Evaluation of a Sensor/Actuator Platform for Autonomous Driving

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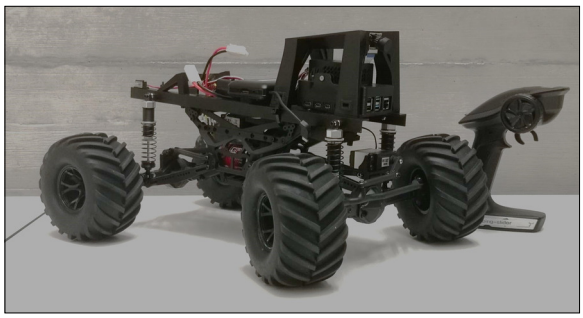
Introduction: Autonomous driving is an increasingly relevant topic, as it is a solid solution to ensure safety and efficiency on the road. Nowadays, there are several autonomous driving systems available for commercial use. Some very successful ones, e.g. the one implemented by Tesla, are data-driven. However, data-driven approaches have two major drawbacks: they need a huge amount of high-quality data for training, and in case of accidents, the actual system behaviour is not entirely understandable. This leads to challenging legal questions. Hence, an interesting research topic is a performance comparison between such data-driven and conventional control theory approaches.

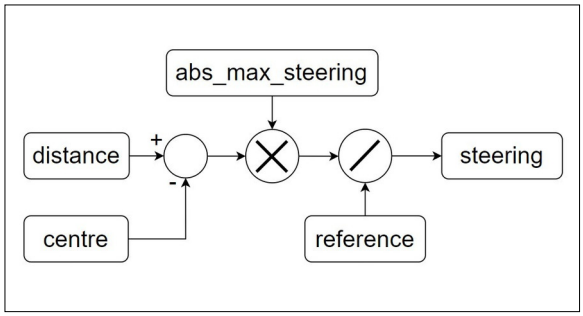
Definition of Task: In this project, two distinct approaches for self-driving vehicles are analysed and evaluated. The first one is a data-driven method. Here, an artificial intelligence system learns from a human driver how to drive correctly around a circuit. The second one is a classical approach based on control theory: An already existing computer vision algorithm detects the centre of the driving lane. After that, the controller compares this input with the actual heading of the car and calculates the corresponding steering angle.

Result: The experiments show that the control theory approach proved a significantly better driving performance. The data-driven approach has the drawback that high-quality data is needed for training. Even at the lowest speed it is impossible for a skilled RC car driver to drive a perfect lap on the circuit for several times. Due to specific training data that has been collected under particular lighting conditions and track conformation, it is unlikely to get an AI with optimal driving skills under different environmental conditions. In contrast to that, the control theory approach does not require training data or any learning phase to drive an unknown circuit in the correct way. The only input needed is a correct tuning of the lane detection algorithm on the right lane colour. Moreover, in terms of speed, the car driven by the control theory approach is even faster and more precise than the same car driven by a skilled human.

The prototype model car with the Raspberry PI
Own presentment



Steering regulator diagram
Own presentment



Simulated environment model
Own presentment

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Subject Area
Embedded Software Engineering