

MEDICAL DEVICES

Surgical and Image-Guided Technologies

EDITED BY

MARTIN CULJAT • RAHUL SINGH • HUA LEE



 **WILEY**

MEDICAL DEVICES

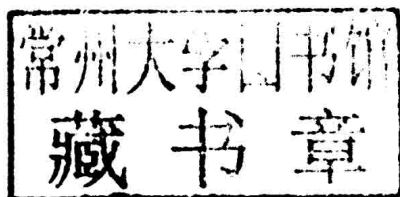
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TECHNOLOGIES

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Martin Culjat

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MEDICAL DEVICES

PREFACE

Recent decades have seen considerable advances in the development of medical devices and technologies. Innovations in instrumentation, implantable devices, and imaging systems have led to new diagnostic and therapeutic techniques and even new medical disciplines. Because of these and other advances in medicine, an increasing number of conditions can now be treated and patient outcomes continue to improve. Researchers, engineers, and clinicians in the biomedical engineering field are now developing the next generation of technologies that will enable procedures never imagined and make modern medicine accessible to more people worldwide. A challenge is to realize these innovations while reducing rather than increasing the cost of health care.

This book is intended primarily for the growing number of undergraduates, graduate students, medical students, and researchers who are interested in medical device design. Currently, there is a lack of concise, modern, device-focused texts that are written for such an audience. As the complexity of medical technologies continues to increase, there will be an acute need for individuals with the knowledge and skills necessary to lead this growing field.

The content of this text was inspired by research activities at the UCLA Center for Advanced Surgical and Interventional Technology (CASIT). To gauge a preliminary assessment of the effectiveness of this book's technical coverage, the editors and several of the authors participated in a one-quarter seminar course at the UC, Santa Barbara during the fall of 2008, receiving superb ratings and reviews. The class attracted students from all engineering majors, as well as the pre-med program, with a breadth of audience and interest level that this book carries through gracefully.

The technical content in this book is presented in a comprehensive manner, consistent with junior/senior undergraduate and first-year graduate students' background level in mathematics, physics, chemistry, and biology. The chapters are written and organized in the form of independent modules, such that lectures can be configured with a high degree of flexibility from year to year. Each chapter was written by one or more clinical or engineering experts, primarily from the fields of biomedical engineering, electrical engineering, mechanical engineering, computer science, surgery, and radiology.

The book is organized into five sections, each with a separate focus. The first section *Introduction to Medical Devices* features two chapters. Chapter 1 provides a brief introduction on the history, future, and terminology related to medical devices, and Chapter 2 provides a thorough overview of factors to consider

during the medical device design process, including topics such as regulatory affairs and manufacturing. The second section focuses on *Minimally Invasive Devices and Techniques* and features four chapters. Chapter 3 discusses principles and tools of laparoscopic surgery, Chapter 4 describes minimally invasive techniques in ophthalmology, Chapter 5 discusses surgical robotics and their application to minimally invasive surgery, and Chapter 6 describes interventional applications of catheters and catheter technologies. *Energy Delivery Devices and Systems* are described in the third section. This section contains chapters on electrosurgical tools used for cautery and coagulation of tissues (Chapter 7), devices used to ablate tissues such as tumors (Chapter 8), and lasers and their application to medicine (Chapter 9). The fourth section, *Implantable Devices and Systems* features chapters on implantable devices for vascular and cardiovascular procedures (Chapter 10), circulatory assist devices for heart failure (Chapter 11), and orthopedic implants, such as hip replacements and spinal fusion devices (Chapter 12). The final section covers *Imaging and Image-Guided Techniques* and includes four chapters. Chapter 13 focuses on endoscopic devices and systems for minimally invasive procedures; Chapter 14 on ultrasound devices used for both imaging and therapy; Chapter 15 on X-ray imaging technologies, including fluoroscopy, mammography, and computed tomography (CT); and Chapter 16 on techniques for image fusion and image-guided navigation of instruments during neurosurgery.

This book does not attempt to cover all of the medical devices and technologies in use today. Instead, the chapters were carefully selected such that a broad spectrum of representative topics in biomedical engineering could be discussed comprehensively. These topics are highly relevant to the state-of-the-art minimally invasive, image-guided, and interventional techniques that are used today.

The editors would like to thank everyone at the CASIT for their input into the development of this project. Additional thanks goes to Ms. Susan Ly for her assistance with copy editing.

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