Gaussian-Process-based Modeling of Human Drivers from Real Data

TECHNISCHE UNIVERSITÄT DARMSTADT

Proposal for a Master's Thesis Project

Safe intersection crossing in mixed traffic, i.e., with both autonomous and human-driven vehicles, remains challenging due to the wide range of human driving behavior. Furthermore, multiple intentions of the human drivers - turning left, turning right, going straight on - need to be considered. One way to deal with this challenging task is to employ multi-mode model predictive control. However, such a controller requires a model to predict the future behavior of human-driven vehicles. Current approaches use Gaussian process (GP) regression, a probabilistic machine learning approach, to learn a standard human driving behavior from demonstration data. Besides this nominal prediction, GPs yield a measure of uncertainty in terms of a Gaussian probability distribution that captures variations in the demonstrations. Exploiting the uncertainty in the controller design yields robustness against deviations of individual human driving behaviors from the standard one.

While the above described approach aims at modeling the human-driven vehicles as autonomous systems, another modeling approach is to be investigated in the scope of this thesis. Therein, the vehicle dynamics will be described by a standard model from literature and the human driver will be considered as a (feedback) controller with unknown control law. Hence, the objective is to employ GP regression to learn a control law representing human drivers from real-world data. Possible approaches range from learning a common control policy to learning individual control policies using autoregressive model structures. A strategy for uncertainty propagation during recursive model evaluations, e.g., using approaches proposed in literature, shall be developed and validated.

The following prerequisites will be useful for the project:

Experience with / knowledge about:	Gaussian process regression, optimal parameter estimation
Programming skills:	Python
Language:	German or English

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CCPS Control and Cyber-Physical Systems