Preface

The vision is clear: several unmanned aerial vehicles collaborate and coordinate their flight and actions to achieve a mission, while human operators, barely involved, monitor the progress of the vehicles. This vision is not yet a reality. Before multiple unmanned aerial vehicles are deployed in a coordinated fashion, novel systems must be devised. Among those, systems that ensure safe and reliable operations. Currently, a great many researchers are deploying every effort to design more effective multi-vehicle control concepts and algorithms. Furthermore, there exists a vast body of knowledge in fault-tolerant control, and in fault detection and fault recovery techniques for the individual aerial platform. Yet, very little has been said to date about how to perform reliable and safe autonomous multi-vehicle operations. Indeed, ensuring mission success despite off-nominal, or degraded, operations of mission-critical vehicle components is an open problem which has drawn attention only recently. Despite fault-tolerant control software and hardware embedded onboard air vehicles, overall fleet performance may still be degraded after the occurrence of anomalous events, such as systems malfunctions, damage and failures. As far as we are aware, this book is the first of its kind in presenting a set of basic principles and algorithms for the analysis and design of health management systems for cooperating unmanned aerial vehicles. Such systems rely upon monitoring and fault adaptation schemes. Cooperative health management systems seek to provide adaptation to the presence of faults, from a team perspective, by capitalizing on the availability of interconnected computing, sensing, and actuation resources. There is currently little literature on the safety and reliability for cooperating unmanned aerial systems, although the topic of cooperation for effective fleet monitoring and fault-adaptation purposes is emerging.

This monograph is the culmination of several years of research, and as such is biased with previous results obtained by the authors. We have our own view on the problem of health management, and have addressed a limited number of scenarios. This monograph presents the concepts in the form of theorems, lemmas, propositions, and step-by-step procedures. The health management concepts are illustrated by means of simple examples and numerical simulations of practical UAS operations. Cases of tight formation control and coordinated rendezvous for a network of formations are addressed in this book. Therefore, researchers, academics, graduate students and aerospace engineers, we hope, will appreciate the content.

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