Preface

The impact that the aerospace and aviation industry has on today's modern society and world's economy is very prominent. As such, the aerospace industry continues at the forefront of engineering research and development technologies. The sector needs continuous improvement including insertion of new technologies. Generally, new technologies are adopted only when there is a clear need in terms of cost or performance benefit: any modification to the existing in-service and already proven technical solutions should be motivated, first of all, by a real industrial need. The technology driver is mainly the market pull. On the other hand, despite potential cost and performance advantages, new methods and technologies entail risk and thus must undergo extensive development, validation, and verification before they can be transitioned to real-world systems. This is especially true for aerospace and aircraft systems. Recent developments in control engineering have had attractive potential for resolving numerous issues related to guidance, navigation, and control (GNC) of flight vehicles. Satisfying the more and more stringent flight requirements requires innovative Fault Detection, Identification, and Recovery (FDIR) approaches and mechanization schemes which can help achieve improved flight performance and reliability, self-protection, and autonomy. The challenges range from predesign and design stages for upcoming and new programs to the improvement of the performance for in-service flying systems. Many future space missions will require increased onboard autonomy including fault diagnosis and the subsequent control and guidance recovery actions. Autonomy supports cost-effective accomplishment of mission goals, and space missions lacking onboard autonomy will be unable to achieve the full range of advanced mission objectives. On the other hand, one of the main issues for the development of future aircraft programs is to improve "green transport," that is, to provide society with an air transport that leaves a smaller carbon footprint. Sustainable air transport will be a serious worldwide challenge, given the anticipated increase in traffic volume and continuing expansion of the world's aviation network with greater aviation connectivity. This will need continuing technological progress in the design of all aircraft systems: airframes, propulsion systems, airborne systems, software and hardware, communications, navigation, control and guidance, etc. At first sight, the link between innovating

FDIR technologies and sustainable development of air transport may not seem obvious. Yet, early and robust diagnosis of faults that have an influence on structural loads could contribute to the overall optimization of aircraft design and so to weight saving for better overall performance in terms of fuel burn, noise, range, and environmental footprint. Putting innovating aircraft FDIR in this perspective can be an important driving factor for its future developments. This will help anticipate the more and more stringent requirements which will come in force for future and more environmentally friendlier programs.

This book focuses on design and analysis of advanced and viable FDIR technologies for aerospace vehicles. The term "viable" covers here some important aspects which are often underestimated in the classical academic literature: tuning, complexity of the design, real-time capability, modularity and possibility to "reuse" or "build around it," evaluation of worst-case performance, robustness in harsh environment, etc. Unfortunately, the lack of consideration of the above issues has led to a widening gap between the advanced scientific methods being developed by the academic control community and technological solutions demanded by the aerospace industry. While the research in all aspects of model-based FDIR went forward since early 1970s, the design methodology involving feasibility analysis and real-world requirements specification is still missing. This is a major reason for the slow progress in applying advanced model-based FDIR at the GNC level of flight vehicles.

The developments offered in this book are based on the authors' experience and lessons learned through their involvement in a number of aerospace research projects with major academic and industrial actors in Europe over the past few years. The chapters are mostly organized according to a "sandwich" model: concrete-theory-concrete. That is, we will motivate the chapter with a specific aerospace application, work out the theory, and finally return to the specific concrete problem. I believe that this model is most useful as it provides clear operational procedures under the conditions that are explicitly stated.

My first thanks go to my coauthors. Within a very inspiring teamwork, their valuable and everyday work and effort contributed very much to the fascinating topics covered in this book. The last author (Dr. Philippe Goupil) is with Airbus Operations S.A.S., Toulouse, France, where he is in charge of FDIR activities. I am very grateful to him for giving us continuous precious support and for his patient explanations about flight FDIR technologies, the today industrial constraints, and the future needs. Over the past few years, he played a major role in Europe to bridge the gap between industrial aircraft world and the academic control community in order to pave the way for successful and innovating solutions for future aircraft systems.

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Bordeaux, France Ali Zolghadri
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