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Evaluation of 3D Map using Entropy of Point Cloud on Road Surfaces

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3D point cloud map used in autonomous driving systems may contain errors such as plane thickness and doubled wall due to errors in SLAM(Simultaneous Localization and Mapping)/MMS(Mobile Mapping System). Therefore, some methods have been proposed to detect and evaluate errors in point clouds. One of them is the entropy of the point cloud, which is used to evaluate the overall quality of the point cloud map. However, the accuracy evaluation based on point cloud entropy has the problems of computational cost and the fact that the evaluation value is affected by the surrounding environment. Therefore, it is difficult to automatically identify the areas where the accuracy is deteriorating.

Therefore, we propose an efficient method for evaluating the accuracy of 3D point cloud maps to be used in autonomous driving systems. First, we clarify the effectiveness of conventional methods that utilize the MME(Mean Map Entropy) of point clouds and their problems. Then, we propose a method for evaluating point clouds by focusing on the road surface, which is a plane. The proposed method calculates MME on the road surface along the trajectory. The proposed method is expected to reduce the calculation cost while enabling the detection of areas where the point cloud accuracy deteriorates.

Figure 4 shows the processing flow of the proposed method. In each step, the following process is performed.

(1) Set evaluation points at fixed distances along the trajectory, extract a fixed range of road surface points around the evaluation points.

(2) Calculate the MME for the road surface points extracted in (1).

(3) Calculate a two moving average of MME using large interval and small interval.

(4) Compare the transition and value of the two moving averages, and use the evaluation values to extract candidates for point cloud accuracy degradation areas.

Figures 2 and 3 show the results of the evaluation of SLAM point clouds acquired at Meijo University. When the moving average of the short-term MME is significantly larger than the moving average of the long-term MME, the accuracy of the point cloud may be degraded and thickness in the road surface may have occurred. It was confirmed that the proposed method can automatically detect where the accuracy of the point cloud is decreasing.

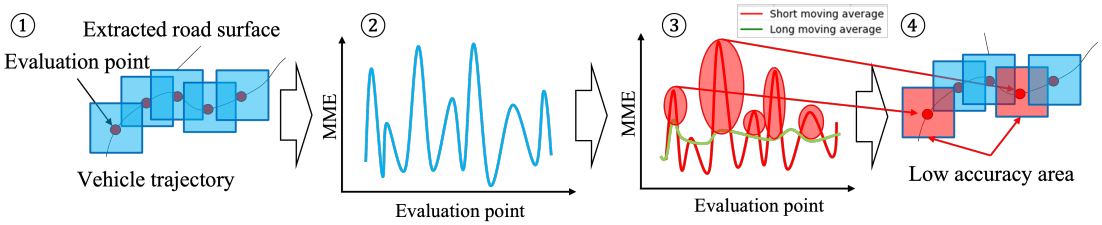

Fig. 1 Overview of the proposed method

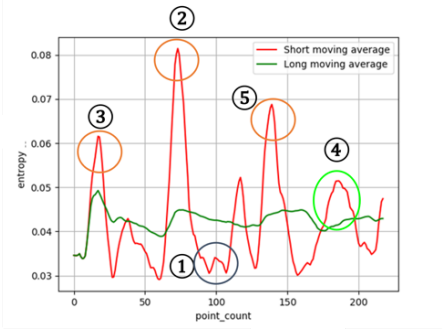

Fig.2 Short/Long moving average of MME at Meijo University dataset

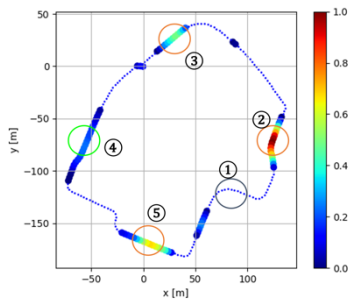

Fig.3 Fig.7 Detected areas of point cloud accuracy degradation at Meijo University dataset