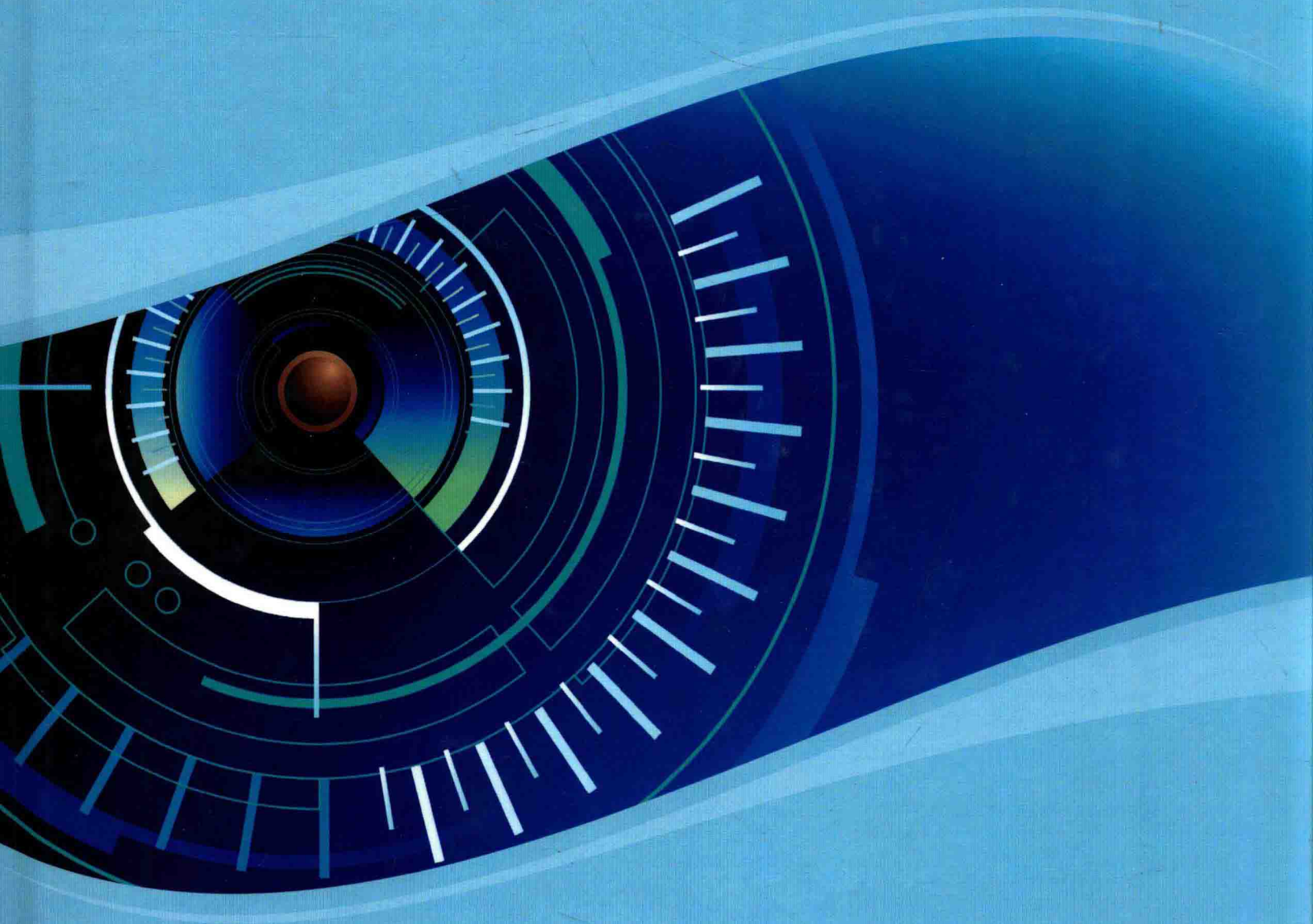
Essential Reference

Volume III

Robotics

Concepts, Methodologies, Tools, and Applications



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Concepts, Methodologies, Tools, and Applications

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Preface

The constantly changing landscape of Robotics challenges experts and practitioners to stay apprized of the field's most up-to-date research. That is why Information Science Reference is pleased to offer this three-volume reference collection that will empower students, researchers, and academicians with a strong understanding of critical issues within Robotics by providing both broad and detailed perspectives on cutting-edge theories and developments in the field. This collection is designed to act as a single reference source on conceptual, methodological, technical, and organizational issues, as well as provide insight into emerging trends and future opportunities within the discipline.

