In recent years, research and development of unmanned systems have gained much attention in the academic and military communities worldwide. Topics like unmanned aircraft, underwater explorers, satellites, and intelligent robotics are widely investigated as they have potential applications in the military and civilian domains. They are developed to be capable of working autonomously without the interference of a human pilot. The challenge is that they need to deal with various situations that arise in very complicated and uncertain environments, such as unexpected obstacles, enemies attacking and device failures. Besides, they are required to communicate with technical personnel in the ground station. Consideration of a wide range of factors needs to be taken. Control systems for the unmanned vehicles are required to integrate not only basic input-output control laws but also high-level functionalities for decision making and task scheduling. Software systems for unmanned vehicles are required to perform tasks from hardware driving to the management of device operations, and from traditional input-output control law implementation to task scheduling and event management.

In this monograph, the authors aim to explore the research and development of fully functional miniature unmanned-aerial-vehicle (UAV) rotorcraft, which consist of a small-scale basic rotorcraft with all necessary accessories onboard and a ground station. The unmanned system is an integration of advanced technologies developed in the communications, computing, and control areas. It is an excellent test bed for testing and implementing modern control techniques. It is, however, a highly challenging process. The flight dynamics of small-scale rotorcraft such as a hobby helicopter is similar to its full-scale counterpart but owns some unique characteristics such as the utilization of a stabilizer bar, higher rotor stiffness, and yaw rate feedback control. Besides these, the strict limitation on payload also increases the difficulty in upgrading a small-scale rotorcraft to a UAV with full capacities. Based on its various characteristics and limitations, a lightweight but effective onboard avionic system with corresponding onboard/ground software should be carefully designed to realize the system identification and automatic flight requirements. These issues will be addressed in detail in this monograph. Research on utilizing the vision-based system for accomplishing ground target tracking and following, cooperative control, and flight formation of multiple unmanned rotorcraft is also highlighted.
The intended audience of this monograph includes practicing engineers in rotorcraft industry and researchers in the areas related to the development of unmanned aerial systems. An appropriate background for this book would be some senior level and/or first-year graduate level courses in aerodynamic engineering, control engineering, electrical engineering, and/or mechanical engineering.

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