is expected to be a mainstream method of representing three-dimensional data, a massive amount of data of a point group 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 MPEG-4 AVC and 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 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 reducing an amount of processing in encoding and decoding of three-dimensional data.

[0008]

~~The~~Embodiments of the present disclosure ~~has an object to~~ 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 reducing the amount of processing.

SOLUTIONS TO PROBLEM

[0009]

~~A three-dimensional data encoding method according to one aspect of the present disclosure includes: encoding a first flag indicating whether a node having~~

~~a parent node different from a parent node of a current node is to be referred to in encoding of the current node included in an N-ary tree structure of three-dimensional points included in three-dimensional data, N being an integer greater than or equal to 2; selecting a coding table from N coding tables according to occupancy states of neighboring nodes of the current node, and performing arithmetic encoding on information of the current node using the coding table selected, when the first flag indicates that the node is to be referred to; and selecting a coding table from M coding tables according to the occupancy states of the neighboring nodes of the current node, and performing arithmetic encoding on information of the current node using the coding table selected, when the first flag indicates that the node is not to be referred to, M being an integer different from N.~~

According to a first aspect of the present disclosure, there is provided a three-dimensional data encoding method, including: generating an n-ary tree structure of three-dimensional points included in three-dimensional data, n being an integer greater than or equal to 2; encoding a first parameter; determining a value indicated by the first parameter; when the first parameter is determined as indicating a first value, (i) selecting a group from N groups according to occupancy states of neighboring nodes neighboring the current node and located inside or outside a parent node of the current node, N being an integer greater than 1, (ii) selecting contexts based on the selected group, and (iii) performing arithmetic encoding on information of the current node using the selected contexts; and when the first parameter is determined as indicating a second value different from the first value, (i) selecting a group from M groups according to the occupancy states of neighboring nodes neighboring the current node and located inside a parent node of the current node, M being an integer different from N and greater than 1, (ii) selecting contexts based on the selected group, and (iii) performing arithmetic encoding on information of the current node using the selected contexts.

[0009a]

According to a second aspect of the present disclosure, there is provided a three-dimensional data encoding device that encodes three-dimensional points

each including attribute information, the three-dimensional data encoding device including: a processor; and memory, wherein using the memory, the processor: generates an n-ary tree structure of three-dimensional points included in three-dimensional data, n being an integer greater than or equal to 2; encodes a first parameter; determines a value indicated by the first parameter; when the first parameter is determined as indicating a first value, (i) selects a group from N groups according to occupancy states of neighboring nodes neighboring the current node and located inside or outside a parent node, N being an integer greater than 1, (ii) selects contexts based on the selected group, and (iii) performs arithmetic encoding on information of the current node using the selected contexts; and when the first parameter is determined as indicating a second value different from the first value, (i) selects a group from M groups according to occupancy states of the neighboring nodes neighboring the current node and located inside a parent node of the current node, M being an integer different from N and greater than 1, (ii) selects contexts based on the selected group, and (iii) performs arithmetic encoding on information of the current node using the selected contexts.

[0010]

~~A three-dimensional data decoding method according to one aspect of the present disclosure includes: decoding a first flag indicating whether a node having a parent node different from a parent node of a current node is to be referred to in decoding of the current node included in an N-ary tree structure of three-dimensional points included in three-dimensional data, N being an integer greater than or equal to 2; selecting a coding table from N coding tables according to occupancy states of neighboring nodes of the current node, and performing arithmetic decoding on information of the current node using the coding table selected, when the first flag indicates that the node is to be referred to; and selecting a coding table from M coding tables according to the occupancy states of the neighboring nodes of the current node, and performing arithmetic decoding on information of the current node using the coding table selected, when the first flag indicates that the node is not to be referred to, M being an integer different from N.~~

[0010a]

According to a third aspect of the present disclosure, there is provided a three-dimensional data decoding method, including: obtaining an n-ary tree structure of three-dimensional points included in three-dimensional data, n being an integer greater than or equal to 2; obtaining a first parameter; determining a value indicated by the first parameter; when the first parameter is determined as indicating a first value, (i) selecting a group from N groups according to occupancy states of neighboring nodes neighboring the current node and located inside or outside a parent node of the current node, N being an integer greater than 1, (ii) selecting contexts based on the selected group, and (iii) performing arithmetic decoding on information of the current node using the selected contexts; when the first parameter is determined as indicating a second value different from the first value, (i) selecting a group from M groups according to occupancy states of the neighboring nodes neighboring the current node and located inside the parent node of the current node, M being an integer different from N and greater than 1, (ii) selecting contexts based on the selected group, and (iii) performing arithmetic decoding on information of the current node using the selected contexts.

