Institut für Photogrammetrie und GeoInformation

Leibniz Universität Hannover

Deep Learning-Based Detection and Delineation of Road Infrastructure Boundaries for Automated Commercial Vehicles

Proposal for a Master thesis topic in cooperation with ZF (DE/EN)

Fakultät für Bauingenieurwesen und Geodäsie

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The automation of commercial vehicles is a crucial area of research aimed at improving safety, efficiency, and reliability. A key requirement for automated navigation is the precise perception of the vehicle's surroundings, particularly the detection of road infrastructure boundaries that define the drivable space. Image-based perception methods based on deep learning have shown promising results in edge and contour detection. However, real-world challenges such as varying lighting conditions, different appearance of these boundaries as well as sensor limitations necessitate robust and scalable solutions. This thesis aims to develop a deep learning-based method for detecting and segmenting road infrastructure boundaries in image data, specifically optimized for commercial vehicle applications.

The goal of this thesis is the development of a method capable of accurately detecting and delineating road infrastructure boundaries based on single images acquired by a camera mounted on a moving vehicle. To achieve this goal, a suitable neural network architecture must be developed, trained and tested. In the end, each detected boundary should be represented by polygons marking its border which implies the classification of the pixels in the image.

The pursuing candidate must design and implement an appropriate architecture based on the PyTorch framework. As foundation, a comprehensive literature review should be conducted, focusing on the applicability of methods in commercial vehicle environments. Potential modules include Convolutional Neural Networks, Transformer models or Graph Neural Networks. The developed method will be trained and tested using both, simulated and real data, assessing its performance and integration potential into commercial vehicle perception systems. The algorithm should be optimized for computational efficiency and evaluated in terms of detection accuracy and robustness across varying environmental conditions. The feasibility for real-time deployment will be proven by a vehicle application.

By addressing current challenges in road boundary detection, this thesis contributes to the advancement of automated vehicle navigation, providing insights into the practical application of deep learning techniques in real-world driving environments.

This thesis will be conducted in cooperation with ZF CV Systems Hannover GmbH, which is part of ZF Commercial Vehicle Solutions. They provide the working environment and both real and simulated training and test data for the evaluation.

At the Institute of Photogrammetry and GeoInformation, the thesis will be supervised by Christian Grannemann (M.Sc.) and A/Prof. Franz Rottensteiner.

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