Preface

This book is an extension of my previous book entitled *Magnetorheological Dampers in Vibration Control*, published in 2006 by AGH University of Science and Technology Press. The book summarizes the work completed under the research project devoted to real-time control of magnetorheological (MR) dampers in mechanical systems. The project was carried out in 2006-2008 in the Department of Process Control/AGH University of Science and Technology.

My intention was to master the required interdisciplinary knowledge to provide a better insight into real-time control aspects of MR dampers in mechanical systems. I believe that it will be largely achieved by experimental support provided in successive chapters of the book.

Chapter 1 recalls selected aspects of damping in mechanical systems. The issues addressed include: damping process and their models, the general linear model of damping and damping model uncertainty, dissipative forces in discrete and continuous systems, problems of proportional damping and non-proportional damping, and complex modes. The remarks on optimal damping and physical criteria of dampers' classification are outlined.

Chapter 2 describes physical composition, properties, behavior, model and modes of MR fluids. The structure, operation principle and parameters of the MR damper operating in the flow mode are characterized. Structures, technical data and basic characteristics of two small-scale MR dampers are presented. The response time dependence on operating parameters of these dampers is discussed.

Chapter 3 discusses several control concepts. A direct engineering approach based on real-time experiment is recommended. General ideas of control algorithms known as the rule-base, fuzzy or neural denoted as the intelligent methods are considered. There is the linear quadratic regulator problem presented in detail. Control approaches dedicated to the MR damper are announced. It is also indicated how to benefit by automatic control.

Chapter 4 focuses on computer systems that operate in real-time. The requirements of a real-time operating mode are characterized. The task structure, scheduling policies, synchronization and inter-process communication methods applied in real-time operating systems are described. The main methods of accessing external signals are outlined. The methods of the Real-Time Windows Target toolbox and the System-on-a-Chip architecture running the Xilinx microkernel are explained.

Chapter 5 reviews selected problems of measurement and control equipment used for MR dampers' control in the investigated mechanical systems. Technical specification of sensors and an engineered and power controller are provided. On-line processing problems such as amplifying, filtering and signal conversion of measurement signals are discussed.

Chapter 6 deals with control of an MR damper in a driver's seat suspension to reduce vibration transmitted to the driver. The driver's seat is investigated as a system with one- and two-degrees-of-freedom. The algorithms applied to the damper, the experimental setup and results of experiments are presented. The control system based on the ST52E420 microcontroller is described.

Chapter 7 is devoted to MR dampers control in a vehicle suspension to reduce vibration transmitted to the human occupying the vehicle. The vehicle suspension is investigated as a system with two- or three-degrees-of-freedom. The algorithms applied to the dampers, the experimental setup and results of experiments are presented. The control system based on a phyCORE-MPC555 microcontroller is described.

Chapters 8 deals with control of an MR damper attached transversally to a suspended cable near one of the support to reduce free vibration. The cable is investigated as a continuous system with distributed mass and stiffness. The algorithms applied to the damper, the experimental setup and results of experiments are presented. The control system based on the Memec VIRTEX-4FX FPGA board is described.

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