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Chingiz Hajiyeu and Fikret Caliskan

# **Fault Diagnosis and Reconfiguration in Flight Control Systems**

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# Fault Diagnosis And Reconfiguration In Flight Control Systems

**Daniel Simon, Ye-Qiong  
Song, Christophe Aubrun**



## **Fault Diagnosis And Reconfiguration In Flight Control Systems:**

*Fault Diagnosis and Reconfiguration in Flight Control Systems* C. Hajiyeve, F. Caliskan, 2013-12-01 The problem of fault diagnosis and reconfigurable control is a new and actually developing field of science and engineering The subject becomes more interesting since there is an increasing demand for the navigation and control systems of aerospace vehicles automated actuators etc to be more safe and reliable Nowadays the problems of fault detection and isolation and reconfigurable control attract the attention the scientists in the world The subject is emphasized in the recent international congresses such as IFAC World Congresses San Francisco 1996 Beijing 1999 and Barcelona 2002 and IMEKO World Congresses Tampere 1997 Osaka 1999 Vienna 2000 and also in the international conferences on fault diagnosis such as SAFEPROCESS Conferences Hull 1997 Budapest 2000 The presented methods in the book are based on linear and nonlinear dynamic mathematical models of the systems Technical objects and systems stated by these models are very large and include various control systems actuators sensors computer systems communication systems and mechanical hydraulic pneumatic electrical and electronic devices The analytical fault diagnosis techniques of these objects have been developed for several decades Many of those techniques are based on the use of the results of modern control theory This is natural because it is known that fault diagnosis process in control systems is considered as a part of general control process xxii In organization of fault diagnosis of control systems the use of the concepts and methods of modern control theory including concepts of state space modeling controllability observability estimation identification and filtering is very efficient Fault Diagnosis and Reconfiguration in Flight Control Systems Chingiz Hajiyeve, Fikret Caliskan, 2014-09-01 **Fault-tolerant Control Systems** Hassan

Noura, