coding efficiency.

SOLUTIONS TO PROBLEMS

[0009]

According to a first aspect of the present disclosure, there is provided a three-dimensional data encoding method, including: quantizing geometry information of each of three-dimensional points, using a first quantization parameter; quantizing a first component using a second quantization parameter and quantizing a second component using a third quantization parameter, the first component and the second component configuring first attribute information among attribute information of each of the three dimensional points; and generating a bitstream including the geometry information quantized, the first component quantized, the second component quantized, the first quantization parameter, the second quantization parameter, and a first difference between the second quantization parameter and the third quantization parameter, wherein the first component and the second component configure first attribute information of the three-dimensional points, wherein in the quantizing using the second quantization parameter, for each of subspaces obtained by dividing a current space including the three-dimensional points, the first component of at least one three-dimensional point included in the subspace is quantized further using a fifth quantization parameter, in the quantizing using the third quantization parameter, the second component of the at least one three-dimensional point is quantized further using a sixth quantization parameter, and in the generating, the bitstream generated further includes a second difference between the second quantization parameter and the fifth quantization parameter and a third difference between the third quantization parameter and the sixth quantization parameter.

[0009a]

According to a second aspect of the present disclosure, there is provided a three-dimensional data encoding device, including: a processor; and a memory,

wherein using the memory, the processor: quantizes geometry information of each of three-dimensional points, using a first quantization parameter; quantizes a first component using a second quantization parameter and quantizes a second component using a third quantization parameter, the first component and the second component configuring first attribute information among attribute information of each of the three dimensional points; and generates a bitstream including the geometry information quantized, the first component quantized, the second component quantized, the first quantization parameter, the second quantization parameter, and a first difference between the second quantization parameter and the third quantization parameter, wherein in the quantizing using the second quantization parameter, for each of subspaces obtained by dividing a current space including the three-dimensional points, the first component of at least one three-dimensional point included in the subspace is quantized further using a fifth quantization parameter, in the quantizing using the third quantization parameter, the second component of the at least one three-dimensional point is quantized further using a sixth quantization parameter, and in the generating, the bitstream generated further includes a second difference between the second quantization parameter and the fifth quantization parameter and a third difference between the third quantization parameter and the sixth quantization parameter.

[0010]

According to a third aspect of the present disclosure, there is provided a three-dimensional data decoding method, including: obtaining quantized geometry information, a quantized first component, a quantized second component, a first quantization parameter, a second quantization parameter, and a first difference between the second quantization parameter and a third quantization parameter, by obtaining a bitstream; calculating geometry information of three-dimensional points by inverse-quantizing the quantized geometry information using the first quantization parameter; calculating a first component by inverse-quantizing the quantized first component using the second quantization parameter; and calculating a second component by inverse-quantizing the quantized second component using the third quantization parameter obtained from the second quantization parameter and the first difference, wherein the first component and the second component configure first attribute information of the three-dimensional points, wherein in the obtaining, a second difference between the second quantization parameter and a fifth quantization parameter and a third difference between the third quantization parameter and a sixth quantization parameter are further obtained by obtaining the bitstream, in the calculating of the first component, a first component of at least one three-dimensional point is calculated by inverse-quantizing the quantized first component using the second quantization parameter and the fifth quantization parameter obtained from the second difference, the at least one three-dimensional point being included in each of subspaces obtained by dividing a current space including the three-dimensional points, the quantized first component being the luminance obtained by quantizing the first component of the at least one three-dimensional point using the second quantization parameter and the fifth quantization parameter, and in the calculating of the second component, a second component of the at least one three-dimensional point is calculated by inverse-quantizing the quantized second component using the third quantization parameter and the sixth quantization parameter obtained from the third difference, the quantized second component being the chrominance obtained by quantizing the second component of the at least one three-dimensional point using the third quantization parameter and the sixth quantization parameter.

[00010a]

According to a fourth aspect of the present disclosure, there is provided a three-dimensional data decoding device, including: a processor; and a memory, wherein using the memory, the processor: obtains quantized geometry

information, a quantized first component, a quantized second component, a first quantization parameter, a second quantization parameter, and a first difference between the second quantization parameter and a third quantization parameter, by obtaining a bitstream; calculates geometry information of three-dimensional points by inverse-quantizing the quantized geometry information using the first quantization parameter; calculates a first component by inverse-quantizing the quantized first component using the second quantization parameter; and calculates second component by inverse-quantizing the quantized second component using the third quantization parameter obtained from the second quantization parameter and the first difference, wherein the first component and the second component configure first attribute information of the three-dimensional points, wherein in the obtaining, a second difference between the second quantization parameter and a fifth quantization parameter and a third difference between the third quantization parameter and a sixth quantization parameter are further obtained by obtaining the bitstream, in the calculating of the first component, a first component of at least one three-dimensional point is calculated by inverse-quantizing the quantized first component using the second quantization parameter and the fifth quantization parameter obtained from the second difference, the at least one three-dimensional point being included in each of subspaces obtained by dividing a current space including the three-dimensional points, the quantized first component being the luminance obtained by quantizing the first component of the at least one three-dimensional point using the second quantization parameter and the fifth quantization parameter, and in the calculating of the second component, a second component of the at least one three-dimensional point is calculated by inverse-quantizing the quantized second component using the third quantization parameter and the sixth quantization parameter obtained from the third difference, the quantized second component being the chrominance obtained by quantizing the second component of the at least one three-dimensional point using the third quantization parameter and the sixth quantization parameter.

