Preface

As scholars we have the rare privilege to take part in the excitement that students feel when their thoughts and abstract mathematical forms are implemented on electrical-mechanical systems—motors start to spin, parts start to move, image processing reveals hidden features, the systems become 'alive'. No matter how many times we have witnessed those thrills, again and again these small "miracles" and students' passion make teaching and research so rewarding. And this is especially true for robotics that is considered likely to become one of the most influential technologies in the decades to come. Rapid development of electronics, emergence of new materials, and advances in computer science provide for the implementation of complex algorithms and structures that are capable of raising the cognitive and manipulative abilities of robots to a new level and introducing them into new fields.

One of these new fields of robotics is so-called aerial robotics—technology that provides services and facilitates the execution of tasks (such as observation, inspection, mapping, search and rescue, maintenance) by using unmanned aerial vehicles equipped with various sensors and actuators. While some of these services have already been put into practice (e.g., aerial inspection and aerial mapping), others (like aerial manipulation) are still at the level of laboratory experimentation on account of their complexity. The ability of an aerial robotic system to interact physically with objects within its surroundings completely transforms the way we view applications of unmanned aerial systems in near-earth environments. This change in paradigm conveying such new functionalities as aerial tactile inspection; aerial repair, construction, and assembly; aerial agricultural care; and aerial urban sanitation requires an extension of current modeling and control techniques as well as the development of novel concepts.

Working for more than ten years in the field, we have discerned the expeditious growth of scientific publications related to aerial robotics—special sessions and workshops have been organized as a part of major robotics conferences, leading journals in the field have published special issues on the topic, and aerial robotics competitions and challenges have been arranged. All this has been closely followed by articles for the general public aimed at the popularization of this new scientific

field and in the same time by the rise of hundreds of small companies eager to commercialize the latest findings. Even though far from being mature, aerial robotics slowly but surely is becoming a very important aspect in the creation of novel industries that will mark this century. This book is a modest attempt to provide an in-depth treatment of aerial manipulation—the most complex area of aerial robotics. Covering all the steps, from the physical basics of rigid body kinematics and dynamics through modeling of an unmanned aerial vehicle equipped with a dexterous manipulator to the description of aerodynamic phenomena associated with propulsion systems and the design of complex control compositions, this book is a sound foundation for a newcomer in the field and at the same time represents complementary material for researchers seeking to enhance expertise in the field of aerial manipulation.

Careful selection of the fundamental elements of rigid body dynamics and kinematics, as well as essential principles of aerodynamics, provides a well-balanced background for effective and efficient design of unmanned aerial manipulation systems. A systematic presentation of control techniques and aerial robotic systems control structures provides a blueprint for immediate implementation to real-world problems. Easy-to-follow exercises and examples offer students and researchers unique insight into the practice of modeling and control of aerial robotics systems.

We hope that our text will help in understanding the phenomena encountered in aerial robotics, thus eliciting exciting moments and encouraging engineering "miracles" in research laboratories and industrial facilities.

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