論　文　の　要　旨

題　目　Precise 3D Modeling and Feature Extraction based on Mobile Mapping Data in Road Environment

（モービルマッピングデータに基づく道路の高精度3次元モデリングと特徴抽出）

氏　名　蘇　景昕

In recent years, autonomous driving has become an increasingly important topic in the academia and industry. While various techniques have been developed to handle different types of issues, it is recognized that stability and reliability are both key consideration in the assessment of systems. However, to help the self-driving car development and evaluation, a high accuracy and high precision three-dimensional model of the road surface is necessary and very valuable. The aim of the present study is to outline a workflow for 3D modeling road surface based on mobile mapping data.

In Chapter 1, we introduce the definition of road characteristics and environmental factors and motivation of our study.

In Chapter 2, we propose an approach for precise 3D modeling of lane marks by combining both image and point cloud features. Instead of applying only 2D image processing techniques for lane markings detection, we introduce a line-based point cloud region growing method and an image-based scan-line method for the extraction. The line-based point cloud region growing is used to identify boundary points, which guarantees a precise road surface region segmentation and boundary points extraction. The image-based scan-line algorithm is designed specifically for the environments where it is difficult to clearly identify the road surface region. The road surface points are projected onto color image to find precise lane mark region. Then, we perform an inverse projection to recover the 3D coordinates of the detected 2D lane mark points. Quantitative evaluation is conducted with comparison of the proposed method and a region of interest method.

In Chapter 3, we use the obtained 3D lane marking model for the road trajectory estimation directly. A morphological closing operation is used to refine the lane marks. Next, using the length and angle information of points, we produce a two-dimensional representation of the 3D points. This allows us to apply mature two-dimensional algorithm to obtain the missing points. Points are represented in a length-angle space in order to estimate the points between broken white lines. Considering that the road trajectories are the sequences consists of centerline points. Finally, we generate a 3D point sequence to represent the trajectory points. Since there is no ground truth data and design curvature of the road trajectory, we manually build a reference dataset for the comparison and evaluation. The result shows that a continuous-curvature trajectory was obtained by the proposed method.

In Chapter 4, we make use of road trajectory points the reference line and use a curved regular grid (CRG) model to get a complete view of road surface that contains geographic information of road surface and use elevation information to show the shape of road surface. We firstly apply a robust and effective method that can divide road into three road segment categories: straight line, circular arc and clothoid curve. To create CRG model file, a regular elevation grid which provides elevation values is needed. To effectively and accurately interpolate the elevation values, the regular grid is

created using a non-regular gird. In the next step, we estimate the regular grid from the non-regular grid by applying the bilinear interpolation method. Experimental results on real world road scenarios is evaluated based on the root-mean-square error between the proposed method and an existing nearest-neighbour search method. The numerical analysis shows that the proposed approaches are capable of accurately modeling the road surface. Finally, we build a precise road model that contains geographic information of road surface features and use elevation information to show the shape of road surface in high-resolution. The next step in future development, we may further build the road network database. Some conclusions and final remarks are provided in Chapter 5.