Structured Development of the Information Processing for the Active Suspension of a Railway Vehicle

Abstract of the Ph.D. thesis by Dipl.-Ing. Dipl.-Phys. Thorsten Hestermeyer

Since 1997, the research initiative Neue Bahntechnik Paderborn (New Railway Technology Paderborn) has been developing a comprehensive concept to increase the attractiveness of the railway system. The concept envisions railway traffic with small, autonomous railway vehicles, so called “Railcabs”, of which a first innovative prototype has been realized at a scale of 1:2.5 with a mass of 1.2 t and a length of 3.4 m. In particular, the Railcab features a fully active, hydraulic secondary suspension in all spatial degrees of freedom.

This thesis describes **the physical setup of the suspension** and presents its information processing **including control and process supervision**. This includes sky-hook-damping, active tilt and lateral centering. The operability of the suspension is demonstrated by the results of experimental runs on a dedicated test track.

For further improvement of the suspension, a model study with **self-learning disturbance compensation and reference trajectory** is presented. In this study, the Railcab vehicles learn the exact track profile using intelligent track nodes. The track profile can then be used for the disturbance compensation. As only information gathered during normal operation is employed, separate measurement runs with special vehicles are no longer required.

Special emphasis is placed on how to structure the information processing into macro-modules with an internal micro-structure.

In order to obtain the **macro-structure** of the information processing this thesis suggests aggregating the overall mechatronic system in a function-oriented way and extracting the macro-structure from the resulting aggregate structure. The tools necessary for this process are provided. The resulting control configuration, a “generalized cascade“, is discussed with special regard to the interaction between decentralized controllers.

As **micro-structure**, a three-layer Operator-Controller-Module is presented. It divides the information processing of a macro-module with its different tasks like control, supervision and optimization/adaptation into three different layers according to real-time requirements and the dynamic coupling to the control plant. The resulting structuring concept shows deliberate similarities to structures known from the field of artificial intelligence.