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Advanced Control for Vehicle Active Suspension Systems

Springer

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Preface

With increased requirements for vehicle performances, vehicle suspension systems are of importance for contributing to the cars handling and keeping vehicle occupants comfortable and reasonably well isolated from road noise, bumps, vibrations, etc. A well-designed suspension system can effectively promote the whole performances of automobile chassis. Basically, vehicle suspension system consists of wishbone, spring, and shock absorber to transmit and filter all forces between car body and the road. From a perspective of the control mode, vehicle suspensions can be categorized into three types: passive, semi-active, and active suspensions. Among the three kinds of suspensions, active suspensions have the greatest potential to improve the ride comfort and vehicle maneuverability, and this research area has remained attractive for many years.

In active suspensions, actuators are placed between the car body and wheel-axle parallel to the suspension elements, and are able to both add and dissipate energy from the system, which enables the suspension to control the attitude of the vehicle, to reduce the effects of braking and the vehicle roll during cornering maneuvers to increase ride comfort and vehicle road handling. Although active suspensions have many advantages, some problems are also needed to be solved urgently. The main limitative factors of active suspensions fall into three areas: (1) difficult control algorithm; (2) potential risk in reliability; and (3) extra energy consumption.

Focused on the above three aspect problems, the book is organized as eight chapters. Chapter 1 introduces the background, modeling, and problem statements of active suspensions, which can be viewed as the fundamental description of active suspension control. Chapter 2 is concerned with the constrained H_∞ control approaches of active suspension systems in the entire frequency domain, which mainly concentrates on linear convex optimization approach in H_∞ sense. Chapter 3 focuses on the state feedback and dynamic output feedback controller in the finite frequency domain which people are most sensitive to. Chapter 4 aims at nonlinear constrained tracking control via terminal sliding-mode control and adaptive robust theory. Chapter 5 is mainly about the controller design of active suspensions when actuator saturation is taken into consideration. Chapter 6 focuses on the reliability control of active suspension systems, where several kinds of the most possible problems in actuators are considered in controller design. Chapter 7 considers actuator dynamics in the controller design to improve the accuracy, and the electro-hydraulic systems are exampled as actuators to supply the active forces into suspension systems. Chapter 8 carries out active suspension control from an energy point of view, and the energy regeneration scheme and self-powered criterion of motor-driven active suspension systems are investigated.

To summarize, this book presents the most recent theoretical findings on control issues for active suspension systems. By integrating novel ideas, fresh insights, and rigorous results in a systematic way, this book is aimed at providing a base for further theoretical research as well as a design guide for engineering applications of active suspensions. This book can serve as a reference to the main research issues and results on active suspension systems for researchers devoted to control theory or vehicle dynamics control, as well as a material for graduate and undergraduate students interested in control theory and vehicle suspension systems. Some prerequisites for reading this book include linear system theory, matrix theory, mathematics, adaptive control theory, and so on.

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Contents