

CLAIMS

1. A device, comprising:

a memory configured to store an octree for representing a three-dimensional shape, nodes of the octree including empty nodes and non-empty nodes, the empty nodes excluding the three-dimensional shape and being leaf nodes of the octree, and the non-empty nodes including at least a part of the three-dimensional shape; and

a processing unit coupled to the memory and configured to perform acts including:

obtaining the octree for representing the three-dimensional shape from the memory;

for nodes in the octree with a depth associated with a convolutional layer of a convolutional neural network, performing a convolutional operation of the convolutional layer to obtain an output of the convolutional layer, performing the convolutional operation of the convolutional layer comprising:

determining eight nodes having a same parent node from the nodes with the depth associated with the convolutional layer;

determining a node neighborhood of the eight nodes based on the octree, the node neighborhood including nodes adjacent to at least one of the eight nodes; and

performing the operation of the convolution layer for the eight nodes on the node neighborhood; and

the convolutional neural network includes a deconvolutional layer and the acts further include:

determining eight nodes having a same parent node from nodes with a depth associated with the deconvolutional layer;

determining a node neighborhood of the eight nodes based on the octree, the node neighborhood including nodes adjacent to at least one of the eight nodes; and

performing an operation of the deconvolutional layer for the eight nodes on the node neighborhood.

2. The device according to Claim 1, wherein obtaining the octree for representing the three-dimensional shape comprises obtaining, based on a spatial segmentation for the three-dimensional shape, at least one of:

an index of a node of the octree;

a label of a node of the octree, the label at least indicating whether the node is an empty node or a non-empty node;

shape data of a node of the octree, the shape data at least indicating a shape of the

three-dimensional shape in the node; and

a hierarchical structure of the octree.

3. The device according to Claim 1, wherein obtaining the octree for representing the three-dimensional shape comprises:

receiving a data signal representing the three-dimensional shape; and

in response to receiving the data signal, determining the octree for representing the three-dimensional shape.

4. The device according to Claim 1, wherein the convolutional neural network includes a pooling layer, and wherein the acts further include:

determining eight nodes having a same parent node from nodes with a depth associated with the pooling layer; and

performing a down-sampling operation on shape data of the eight nodes.

5. The device according to Claim 1, wherein the convolutional neural network includes an unpooling layer and the acts further include:

determining eight nodes having a same parent node from nodes with a depth associated with the unpooling layer; and

performing an up-sampling operation on shape data of the eight nodes.

6. The device according to Claim 2, wherein at least one of the index, the label, the shape data and the hierarchical structure is defined as a continuous vector.

7. The device according to Claim 1, wherein the device is a graphic processing unit (GPU).

8. A computer-implemented method, comprising:

obtaining an octree for representing a three-dimensional shape, nodes of the octree including empty nodes and non-empty nodes, the empty nodes excluding the three-dimensional shape and being leaf nodes of the octree, and the non-empty nodes including at least a part of the three-dimensional shape;

for nodes in the octree with a depth associated with a convolutional layer of a convolutional neural network, performing a convolutional operation of the convolutional layer to obtain an output of the convolutional layer, the step of performing the convolutional operation including the steps of;

determining eight nodes having a same parent node from the nodes with the depth associated with the convolutional layer;

determining a node neighborhood of the eight nodes based on the octree, the node neighborhood including nodes adjacent to at least one of the eight nodes; and

performing the operation of the convolutional layer for the eight nodes on the node neighborhood;

determining eight nodes having a same parent node from nodes with a depth associated with a deconvolutional layer of the convolutional neural network;

determining a node neighborhood of the eight nodes based on the octree, the node neighborhood including nodes adjacent to at least one of the eight nodes; and

performing an operation of the deconvolutional layer for the eight nodes on the node neighborhood.

9. The method according to Claim 8, wherein obtaining an octree for representing a three-dimensional shape comprises obtaining, based on a spatial segmentation for the three-dimensional shape, at least one of:

an index of a node of the octree;

a label of a node of the octree, the label at least indicating whether the node is an empty node or a non-empty node;

shape data of a node of the octree, the shape data at least indicating a shape of the three-dimensional shape in the node; and

a hierarchical structure of the octree.

10. The method according to Claim 8, wherein obtaining an octree for representing a three-dimensional shape comprises:

receiving a data signal representing the three-dimensional shape; and

in response to receiving the data signal, determining the octree for representing the three-dimensional shape.

11. A computer program product including instructions tangibly stored on a computer readable medium, the instructions, when executed by a machine, causing the machine to implement a method comprising:

obtaining an octree for representing a three-dimensional shape, nodes of the octree including empty nodes and non-empty nodes, the empty nodes excluding the three-dimensional shape and being leaf nodes of the octree, and the non-empty nodes including at least a part of the three-dimensional shape;

for nodes in the octree with a depth associated with a convolutional layer of a convolutional neural network, performing a convolutional operation of the convolutional layer to obtain an output of the convolutional layer, performing the convolutional operation of deconvolution layer comprising:

determining eight nodes having a same parent node from the nodes with the

depth associated with the convolutional layer;

determining a node neighborhood of the eight nodes based on the octree, the node neighborhood including nodes adjacent to at least one of the eight nodes; and

performing the operation of the convolutional layer for the eight nodes on the node neighborhood;

determining eight nodes having a same parent node from nodes with a depth associated with a deconvolutional layer of the convolutional neural network;

determining a node neighborhood of the eight nodes based on the octree, the node neighborhood including nodes adjacent to at least one of the eight nodes; and

performing an operation of the deconvolutional layer for the eight nodes on the node neighborhood.

12. The computer program product according to Claim 11, wherein obtaining an octree for representing a three-dimensional shape comprises obtaining, based on a spatial segmentation for the three-dimensional shape, at least one of:

an index of a node of the octree;

a label of a node of the octree, the label at least indicating whether the node is an empty node or a non-empty node;

shape data of a node of the octree, the shape data at least indicating a shape of the three-dimensional shape in the node; and

a hierarchical structure of the octree.