[0010a]

According to a fourth aspect of the present disclosure, there is provided a three-dimensional data decoding device that decodes three-dimensional points each including attribute information, the three-dimensional data decoding device including: a processor; and memory, wherein using the memory, the processor: obtains an n-ary tree structure of three-dimensional points included in three-dimensional data, n being an integer greater than or equal to 2; obtains a first parameter; determines a value indicated by the first parameter; when the first parameter is determined as indicating a first value, (i) selects a group from N groups according to occupancy states of neighboring nodes neighboring the current node and located inside or outside a parent node of the current node, N being an integer greater than 1, (ii) selects contexts based on the selected group, and (ii) performs arithmetic decoding on information of the current node using the selected contexts; when the first parameter is determined as indicating a second value different from the first value, (i) selects a group from M groups according to

occupancy states of the neighboring nodes neighboring the current node and located inside the parent node of the current node, M being an integer different from N and greater than 1, (ii) selects contexts based on the selected group, and (iii) performs arithmetic decoding on information of the current node using the selected contexts.

ADVANTAGEOUS EFFECT OF INVENTION

[0011]

~~The~~Embodiments of the present disclosure provides 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 reducing an amount of processing.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

FIG. 1 is a diagram showing the structure of encoded three-dimensional data according to Embodiment 1.

FIG. 2 is a diagram showing an example of prediction structures among SPCs that belong to the lowermost layer in a GOS according to Embodiment 1.

FIG. 3 is a diagram showing an example of prediction structures among layers according to Embodiment 1.

FIG. 4 is a diagram showing an example order of encoding GOSs according to Embodiment 1.

FIG. 5 is a diagram showing an example order of encoding GOSs according to Embodiment 1.

FIG. 6 is a block diagram of a three-dimensional data encoding device according to Embodiment 1.

FIG. 7 is a flowchart of encoding processes according to Embodiment 1.

FIG. 8 is a block diagram of a three-dimensional data decoding device according to Embodiment 1.

CLAIMS

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

encoding a first flag indicating whether a node having a parent node different from a parent node of a current node is to be referred to in encoding of the current node included in an n-ary tree structure of three-dimensional points included in three-dimensional data, n being an integer greater than or equal to 2;

selecting a coding table from N coding tables according to occupancy states of neighboring nodes of the current node, and performing arithmetic encoding on information of the current node using the coding table selected, when the first flag indicates that the node is to be referred to; and

selecting a coding table from M coding tables according to the occupancy states of the neighboring nodes of the current node, and performing arithmetic encoding on information of the current node using the coding table selected, when the first flag indicates that the node is not to be referred to, M being an integer different from N.

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

wherein N is greater than M.

3. The three-dimensional data encoding method according to claim 1 or 2,

wherein when a coding table is selected from the M coding tables, the coding table is selected from the M coding tables by reference to a correspondence table according to the occupancy states of the neighboring nodes, the correspondence table indicating a correspondence relationship between L occupancy patterns indicating the occupancy states of the neighboring nodes and the M coding tables, L being an integer greater than M.

4. The three-dimensional data encoding method according to claim 1 or 2,

wherein when a coding table is selected from the M coding tables, the coding table is selected from the M coding tables by reference to a first correspondence table and a second correspondence table, according to the occupancy states of the neighboring nodes, the first correspondence table

~~indicating a correspondence relationship between L occupancy patterns indicating the occupancy states of the neighboring nodes and I coding tables, the second correspondence table indicating a correspondence relationship between the I coding tables and the M coding tables, L being an integer greater than I, I being an integer greater than M.~~

~~5. The three-dimensional data encoding method according to any one of claims 1 to 4,~~

~~wherein the occupancy states of the neighboring nodes when the first flag indicates that the node is not to be referred to are occupancy patterns represented by combinations of a position of the current node in a parent node and occupancy states of three neighboring nodes in the parent node, and~~

~~an identical coding table among the M coding tables is assigned to, among the occupancy patterns, occupancy patterns in which one of the three neighboring nodes is occupied and neighbors the current node in a direction horizontal to an x-y plane.~~

~~6. The three-dimensional data encoding method according to any one of claims 1 to 4,~~

