

Preface

Mechatronics and robotics have been widely used in many arenas, such as manufacturing, medical, and space. With the rapid development of mechatronics and MEMS technologies, a follow-up edition of the book *Advanced Mechatronics and MEMS Devices* is deemed necessary. The aim of *Advanced Mechatronics and MEMS Devices II* is to introduce the state-of-the-art technologies in the field of mechatronics, robotics, and MEMS devices in order to further summarize and improve the methodologies of mechatronics and MEMS devices. Advances made in the past decades will be well described in this book, including mechatronics, robotics, and MEMS-related issues.

We would like to express our deep appreciation to all the authors for their significant contributions to the book. Their commitment, enthusiasm, and technical expertise are what made this book possible. We are also grateful to the publisher for supporting this project and would especially like to thank Marta Moldvai of Springer Science Business Media (USA) for her constructive assistance and cooperation, both with the publishing venture in general and the editorial details. We hope the readers find this book informative and useful.

This book consists of 30 chapters. Chapter 1 presents the theory and application of actuation of elastomeric micro-devices via capillary force technology. Chapter 2 provides insight into the fundamental design, working principles, and practical guidance of MEMS accelerometers. Details of experimental setups, signal conditioning, and data processing are also provided to construct an integrated performance assessment system. Chapter 3 gives an overview of the impact of the change from a focus on analysis, simulation, and modeling combined with outsourcing hardware design to the use of digital fabrication tools allowing a cyclic design process inside the lab, using many examples from various projects, and shares some insights and lessons learned for facilitating and implementing this process. Chapter 4 presents the design of a family of micro-robots capable of object manipulation in a fluidic environment. Chapter 5 discusses how state-of-the-art mobile technologies may be integrated into human-in-the-loop cyber-physical systems and exploited to provide natural mappings for remote interactions with such systems. A demonstrative example is used to show how an intuitive metaphor is

uncovered for performing a balancing task through the teleoperation of a ball and beam test bed. Chapter 6 provides an overview on force/tactile sensor development. By exploiting optoelectronic technology, two tactile sensors that can be used to execute both fine manipulation of objects and safe interaction tasks with humans are designed and realized. Chapter 7 addresses a brief account of issues related to mechanical properties of MEMS. Micro-testing techniques including micro-tensile and micro-fatigue testing along with the hardware are described with typical sample type, shape, and geometry, depicted with diagrams and images. Chapter 8 studies a type of marmot-like rescue robot for mine safety detection and rescuing. The kinematics, maximum stiffness, minimum stiffness, and global stiffness of the head section of the rescue robot are modeled and analyzed. Chapter 9 presents a systematic review of key control schemes for reconfigurable robotic systems, highlighting their benefits and disadvantages, and also reviews the application of these systems at microscale. Chapter 10 gives a detailed overview of MEMS-based sensors and actuators. Chapter 11 proposes a novel sensing approach to in situ particulate material (soot) load measurement in a diesel particulate filter using electrical capacitance tomography (ECT). Chapter 12 provides an overview of three actuation mechanisms that are relevant for biomedical applications of microfluidics. The topics dealt with include dielectrophoresis, acoustophoresis, and magnetophoresis. Chapter 13 reviews a few mechatronic devices designed and used in ASD screening and discusses a few devices used for therapeutic purposes. Chapter 14 conducts a critical and thorough review on vapor/gas sensing properties of a wide range of electrochemically derived metal oxide nano-forms as the sensing layer employing a different device configuration. Chapter 15 develops a wearable blood pressure monitoring system using ultrasound and a microperfusion system using a metal needle with micro-flow channel for measurement of subepidermal biological substances. Chapter 16 discusses the fabrication strategies and materials for the development of physical, chemical, and biosensors. The emerging applications of flexible electronics in wound healing, wearable electronics, implantable devices, and surgical tools, as well as point-of-care diagnostic devices, are also explored. Chapter 17 presents several MEMS devices where the main application is agriculture. Chapter 18 shows the design, fabrication, and testing of a multifunctional MEMS sensor for use in hydraulic systems. The MEMS device is incorporated into a typical fluid power component. Chapter 19 proposes a piezoelectric-actuated rigid nano-needle for single cell wall (SCW) cutting. A fabricated tungsten (W) nano-needle is assembled with a commercial piezoelectric actuator laterally and perpendicularly. Chapter 20 develops a process planning-driven approach for the development of a robotic percussive riveting system for aircraft assembly automation. Chapter 21 introduces photoinduced fabrication technologies for 3D MEMS devices and examines four technologies and their outcome of applications where fabricated feature sizes decrease and resolution increases. Chapter 22 presents a design principle of the OKES by deriving a mathematical model and characterized the OKES performance in terms of working range, positioning accuracy, resolution, linearity, bandwidth, and control effectiveness with the nano-positioning systems. Chapter 23 presents a lab-on-chip microfluidics system for SCM measurement,

related to the force required to drag a single cell and Newton's law of motion inside microfluidics channel. Chapter 24 focuses on the characteristics of micro-manipulation in terms of the types and principles of gripping forces. Chapter 25 discusses three important aspects of inertial microfluidics: fundamental mechanism, microchannel designs, and applications. Chapter 26 provides a detailed overview of the different types of piezoelectric force sensors and the dynamic calibration techniques that have been used to calibrate these sensors. Chapter 27 introduces a magnetically driven micro-robotics system to explain the procedure of developing a magnetic levitation stage and proposes a sensor switching mechanism that combines magnetic flux measurement-based position determination and optical sensor-based position detection. Chapter 28 applies 3D printing molding methods to fabricate a miniature magnetic actuator for an optical image stabilizer, and the application of robust control techniques to actuate the developed miniature magnetic actuators is discussed. Chapter 29 deals with the concept of biofeedback control systems and its structure, and various applicable control methods which are designed to fulfill different system requirements are provided. Chapter 30 develops an inverse adaptive controller design method for the purpose of mitigating the hysteresis effect in the magnetostrictive-actuated dynamic systems.

Finally, we would like to sincerely acknowledge all the friends and colleagues who have contributed to this book.

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February 2016

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Advanced Mechatronics and MEMS Devices II

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2017, XVII, 718 p. 460 illus., 373 illus. in color.,

Hardcover

ISBN: 978-3-319-32178-3