Robotics: Concepts, Methodologies, Tools, and Applications is organized into six distinct sections that provide comprehensive coverage of important topics. The sections are (1) Fundamental Concepts and Theories, (2) Development and Design Methodologies, (3) Tools and Technologies, (4) Utilization and Application, (5) Organizational and Social Implications, and (6) Emerging Trends. The following paragraphs provide a summary of what readers may expect from this invaluable reference tool.

Section 1, "Fundamental Concepts and Theories," provides an overview of the subject by exploring several key topics and applications in the field of Robotics. The section begins with *History of Service Robots* by Zielinska Teresa, a chapter that brings together the current state of robotic assistive technologies with future trends in the field. In addition to service robotics, chapters in this section discuss computer vision technologies and applications (*3D Scene Capture and Analysis for Intelligent Robotics* by Ray Jarvis), artificial intelligence (*A Framework for Prototyping of Autonomous Multi-Robot Systems for Search, Rescue, and Reconnaissance* by Sedat Dogru, Sebahattin Topal, Aydan M. Erkmen, and Ismet Erkmen), and applications for education (*Educational Robotics Theories and Practice* by Amy Eguchi) and public libraries (*The Inevitability of Library Automation* by Edward Iglesias). In all, this section introduces the reader to some of the important ideas and current considerations in the research and development of robotic systems, concepts that will be explored in greater depth throughout the remaining sections.

Section 2, "Development and Design Methodologies," explores some of the fundamental properties of Robotics systems. The first few chapters build on the service applications described in Section One to include learning and reasoning tools, such as *Mission Planning of Mobile Robots and Manipulators for Service Applications* by Elias K. Xidias, Nikos A. Aspragathos, and Philip N. Azariadis and *Gesture Learning by Imitation Architecture for a Social Robot* by J. P. Bandera, J. A. Rodríguez, and A. Bandera. Subsequently, the section addresses the concept of swarm intelligence and interactions between robots in *Self Control and Server-Supervisory Control for Multiple Mobile Robots, and its Applicability to Intelligent DNC System* by F. Nagata, T. Yamashiro, N. Kitahara, A. Otsuka, K. Watanabe, and Maki K. Habib, as well as several other central chapters. Finally, the section concludes with two chapters on the

functional design of robots for particular applications: *Design and Operation of Two Service Robot Arms* by Jean-Pierre Gazeau and Saïd Zeghloul, and *Prototyping of Lunabotic Excavator Robotic System* by Nicolae Gari and Xingguo Xiong.

Section 3, "Tools and Technologies," bridges the gap between theory and practice with a discussion of recent development in tangible Robotics technologies. The opening chapters continue from the previous section by describing various robotic limbs and manipulators, such as *Portable Haptic Arm Exoskeleton* by Pierre Letier and André Preumont and *Medical Manipulators for Surgical Applications* by Xing-guang Duan, Xing-tao Wang, and Qiang Huang. Next, the section explores some potential applications for these technologies, with chapters such as *Agile Wheeled Mobile Robots for Service in Natural Environment* by Jean-Christophe Fauroux, Belhassen-Chedli Bouzgarrou, Nicolas Bouton, Philippe Vaslin, Roland Lenain, and Frédéric Chapelle and *Needle Insertion Force Modeling using Genetic Programming Polynomial Higher Order Neural Network* by Mehdi Fallahnezhad and Hashem Yousefi, among others. The closing chapters focus on robotic vision technologies, ending with *Visual Control of an Autonomous Indoor Robotic Blimp* by L. M. Alkurdi and R. B. Fisher, a chapter that transitions nicely into the next section and its discussion of robot applications in indoor environments.

Section 4, "Utilization and Application," describes some of the various uses for the technologies presented in the first three sections, further demonstrating the applicability of Robotics to other diverse fields and endeavors. The section begins with applications in restricted environments, such as homes and industrial infrastructure. Notably, *Study and Design of an Autonomous Mobile Robot Applied to Underwater Cleaning* by Lafaete Creomar Lima Junior, Armando Carlos de Pina Filho, and Aloísio Carlos de Pina and *Prototyping of Fully Autonomous Indoor Patrolling Mobile Robots* by Xiaojun Wu, Bingbing Liu, Jun-Hong Lee, Vikas Reddy, and Xi Zheng explore two such applications. Next, the following chapters expand upon the swarm intelligence concepts illustrated in Section Two, including *Safer and Faster Humanitarian Demining with Robots* by Emin Faruk Kececi. Additional applications can be found in the energy (*Mechatronics Technology for Solar Cells* by H. Henry Zhang, Danny Rodriguez, and Qiong Li) and agricultural (*Service Robots for Agriculture* by Andrea Manuello Bertetto) sectors, and the final chapters cover Medical Robotics, notably *Surgical Robots* by Tamás Haidegger and *Wearable Power Assist Robot Driven with Pneumatic Rubber Artificial Muscles* by Toshiro Noritsugu.