~~wherein the occupancy states of the neighboring nodes when the first flag indicates that the node is not to be referred to are occupancy patterns represented by combinations of a position of the current node in a parent node and occupancy states of three neighboring nodes in the parent node, and~~

~~an identical coding table among the M coding tables is assigned to, among the occupancy patterns, occupancy patterns in which one of the three neighboring nodes is occupied and neighbors the current node in a direction vertical to an x-y plane.~~

~~7. The three-dimensional data encoding method according to any one of claims 1 to 4,~~

~~wherein the occupancy states of the neighboring nodes when the first flag indicates that the node is not to be referred to are occupancy patterns represented~~

by combinations of a position of the current node in a parent node and occupancy states of three neighboring nodes in the parent node, and

an identical coding table among the M coding tables is assigned to, among the occupancy patterns, occupancy patterns in which two of the three neighboring nodes are occupied and a plane defined by the two of the three neighboring nodes occupied and the current node is horizontal to an x-y plane.

8. The three-dimensional data encoding method according to any one of claims 1 to 4,

wherein the occupancy states of the neighboring nodes when the first flag indicates that the node is not to be referred to are occupancy patterns represented by combinations of a position of the current node in a parent node and occupancy states of three neighboring nodes in the parent node, and

an identical coding table among the M coding tables is assigned to, among the occupancy patterns, occupancy patterns in which two of the three neighboring nodes are occupied and a plane defined by the two of the three neighboring nodes occupied and the current node is vertical to an x-y plane.

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

decoding a first flag indicating whether a node having a parent node different from a parent node of a current node is to be referred to in decoding of the current node included in an n-ary tree structure of three-dimensional points included in three-dimensional data, n being an integer greater than or equal to 2;

selecting a coding table from N coding tables according to occupancy states of neighboring nodes of the current node, and performing arithmetic decoding on information of the current node using the coding table selected, when the first flag indicates that the node is to be referred to; and

selecting a coding table from M coding tables according to the occupancy states of the neighboring nodes of the current node, and performing arithmetic decoding on information of the current node using the coding table selected, when the first flag indicates that the node is not to be referred to, M being an integer different from N.

10. The three-dimensional data decoding method according to claim 9, wherein N is greater than M.

11. The three-dimensional data decoding method according to claim 9 or 10, wherein when a coding table is selected from the M coding tables, the coding table is selected from the M coding tables by reference to a correspondence table, according to the occupancy states of the neighboring nodes, the correspondence table indicating a correspondence relationship between L occupancy patterns indicating the occupancy states of the neighboring nodes and the M coding tables, L being an integer greater than M.

12. The three-dimensional data decoding method according to claim 9 or 10,

wherein when a coding table is selected from the M coding tables, the coding table is selected from the M coding tables by reference to a first correspondence table and a second correspondence table, according to the occupancy states of the neighboring nodes, the first correspondence table indicating a correspondence relationship between L occupancy patterns indicating the occupancy states of the neighboring nodes and I coding tables, the second correspondence table indicating a correspondence relationship between the I coding tables and the M coding tables, L being an integer greater than I, I being an integer greater than M.

13. The three-dimensional data decoding method according to any one of claims 9 to 12,

wherein the occupancy states of the neighboring nodes when the first flag indicates that the node is not to be referred to are occupancy patterns represented by combinations of a position of the current node in a parent node and occupancy states of three neighboring nodes in the parent node, and

an identical coding table among the M coding tables is assigned to, among the occupancy patterns, occupancy patterns in which one of the three neighboring nodes is occupied and neighbors the current node in a direction horizontal to an x-

~~y plane.~~

~~14. The three-dimensional data decoding method according to any one of claims 9 to 12,~~

~~wherein the occupancy states of the neighboring nodes when the first flag indicates that the node is not to be referred to are occupancy patterns represented by combinations of a position of the current node in a parent node and occupancy states of three neighboring nodes in the parent node, and~~

~~an identical coding table among the M coding tables is assigned to, among the occupancy patterns, occupancy patterns in which one of the three neighboring nodes is occupied and neighbors the current node in a direction vertical to an x-y plane.~~

~~15. The three-dimensional data decoding method according to any one of claims 9 to 12,~~

~~wherein the occupancy states of the neighboring nodes when the first flag indicates that the node is not to be referred to are occupancy patterns represented by combinations of a position of the current node in a parent node and occupancy states of three neighboring nodes in the parent node, and~~

