Master Project

Real-Time Fault Detection and Isolation for Autonomous Vehicles

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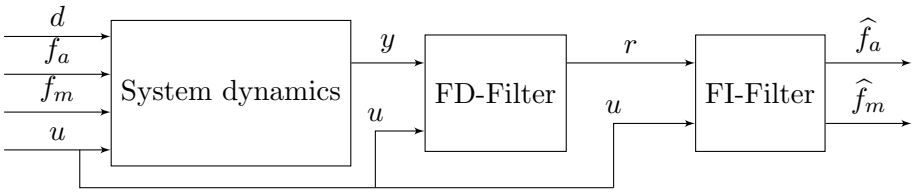
Context

Autonomous vehicles are rapidly becoming the center of attention in the future of the automotive industry. Novel control and observer techniques are continuously being developed to ensure a safe and efficient implementation of autonomous driving in the human society. One of the greater goals for autonomous vehicles is defined as being able to autonomously drive the vehicle without human intervention. A lack of human intervention requires the vehicle to be aware of fault scenarios for which it should undertake appropriate action.



The focus of this project is to detect and isolate faults occurring in the steering system in a lane-keeping scenario. Possible faults can be modeled as different exogenous inputs to the system dynamics (for instance, f_a, f_m in the figure above). A key challenge is the fact that these faults may be indistinguishable from one another. In this project, a lateral vehicle model is derived in order to capture the dynamics of a vehicle for a constant longitudinal velocity. The model is described through a set of differential equations, which is exploited in the next step to design a fault diagnosis filter. It is worth noting that the velocity deviation from the nominal value may deteriorate the

quality of the model, and as such the performance of the resulting diagnosis filter. Therefore, a careful extension of the current existing tools is required to robustify the filter synthesis to model uncertainties. This is a vital step to close the gap between the theoretical developments and an experimental setting for a real application such as autonomous vehicles.

Project tasks

This master thesis opts for developing a fault detection and isolation method applicable to a wide range of models with a particular occurrence of faults. The proposed project comprises the following tasks:

1. Develop a mathematical model describing the dynamics of the vehicle and a particular fault (possible case studies are the lateral control and tires friction).
2. Synthesize a fault detection filter and analyze the corresponding estimation error bound
3. Develop a dynamic feedback control strategy to mitigate the impact of the fault
4. Study the true estimation error as well as the filter sensitivity through extensive simulation experiments
5. Further experimental implementation and testing at TNO

This master thesis project is a joint collaboration between Delft Center for Systems and Control at TU Delft, Dynamics and Control group at TU Eindhoven, and the department of Integrated Vehicle Safety at TNO. The literature review and theoretical phase of the project will be conducted at one of the universities while the experimental phase will be implemented at TNO.