四轮转向车辆鲁棒控制系统快速开发仿真与试验 Rapid Development Simulation and Test of Robust Control System for Four-wheel Steering Vehicle

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关键词： 车辆 四轮转向 鲁棒控制 快速开发 硬件在环仿真

摘　要： 考虑车辆行驶工况的不确定性及系统建模误差，建立了多自由度四轮转向车辆动力学数学模型。基于结构奇异值μ综合鲁棒理论，通过设立不确定性虚拟模块，设计了μ综合控制器，抑制外部扰动；基于Matlab/Simulink/dSPACE建立了四轮转向(4WS)车辆控制系统的HILS快速开发平台，验证测试控制器的有效性；通过实车试验修订硬件在环仿真结果。试验表明四轮转向车辆控制系统的纯数字仿真-实时数字仿真-硬件在环仿真-实车试验整个控制系统开发过程的有效性及优越性，说明该快速开发系统具有较好的扩展性。　Considering the high uncertainty for vehicle working environment, multi-degree of freedom four-wheel steering vehicle model was proposed. Structural singular value μ theory is adapted to design robust controller. By specifying an imaginary uncertainty module, the behavior robust property was inverted into a generalized system to resist the exterior disturbance. A HILS platform based on Matlab/Simulink/dSPACE was developed to real-time carry out the virtual testing by constructing different vehicle surrounding. The four-wheel steering automobile was modified successfully and the developed 4WS controller was then applied in the vehicle field test for validation and further modification. The test data proved that the modified four-wheel steering is prior to front-wheel steering and the former has an excellent maneuverability and stability. Furthermore, the whole procedure of rapid development for 4WS including off-line simulation, real-time simulation, hardware-in-the loop simulation and the validation of the vehicle field test, based on the control development system, was investigated by the 4WS rapid development system. Therefore it was demonstrated by theoretical and experimental results that the 4WS rapid development system is an extended powerful tool for the development of vehicle chassis electronic controllers.

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