~~an identical coding table among the M coding tables is assigned to, among the occupancy patterns, occupancy patterns in which two of the three neighboring nodes are occupied and a plane defined by the two of the three neighboring nodes occupied and the current node is horizontal to an x-y plane.~~

~~16. The three-dimensional data decoding method according to any one of claims 9 to 12,~~

~~wherein the occupancy states of the neighboring nodes when the first flag indicates that the node is not to be referred to are occupancy patterns represented by combinations of a position of the current node in a parent node and occupancy states of three neighboring nodes in the parent node, and~~

~~an identical coding table among the M coding tables is assigned to, among the occupancy patterns, occupancy patterns in which two of the three neighboring~~

~~nodes are occupied and a plane defined by the two of the three neighboring nodes occupied and the current node is vertical to an x-y plane.~~

~~17. A three-dimensional data encoding device that encodes three-dimensional points each including attribute information, the three-dimensional data encoding device comprising:~~

~~a processor; and~~

~~memory,~~

~~wherein using the memory, the processor:~~

~~encodes a first flag indicating whether a node having a parent node different from a parent node of a current node is to be referred to in encoding of the current node included in an n-ary tree structure of three-dimensional points included in three-dimensional data, n being an integer greater than or equal to 2;~~

~~selects a coding table from N coding tables according to occupancy states of neighboring nodes of the current node, and performs arithmetic encoding on information of the current node using the coding table selected, when the first flag indicates that the node is to be referred to; and~~

~~selects a coding table from M coding tables according to the occupancy states of the neighboring nodes of the current node, and performs arithmetic encoding on information of the current node using the coding table selected, when the first flag indicates that the node is not to be referred to, M being an integer different from N.~~

~~18. A three-dimensional data decoding device that decodes three-dimensional points each including attribute information, the three-dimensional data decoding device comprising:~~

~~a processor; and~~

~~memory,~~

~~wherein using the memory, the processor:~~

~~decodes a first flag indicating whether a node having a parent node different from a parent node of a current node is to be referred to in decoding of the current node included in an n-ary tree structure of three-dimensional points~~

~~included in three-dimensional data, n being an integer greater than or equal to 2;~~

~~selects a coding table from N coding tables according to occupancy states of neighboring nodes of the current node, and performs arithmetic decoding on information of the current node using the coding table selected, when the first flag indicates that the node is to be referred to; and~~

~~selects a coding table from M coding tables according to the occupancy states of the neighboring nodes of the current node, and performs arithmetic decoding on information of the current node using the coding table selected, when the first flag indicates that the node is not to be referred to, M being an integer different from N.~~

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

generating an n-ary tree structure of three-dimensional points included in three-dimensional data, n being an integer greater than or equal to 2;

encoding a first parameter;

determining a value indicated by the first parameter;

when the first parameter is determined as indicating a first value, (i) selecting a group from N groups according to occupancy states of neighboring nodes neighboring the current node and located inside or outside a parent node of the current node, N being an integer greater than 1, (ii) selecting contexts based on the selected group, and (iii) performing arithmetic encoding on information of the current node using the selected contexts; and

when the first parameter is determined as indicating a second value different from the first value, (i) selecting a group from M groups according to the occupancy states of neighboring nodes neighboring the current node and located inside a parent node of the current node, M being an integer different from N and greater than 1, (ii) selecting contexts based on the selected group, and (iii) performing arithmetic encoding on information of the current node using the selected contexts.

2. The three-dimensional data encoding method according to claim 1, wherein N is greater than M.

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

obtaining an n-ary tree structure of three-dimensional points included in three-dimensional data, n being an integer greater than or equal to 2;

obtaining a first parameter;

determining a value indicated by the first parameter;

when the first parameter is determined as indicating a first value, (i) selecting a group from N groups according to occupancy states of neighboring nodes neighboring the current node and located inside or outside a parent node of the current node, N being an integer greater than 1, (ii) selecting contexts based on the selected group, and (iii) performing arithmetic decoding on information of the current node using the selected contexts;

when the first parameter is determined as indicating a second value different from the first value, (i) selecting a group from M groups according to occupancy states of the neighboring nodes neighboring the current node and located inside the parent node of the current node, M being an integer different from N and greater than 1, (ii) selecting contexts based on the selected group, and (iii) performing arithmetic decoding on information of the current node using the selected contexts.

