Aerial Robotics and the Quadrotor

By Robert Mahony and Vijay Kumar

Aerial robotics is a growing field with tremendous civil and military applications. Potential applications include surveying and maintenance tasks, aerial transportation and manipulation, search and rescue, and surveillance. The challenges associated with tackling robotics tasks in complex, three-dimensional, indoor and outdoor environments bring into focus some of the limitations of accepted solutions to classical robotics problems in sensing, planning, localization, and mapping. Moreover, the fundamental weight and size limitations of flying vehicles pose challenges in engineering design as well as efficiency of sensing paradigms and control and estimation algorithms. Quadrotor aerial vehicles are one of the most flexible and adaptable platforms for undertaking aerial research. In the same way that the wheeled mobile robots was the testing ground of much of the fundamental work in robotic vehicle mobility throughout the 1990s, the quadrotor platform is emerging as the fundamental research platform of choice for aerial robotics research to investigate research problems related to three-dimensional mobility and perception. This special issue consists of articles describing research on component technologies and articles addressing systems design and technological challenges in aerial robotics and with respect to the quadrotor platform in particular. This special issue brings together articles from experts in the field to address the theory and practice underlying quadrotor robots.

The first article by Mahony et al. is a tutorial on quadrotors. The authors present a comprehensive treatment of the rigid body dynamics and the aerodynamics for these vehicles and a discussion of algorithms required for estimating the six-dimensional pose and velocity. The article also includes a discussion of the control and planning algorithms required to plan and control three-dimensional motions.

The next article provides valuable information for educational and research institutions starting new quadrotor projects. Lim et al. survey open-source projects on quadrotors, comparing them in terms of implemented control algorithms, electronic components, and embedded software. Detailed comparisons between the open-source projects are provided.

Tomić et al. discuss the deployment of quadrotors in urban search and rescue missions in which robotic systems must operate autonomously. With no external infrastructure for navigation and communication being available, robotic systems are able to operate autonomously. They discuss the flight performance, sensors, and processors for quadrotors constrained in size, weight, and power.

Franchi et al. discuss the challenges with teleoperating quadrotors. They describe the modeling, control, and experimentation with human operators interacting with a remote fleet of semiautonomous unmanned aerial vehicles that maintain formation constraints and avoid collisions with obstacles while collectively following the human commands.

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Palunko et al. address applications related to transportation. Specifically, they develop controllers and trajectory planners that enable a quadrotor to transport suspended payloads while adapting to changes in the mass and inertia, minimizing the swinging of the payload. This work has application in emergence response, search and rescue missions, and construction operations.

We hope that you enjoy this special issue dedicated to quadrotors. We are grateful to the authors, anonymous reviewers, and editor-in-chief for all the support in making this issue possible.

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