Series Editors' Foreword

The series *Advances in Industrial Control* aims to report and encourage technology transfer in control engineering. The rapid development of control technology has an impact on all areas of the control discipline. New theory, new controllers, actuators, sensors, new industrial processes, computer methods, new applications, new philosophies, ..., new challenges. Much of this development work resides in industrial reports, feasibility study papers and the reports of advanced collaborative projects. The series offers an opportunity for researchers to present an extended exposition of such new work in all aspects of industrial control for wider and rapid dissemination.

Autonomous control and guidance has had a long and evolving history. Long ocean voyages, large vessels and advanced propulsion systems soon led to the development of autopilots for sea-going vessels. Control developments for aerial vehicles and aircraft followed a similar pattern. Although some similar ideas prevailed for terrestrial vehicles, it took the emergence of electronic implementations for sophisticated control techniques to become more widespread in road vehicles. This field of control-technological development was designed to ease the task of the sailor, the pilot or the driver while they were still present on the bridge, in the cockpit or in the driver's seat; however, to dispatch a range of tasks in hazardous environments or to perform routine tasks over significant geographical distances, *unmanned* vehicular technology has developed and made significant strides in recent years. In space, autonomous control and guidance is a prerequisite for accomplishing many tasks involving satellites and unmanned planet "rover" vehicles. Aerial vehicles, either fixed-wing aircraft or rotorcraft are well developed for surveillance and other tasks and autonomous unmanned subsea vehicles are a critical enabler in the success of the oil industry in exploiting offshore oil resources.

In recent *Advances in Industrial Control* monographs, Guillaume J.J. Ducard considered some autonomous control aspects in *Fault-tolerant Flight Control and Guidance Systems* (ISBN 978-1-84882-560-4, 2009) for an unmanned fixed-wing aerial craft, while a little further back in time, Pedro Castillo, Rogelio Lozano, Alejandro E. Dzul reported on the *Modelling and Control of Mini-Flying Machines* (ISBN 978-1-85233-957-9, 2005). To add to this literature, the Series Editors are

now pleased to introduce this volume of *Advances in Industrial Control* entitled *Unmanned Rotorcraft Systems* authored by Guowei Cai, Ben M. Chen and Tong H. Lee that describes in comprehensive depth an exemplary development project to build an unmanned rotorcraft aerial system that was undertaken at the National University of Singapore.

Many monographs in the industrial control field, concentrate on the modeling, control design and simulation testing for a particular application but few contributions are able to emulate the authors of this one in describing the system development process, and trying to elucidate the general principles for constructing a complete system of which the control system is but one part. *Unmanned Rotorcraft Systems* has the advantage of being able to illustrate the steps of the development process through the design, construction and testing of a working prototype, the SheLion rotorcraft. Consequently, the monograph progresses through the hardware and software selection stages (Chaps. 3 and 4) and further shows how one advanced control technique (extended Kalman filtering) can be used to enhance the accuracy and performance of some low-cost technology (Chap. 5). The control system development involves modeling (Chap. 6), control design (Chap. 7) and experimental testing (Chap. 8). At each step of the way, the authors demonstrate the need to find solutions that balance technical sophistication against practical specifications, computational constraints and good operational performance. The authors also seek to identify genericity in the procedure so that the techniques can find a wider applicability in the rotorcraft and control system engineering fields. The experimental work reported involves computer simulation, hardware-in-the-loop trials and finally actual flight tests. The authors even extend an invitation to readers to view videos of the flight testing at http://uav.ece.nus.edu.sg/. The monograph closes with two chapters of more innovative work. One chapter (Chap. 10) describes how to achieve formation flying and the final chapter (Chap. 11) reports on the use of vision to follow a moving target. This chapter involves image processing and reports on how to integrate visual information into the rotorcraft control system.

The monograph reports a fascinating project that resulted in real-world outcomes. The comprehensive scope of the activities presented in this monograph and the demonstration of a very practical application of control engineering makes this inspirational material for a wide range of engineering students and researchers. Clearly, these rotorcraft project developments at the National University of Singapore have important industrial relevance and the monograph should be of interest to readers from the aerospace, control, signal processing and electrical engineering disciplines.

Industrial Control Centre
Glasgow, Scotland, UK

M.J. Grimble
M.A. Johnson