4. The three-dimensional data decoding method according to claim 3, wherein N is greater than M.

5. A three-dimensional data encoding device that encodes three-dimensional points each including attribute information, the three-dimensional data encoding device comprising:

a processor; and

memory,

wherein using the memory, the processor:

generates an n-ary tree structure of three-dimensional points included in three-dimensional data, n being an integer greater than or equal to 2;

encodes a first parameter;

determines a value indicated by the first parameter;

when the first parameter is determined as indicating a first value, (i) selects a group from N groups according to occupancy states of neighboring nodes neighboring the current node and located inside or outside a parent node, N being an integer greater than 1, (ii) selects contexts based on the selected group, and (iii) performs arithmetic encoding on information of the current node using the selected contexts; and

when the first parameter is determined as indicating a second value different from the first value, (i) selects a group from M groups according to occupancy states of the neighboring nodes neighboring the current node and located inside a parent node of the current node, M being an integer different from N and greater than 1, (ii) selects contexts based on the selected group, and (iii) performs arithmetic encoding on information of the current node using the selected contexts.

6. A three-dimensional data decoding device that decodes three-dimensional points each including attribute information, the three-dimensional data decoding device comprising:

a processor; and

memory,

wherein using the memory, the processor:

obtains an n-ary tree structure of three-dimensional points included in three-dimensional data, n being an integer greater than or equal to 2;

obtains a first parameter;

determines a value indicated by the first parameter;

when the first parameter is determined as indicating a first value, (i) selects a group from N groups according to occupancy states of neighboring nodes neighboring the current node and located inside or outside a parent node of the current node, N being an integer greater than 1, (ii) selects contexts based on the selected group, and (ii) performs arithmetic decoding on information of the current node using the selected contexts;

when the first parameter is determined as indicating a second value different from the first value, (i) selects a group from M groups according to occupancy states of the neighboring nodes neighboring the current node and located inside the parent node of the current node, M being an integer different from N and greater than 1, (ii) selects contexts based on the selected group, and (iii) performs arithmetic decoding on information of the current node using the selected contexts.

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

when the first parameter is determined as indicating the first value, a first patten of the occupancy states of neighboring nodes is selected as a first group from the N groups,

when the first parameter is determined as indicating the second value, the first patten of the occupancy states of neighboring nodes is selected as a second group from the M groups, and

the first group and the second group indicate that all of the neighboring nodes neighboring the current node do not include a three-dimensional point.

8. The three-dimensional data encoding method according to claim 7, wherein

the number of pattens of the occupancy states of neighboring nodes assigned to the first group of the N groups is one, and

the number of pattens of the occupancy states of neighboring nodes assigned to the second group of the N groups is one.

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

when the first parameter is determined as indicating the first value, a first patten of the occupancy states of neighboring nodes is selected as a first group from the N groups,

when the first parameter is determined as indicating the second value, the first patten of the occupancy states of neighboring nodes is selected as a second group from the M groups, and

the first group and the second group indicate that at least one of the

neighboring nodes neighboring the current node includes a three-dimensional point.

10. The three-dimensional data encoding method according to claim 9, wherein

Q pattens of the occupancy states of neighboring nodes are assigned to the first group of the N groups,

P pattens of the occupancy states of neighboring nodes are assigned to the second group of the N groups, and

P is greater than Q.

11. The three-dimensional data decoding method according to claim 3, wherein

when the first parameter is determined as indicating the first value, a first patten of the occupancy states of neighboring nodes is selected as a first group from the N groups,

when the first parameter is determined as indicating the second value, the first patten of the occupancy states of neighboring nodes is selected as a second group from the M groups, and

the first group and the second group indicate that all of the neighboring nodes neighboring the current node do not include a three-dimensional point.

12. The three-dimensional data decoding method according to claim 11, wherein

the number of pattens of the occupancy states of neighboring nodes assigned to the first group of the N groups is one, and

the number of pattens of the occupancy states of neighboring nodes assigned to the second group of the N groups is one.

13. The three-dimensional data decoding method according to claim 3, wherein

when the first parameter is determined as indicating the first value, a first patten of the occupancy states of neighboring nodes is selected as a first group from the N groups,

when the first parameter is determined as indicating the second value, the

first patten of the occupancy states of neighboring nodes is selected as a second group from the M groups, and

the first group and the second group indicate that at least one of the neighboring nodes neighboring the current node includes a three-dimensional point.

14. The three-dimensional data decoding method according to claim 13, wherein

Q pattens of the occupancy states of neighboring nodes are assigned to the first group of the N groups,

P pattens of the occupancy states of neighboring nodes are assigned to the second group of the N groups, and

P is greater than Q.