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Difference Extraction of Lanes between Detailed Geometry Map and Aerial Image

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The understanding of the surrounding environment is a fundamental and important factor in the autonomous driving system and advanced driving assist system. In order to realize these systems, the accurate map information is important to understand external environment of the vehicle as well as the sensors on the vehicle. Although the map information used as prior information for them, it sometimes has different information from the real situation.

This paper proposes the method extracting the difference of the number of lanes between a map information which has the roads and lanes location and an aerial image such as a satellite image or an image from an airplane, to ensure the accuracy of the information on the map. The method employs semantic segmentation for extracting road area from an aerial image, the image map from the map information, , adjustment the location of the result of road area inference and map information by two optimization steps, and difference extaction. (Fig.1)

Firstly, the semantic segmentation extracts either road, non-road, white line, road boundary information from an aerial image on a pixel-by-pixel basis. U-Net was used as the convolutional neural network model for the semantic segmentation and it performed 95.0% IoU(Intersection of Union) for 0.29m/pixel resolution image and 198,000 images training. The analysis showed that the hidden road area by vegetation, buildings, cars, or tunnels made the performance worse from the view point of miss-extraction and the area similar to the road such as a pedestrian street brought wrong extraction. (Fig.2)

Secondary, the location adjustment between the above extracted information and map information has two stages. First stage is the global adjustment using a projective transformation between the semantic segmentation image and the imaged road information from the map. It used RANSAC(RANdom Sample Consensus) for the optimization. Second stage is the local adjustment using an iterative approach. It changes the node location in the map information step by step according to the designed loss function. The loss function consists of three terms that evaluates (1) the overlapped area between the non-road area and the road area from both images, (2) the change of 3 nodes angle from the original structure from the map, and (3) the overlapped area between the lane which has different lane ID on the map information.

The experimental result using 90 images shows that the proposed method extracted (a) 36 locations as the lacked lanes on the map, and (b) 92 location as the excess lanes on the map. As the analysis result, (a) 29 indications out of 36 were correct (80.5%), which incorrect cases happened on the wrong detection area or wrong adjustment cases, and (b) all of them were incorrect because of miss-extactions mentioned above. As the result, the proposed method is effective when the map has lacked information of the lanes, besides there are the difficulties caused by the hidden road area on the aerial image when the map has excess information of the lanes.

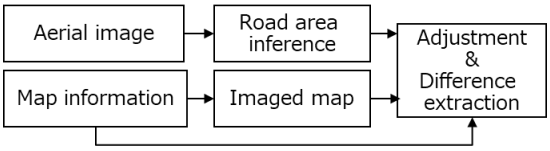

Fig. 1 the proposed extraction method

Fig. 2 inference result, two circled area shows the examples of miss-extraction