Concept and Implementation of a Real-Time Lane Position Estimation System with Side Cameras using Deep Learning Algorithms for Autonomous Vehicles

(Master Thesis)

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Motivation

Visual perception systems play an important role in the architecture of autonomous driving cars, as images provide rich information about the environment. An important information provided by visual systems is an estimation of the relative position of lane markings, which helps to maintain the desired position of the car on the road. Designing such a system is challenging due to varying road conditions, shadows, spurious reflections, differences in illumination, perspective distortions based on angle of view, variations in height of the camera above the ground and many others. While many recent approaches apply particle filter and hand crafted features to the problem, only few publications consider the application of Deep Learning algorithms. Deep Learning, a collective term for neural-network based classifiers and currently a hot topic in machine learning, pushed the boundaries in challenging tasks like image and speech recognition while outperforming many then state-of-the-art classifiers.

Goal

The goal of this thesis is to design and implement a real-time capable system that robustly estimates the relative position of lane markings using deep learning algorithms. If possible, additional information sources like IMU and GPS data will be exploited to improve the robustness of the detection. An extensive evaluation of the system performance will be presented.

Approach

First, in order to gain a general understanding of Deep Learning techniques, related literature has to be collected and reviewed. Traditionally cameras are placed facing forward behind the rear view mirror. As this camera setup does not always provide the best possible views on the lane, the cameras will be placed laterally on either side of the car. Based on a real-world dataset, a Deep Learning network will be designed and trained that is able to estimate the distance of lane markings relative to the car. The network, which will consist of multiple hidden layers and convolutional window filters, outputs the estimated relative distance of lane markings. Subsequently, this information may be filtered using a sensor fusion technique, which combines the classifier output with additional information sources (e.g. IMU, GPS, maps) in order to improve the robustness of the system. Lastly, the systems performance will be evaluated and the results will be compared against existing leading techniques and hand labeled data sets.

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