ADVANTAGEOUS EFFECT OF INVENTION

[0011]

Embodiments of the present disclosure can provide a three-dimensional data encoding method, a three-dimensional data decoding method, a three-dimensional data encoding device, or a three-dimensional data decoding device that is capable of improving coding efficiency.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

FIG. 1 is a diagram illustrating a configuration of a three-dimensional data encoding and decoding system according to Embodiment 1.

FIG. 2 is a diagram illustrating a structure example of point cloud data according to Embodiment 1.

FIG. 3 is a diagram illustrating a structure example of a data file indicating the point cloud data according to Embodiment 1.

FIG. 4 is a diagram illustrating types of the point cloud data according to Embodiment 1.

FIG. 5 is a diagram illustrating a structure of a first encoder according to Embodiment 1.

FIG. 6 is a block diagram illustrating the first encoder according to Embodiment 1.

FIG. 7 is a diagram illustrating a structure of a first decoder according to Embodiment 1.

FIG. 8 is a block diagram illustrating the first decoder according to Embodiment 1.

FIG. 9 is a diagram illustrating a structure of a second encoder

CLAIMS

1. A three-dimensional data encoding method, comprising:

quantizing geometry information of each of three-dimensional points, using a first quantization parameter;

quantizing a first component using a second quantization parameter and quantizing a second component using a third quantization parameter, the first component and the second component configuring first attribute information among attribute information of each of the three dimensional points; and

generating a bitstream including the geometry information quantized, the first component quantized, the second component quantized, the first quantization parameter, the second quantization parameter, and a first difference between the second quantization parameter and the third quantization parameter,

wherein the first component and the second component configure first attribute information of the three-dimensional points,

wherein in the quantizing using the second quantization parameter, for each of subspaces obtained by dividing a current space including the three-dimensional points, the first component of at least one three-dimensional point included in the subspace is quantized further using a fifth quantization parameter,

in the quantizing using the third quantization parameter, the second component of the at least one three-dimensional point is quantized further using a sixth quantization parameter, and

in the generating, the bitstream generated further includes a second difference between the second quantization parameter and the fifth quantization parameter and a third difference between the third quantization parameter and the sixth quantization parameter.

2. The three-dimensional data encoding method according to claim 1, further comprising:

quantizing a reflectance among the attribute information of each of the three-dimensional points, using a fourth quantization parameter,

wherein in the generating, the bitstream generated further includes the reflectance quantized and the fourth quantization parameter.

3. The three-dimensional data encoding method according to claim 1,

wherein in the generating, the bitstream generated further includes identification information indicating that the quantizing using the second quantization parameter was performed using the fifth quantization parameter and the quantizing using the third quantization parameter was performed using the sixth quantization parameter.

4. The three-dimensional data encoding method according to claim 1, further comprising:

quantizing a third component using a seventh quantization parameter and quantizing a fourth component using an eighth quantization parameter, the third component and the fourth component configuring second attribute information among the attribute information of each of the three-dimensional points,

wherein in the generating, the bitstream generated further includes the third component quantized, the fourth component quantized, the seventh quantization parameter, and a fourth difference between the seventh parameter and the eighth parameter.

5. A three-dimensional data decoding method, comprising:

obtaining quantized geometry information, a quantized first component, a quantized second component, a first quantization parameter, a second quantization parameter, and a first difference between the second quantization parameter and a third quantization parameter, by obtaining a bitstream;

calculating geometry information of three-dimensional points by inverse-quantizing the quantized geometry information using the first quantization parameter;

calculating a first component by inverse-quantizing the quantized first component using the second quantization parameter; and

calculating a second component by inverse-quantizing the quantized second component using the third quantization parameter obtained from the second quantization parameter and the first difference,

wherein the first component and the second component configure first attribute information of the three-dimensional points,

wherein in the obtaining, a second difference between the second quantization parameter and a fifth quantization parameter and a third difference between the third quantization parameter and a sixth quantization parameter are further obtained by obtaining the bitstream,

in the calculating of the first component, a first component of at least one three-dimensional point is calculated by inverse-quantizing the quantized first component using the second quantization parameter and the fifth quantization parameter obtained from the second difference, the at least one three-dimensional point being included in each of subspaces obtained by dividing a current space including the three-dimensional points, the quantized first component being the luminance obtained by quantizing the first component of the at least one three-dimensional point using the second quantization parameter and the fifth quantization parameter, and

in the calculating of the second component, a second component of the at least one three-dimensional point is calculated by inverse-quantizing the quantized second component using the third quantization parameter and the sixth quantization parameter obtained from the third difference, the quantized second component being the chrominance obtained by quantizing the second component of the at least one three-dimensional point using the third quantization parameter and the sixth quantization parameter.

