Detection of Vehicle Position on a Pressure-Sensitive Surface Layer

(Master Thesis)

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Motivation

Present road and traffic systems face different challenges like automation and ecology which require fundamental solutions.

This work contributes to the project “Digital Twin of the Road System” by the German research foundation (DFG) which aims to develop a reality model of road systems to enable automated analysis and control.

Sensitive surface layers (SSL) are part of a road surface and enable the perception of the road users, e. g., by measuring pressure. In context of the project, SSL can provide high-precision position information of vehicles. In combination with different real-time road information, SSL can add data to a holistic digital road model.

State of the Art

Currently, numerous localization techniques for vehicles exist. Low-cost positioning systems like GPS or IMU can define positions in magnitude of meters and are thus too inaccurate for many tasks like automatic lane holding[1]. SSL can be categorized as a device for environmental perception and thus does not require specific hardware in the sensed vehicles which distinguishes this approach from other technologies. After initial literature research, street surfaces as data source were neglected by previous research and no similar approaches could be found.

Objective

This thesis aims to detect vehicle positions on a pressure-sensitive surface layer and to enable the integration into a service-oriented infrastructure.

Initially, pressure data grids are generated with given known vehicle positions. It is planned to replace artificial data grids with physical laboratory data upon availability of the required laboratory environment. For vehicle detection from the pressure data grid, model-based approaches will be evaluated and the most suiting one will be selected. This also includes special cases, for example, with less than four tires per vehicle present. The approaches are evaluated regarding accuracy, processing runtime, resource requirements, and scalability.

Planned Approach

After initial research and basic approach evaluation, splitting the vehicle detection into two sub-problems appears appropriate. In the first step, tire positions are detected in the pressure grid data. For this task, the clustering algorithm DBSCAN in combination with threshold filtering is promising as it is computationally lightweight and flexible.

In a second step, the detected tire positions are assigned to vehicles. For this task, shape matching algorithms or geometric tire-to-car assignments are evaluated, among others.

[1] Kuutti; Falla; Katsaro; Dianati; Mccullough; Mouzakitis (2018): A Survey of the State-of-the-Art Localization Techniques and Their Potentials for Autonomous Vehicle Applications. In: *IEEE Internet Things J.* 5 (2)

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10.03.2022

Informatik 11
Embedded Software
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