Semi-active Suspension Control: Improved Vehicle Ride and Road Friendliness

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Springer-Verlag, London, (2008). 294 pp, 129.00 USD, ISBN 978-1-84800-230-2

The fundamental goals of a car suspension are the vibration isolation of the vehicle from the road and the improvement of road handling by means of a spring-type element and damper. The limitations of typical suspension have spurred the investigation of controlled suspension systems, both active and semi-active. Due to their higher reliability, lower cost, and comparable performance semi-active suspension systems have gained wide acceptance throughout the automotive engineering community.

This book provides an overview of vehicle ride control employing smart semi-active damping systems. In this context, the term "smart" refers to the ability to modify the control logic in response to measured vehicle ride and handling indicators. The focus of the book is on controlled semi-active suspension systems for ride control and road friendliness using an approach that highlights the interactions between mechanical, hydraulic, and electromagnetic subsystems. The book analyzes the different technical challenges involved in designing a smart damping system, and emphasizes practical aspects of its implementation with lengthy discussion of case studies and experimental implementations. The book also analyzes issues such as road holding, passenger comfort, and human body response. The primary technical focus of the book is two types of semi-active dampers: friction dampers and magnetorheological dampers.

Chapter 1 is a general introduction to the topic and fundamental concepts. It is both an interesting and informative—the average person with an interest in noise and vibration might be surprised to learn about the depth of the body of knowledge related to suspension control. Chapter 1 is largely descriptive text, presented in an overview fashion that is not overly technical.

Chapter 2 focuses on damper modeling and summarizes vehicle ride and road surface models. The chapter presents a higher level of technical detail than the introductory chapter. Yet, basic concepts are clearly presented. A reader with a strong engineering math background will more fully benefit from this and subsequent chapters. This chapter presents numerous models for assessing vehicle ride, tires, and road surfaces.

Chapter 3 analyzes human body response to vibration. After a brief introduction, the chapter dives into fairly technical discussion of various ways to mathematically evaluate human response to vibration, seated human models, etc. The text in the chapter is concise, and relies heavy on equations to convey mathematical systems used to assess human response in the context of vehicle-induced vibrations.

Chapter 4 is dedicated to semi-active control algorithms. The first few sections provide digestible explanations of different types of control systems (PID, adaptive, and robust control), then the chapter focuses on classical semi-active damper control algorithms. There are good explanations of damper systems, best suited for an audience with a strong engineering background.

Chapter 5 details the design of a semi-active suspension system based on a friction damper. This chapter provides very good explanations of different friction models, and places them into historical context, and explains current use of friction damper design in the automotive industry and modern scale models. This chapter is quite thorough.

Chapter 6 illustrates the design of a magneto-rheological-based semi-active suspension. Magnetorheological dampers (MRD) refer to a suspension system that uses oil that has micron-sized ferromagnetic particles in suspension. Using a solenoid to control the magnetic field applied to the oil, it's possible to change the oil from a liquid to a semi-solid state. After an interesting and thorough introduction, this chapter presents discussions of MRD fluids, the operating modes, the damper designs, and MRD modeling and characteristics identification. The latter topics are covered in great detail, and require a strong engineering background to fully appreciate.

Chapter 7 offers a comprehensive overview of applications with a number of case studies.

The text fully achieves its goals of covering a topic that most readers experience every day while perhaps overlooking its technical subtleties. Semi-Active Suspension…provides a balanced combination of text, calculations, and diagrams to whet the appetite of technical readers, researchers, and students interested in the topic. It also leaves the reader with the feeling that this is a growing area of research and applications.

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