6. The three-dimensional data decoding method according to claim 5,

wherein in the obtaining, a quantized reflectance and a fourth quantization parameter are further obtained by obtaining the bitstream,

the three-dimensional data decoding method further comprising:

calculating a reflectance of the three-dimensional points by inverse-quantizing the quantized reflectance using the fourth quantization parameter.

7. The three-dimensional data decoding method according to claim 5,

wherein in the obtaining, identification information indicating that quantizing was performed using the fifth quantization parameter and the sixth quantization parameter is further obtained by obtaining the bitstream,

in the calculating of the first component, when the identification information indicates that quantizing was performed using the fifth quantization parameter and the sixth quantization parameter, the quantized first component is determined to be the luminance obtained by quantizing the first component of the at least one three-dimensional point, and

in the calculating of the second component, when the identification information indicates that quantizing was performed using the fifth quantization parameter and the sixth quantization parameter, the quantized

second component is determined to be the chrominance obtained by quantizing the second component of the at least one three-dimensional point.

8. The three-dimensional data decoding method according to claim 6,

wherein in the obtaining, a quantized third component, a quantized fourth component, a seventh quantization parameter, and a fourth difference between the seventh quantization parameter and an eighth quantization parameter is further obtained by obtaining the bitstream,

the three-dimensional data decoding method further comprising: calculating a third component by inverse-quantizing the quantized third component using the seventh quantization parameter; and calculating the fourth component by inverse-quantizing the quantized fourth component using the eighth quantization parameter obtained from the seventh quantization parameter and the fourth difference,

wherein the third component and the fourth component configure second attribute information of the three-dimensional points.

9. A three-dimensional data encoding device, comprising:

a processor; and

a memory,

wherein using the memory, the processor: quantizes geometry information of each of three-dimensional points, using a first quantization parameter; quantizes a first component using a second quantization parameter and quantizes a second component using a third quantization parameter, the first component and the second component configuring first attribute information among attribute information of each of the three dimensional points; and generates a bitstream including the geometry information quantized, the first component quantized, the second component quantized, the first quantization parameter, the second quantization parameter, and a first difference between the second quantization parameter and the third quantization parameter,

wherein in the quantizing using the second quantization parameter, for each of subspaces obtained by dividing a current space including the three-dimensional points, the first component of at least one three-dimensional point included in the subspace is quantized further using a fifth quantization parameter,

in the quantizing using the third quantization parameter, the second component of the at least one three-dimensional point is quantized further

using a sixth quantization parameter, and

in the generating, the bitstream generated further includes a second difference between the second quantization parameter and the fifth quantization parameter and a third difference between the third quantization parameter and the sixth quantization parameter.

10. A three-dimensional data decoding device, comprising:

a processor; and

a memory,

wherein using the memory, the processor:

obtains quantized geometry information, a quantized first component, a quantized second component, a first quantization parameter, a second quantization parameter, and a first difference between the second quantization parameter and a third quantization parameter, by obtaining a bitstream;

calculates geometry information of three-dimensional points by inverse-quantizing the quantized geometry information using the first quantization parameter;

calculates a first component by inverse-quantizing the quantized first component using the second quantization parameter; and

calculates second component by inverse-quantizing the quantized second component using the third quantization parameter obtained from the second quantization parameter and the first difference,

wherein the first component and the second component configure first attribute information of the three-dimensional points,

wherein in the obtaining, a second difference between the second quantization parameter and a fifth quantization parameter and a third difference between the third quantization parameter and a sixth quantization parameter are further obtained by obtaining the bitstream,

in the calculating of the first component, a first component of at least one three-dimensional point is calculated by inverse-quantizing the quantized first component using the second quantization parameter and the fifth quantization parameter obtained from the second difference, the at least one three-dimensional point being included in each of subspaces obtained by dividing a current space including the three-dimensional points, the quantized first component being the luminance obtained by quantizing the first component of the at least one three-dimensional point using the second quantization parameter and the fifth quantization parameter, and

in the calculating of the second component, a second component of the at

least one three-dimensional point is calculated by inverse-quantizing the quantized second component using the third quantization parameter and the sixth quantization parameter obtained from the third difference, the quantized second component being the chrominance obtained by quantizing the second component of the at least one three-dimensional point using the third quantization parameter and the sixth quantization parameter.