Preface

The ability to fly has greatly expanded the possibilities for robots to perform surveillance, inspection or map generation tasks. Yet it was only in recent years that research in aerial robotics was mature enough to allow active interactions with the environment. The robots responsible for these interactions are called aerial manipulators and usually combine a multirotor platform and one or more robotic arms.

The main objective of this book is to formalize the concept of aerial manipulator and present guidance methods, using visual information, to provide them with autonomous functionalities.

A key competence to control an aerial manipulator is the ability to localize it in the environment. Traditionally, this localization has required external infrastructure of sensors (*e.g.*, GPS or IR cameras), restricting the real applications. Furthermore, localization methods with on-board sensors, exported from other robotics fields such as simultaneous localization and mapping (SLAM), require large computational units becoming a handicap in vehicles where size, load, and power consumption are important restrictions. In this regard, this book proposes a method to estimate the state of the vehicle (*i.e.*, position, orientation, velocity and acceleration) by means of on-board, low-cost, light-weight and high-rate sensors.

With the physical complexity of these robots, it is required to use advanced control techniques during navigation. Thanks to their redundancy on degrees-of-freedom, they offer the possibility to accomplish not only with mobility requirements but with other tasks simultaneously and hierarchically, prioritizing them depending on their impact to the overall mission success. In this book we present such control laws and define a number of these tasks to drive the vehicle using visual information, guarantee the robot integrity during flight, and improve the platform stability or increase arm operability.

The main contributions of this research work are threefold: (1) Present a localization technique to allow autonomous navigation, this method is specifically designed for aerial platforms with size, load and computational burden restrictions. (2) Obtain control commands to drive the vehicle using visual information (visual servo). (3) Integrate the visual servo commands into a hierarchical control law by exploiting the redundancy of the robot to accomplish secondary tasks during flight. These tasks are specific for aerial manipulators and they are also provided.

All the techniques presented in this book have been validated throughout extensive experimentation with real robotic platforms.

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