Section 5, "Organizational and Social Implications," moves away from the physical aspects of Robotics to explore the impact that these technologies have on society and human interaction. The section begins with chapters on rehabilitation and assistive technologies, including *Gait Rhythm of Parkinson's Disease Patients and an Interpersonal Synchrony Emulation System Based on Cooperative Gait* by Hirotaka Uchitomi, Kazuki Suzuki, Tatsunori Nishi, Michael J. Hove, Yoshihiro Miyake, Satoshi Orimo, and Yoshiaki Wada and *Interactive Games with Robotic and Augmented Reality Technology in Cognitive and Motor Rehabilitation* by Ana Belén Naranjo-Saucedo, Cristina Suárez-Mejías, Carlos L. Parra-Calderón, Ester González-Aguado, Frida Böckel-Martínez, Antoni Yuste-Marco, Pablo Bustos, Luis Manso, Pilar Bachiller, Sergi Plana, Jose M. Diaz, Ricardo Boniche, and Adriá Marco. The majority of the chapters in this section cover human-machine interaction and how modern technologies affect human identity. In particular, *Human-Friendly Mechatronics Systems with Functional Fluids and Elastomers* by Takehito Kikuchi evaluates safety concerns in human-machine coexistence, and *Just Doesn't Look Right* by Julie Carpenter describes how the design and appearance of a robot can affect the way it is perceived by its human counterparts. The section concludes with two chapters on Robotics education, a crucial first step in the development of new Robotics technologies.

Section 6, "Emerging Trends," completes this valuable reference source with insight into the most recent advances and future developments in Robotics technologies. The chapters in this section extrapolate on the concepts and applications discussed in previous sections, including robot vision (*Self-Calibration of Eye-to-Hand and Workspace for Mobile Service Robot* by Jwu-Sheng Hu and Yung-Jung Chang), navigation (*Collaborative Exploration Based on Simultaneous Localization and Mapping* by Domenec Puig), multi-robot systems (*Ad Hoc Communications for Wireless Robots in Indoor Environments* by Laura Victoria Escamilla Del Río and Juan Michel García Díaz), and human-computer interaction (*Understanding the Human-Machine Interface in a Time of Change* by Erica Orange), among others. The diverse natures of the chapters in this section are indicative of the variety of applications and benefits that Robotics technologies provide to enhance human lives. The final chapter, *A Neurorobotics Approach to Investigating Word Learning Behaviors* by Richard Veale effectively concludes this essential three-volume reference by exploring how a greater understanding of robots can help us to better understand ourselves and our environment.

As a comprehensive collection of research on current findings related to the development of interdisciplinary technologies, *Robotics: Concepts, Methodologies, Tools, and Applications* provides researchers, administrators, and all audiences with a complete understanding of the latest advances, applications, and concepts in Robotics. Although the primary organization of the contents in this multi-volume work is based on its six sections, offering a progression of coverage on the important concepts, methodologies, technologies, applications, social issues, and emerging trends, the reader can also identify specific content by utilizing the extensive indexing system found at the end of each volume. Given the vast number of issues concerning usage, successes and failures, policies, strategies, and applications of Robotics in countries around the world, *Robotics: Concepts, Methodologies, Tools, and Applications* addresses the demand for a resource that encompasses the most pertinent research on the technologies being employed to globally bolster the knowledge and implementation of Robotics.

List of Contributors

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Section 2
Development and Design Methodologies

This section explores some of the fundamental properties of Robotics systems. Whether hardware or software, robots of every kind are composed of a variety of parts that work in concert to perform the functions for which they were designed. In particular, machines can be programmed to learn from their experiences, coordinate with other robots, interact with humans, or accomplish fine motor tasks. The 14 chapters that make up this section explore the development and design methodologies that bridge the gap between fundamental concepts and real-world applications in Robotics.

Section 3
Tools and Technologies

This section bridges the gap between theory and practice with a discussion of recent developments in tangible Robotics technologies. Robots are, in essence, machines designed to perform physical tasks, and so their bodies and tools must be appropriately tailored to meet these needs. The authors in this section discuss a wide range of robotic systems, including haptic systems such as graspers, manipulators, and wheels, as well as computer vision and internal memory hardware. With 15 chapters, this section offers a broad treatment of some of the many tools and technologies within Robotics.