【主論文の要旨・記入例】

学位報告４

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主　論　文　の　要　旨

論文題目　POINT CLOUD COMPRESSION FOR 3D LIDAR SENSOR
(3 次元 LiDAR のための点群圧縮)

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論 文 内 容 の 要 旨

Point cloud data from LiDAR sensors is currently the basis of most Level 4 autonomous driving systems, and its use is expanding into many other fields. The sharing and transmission of point cloud data from 3D LiDAR sensors has broad application prospects in areas such as accident investigation, V2V/V2X networks and remote control. Due to the huge volume of data involved, directly sharing and storing this data is expensive and difficult however, making compression indispensable.

Many previous studies have proposed methods of compressing point cloud data. Because of the sparseness and disorderly nature of this data, most of these methods involve arranging point clouds into a 2D format (height map, range image, etc.) or into a tree structure (k-d tree, octree, etc.) and further coding them. However, directly converting point cloud into another format results in information loss, even before spatial redundancy is reduced during compression. In addition, most previous methods have only focused on compression of a single point cloud frame, and have not taken temporal redundancy within streaming point clouds into consideration.

To solve the problem of information loss caused by the reformatting of point cloud data, in Chapter 4.1.2 a new method for losslessly converting point cloud data into a 2D matrix by utilizing raw LiDAR packet data is proposed.

To reduce both the temporal and spatial redundancy of streaming point cloud data, in Chapter 4 the use of an image/video compression method for the compression of 2D formatted, streaming LiDAR data is proposed. To more efficiently r

educe temporal redundancy, in Chapter 5 a more natural frame prediction approach which simulates LiDAR operation and uses LiDAR motion information is proposed. Along with a sequencing module, which is used to optimize the number and location of reference frames, this approach can outperform several of the popular, existing compression methods, including image/video compression-based methods introduced in Chapter 4.

In Chapter 6 and Chapter 7, we explore the potential of using deep learning to compress point cloud data. Starting with a static point cloud frame, Chapter 6 proposes using a Recurrent Neural Network (RNN) with a residual block to compress individual data frames. Thanks to the ability of deep learning to understand the features or textures of data, RNN-based compression methods can significantly outperform popular octree and JPEG-based methods.

To further compress streaming point cloud data, in Chapter 7 a method using a double U-net structure to predict internal data frames is proposed. By using a JPEG-LS based encoder, the proposed method can be executed in real-time, while outperforming MPEG-based and octree-based streaming point cloud compression methods.

In Chapters 4, 5 and 6, we not only quantitatively evaluate various point cloud compression methods by calculating their information loss and compression rates, but also use them in real applications such as mapping and localization, to evaluate the functionality of these methods.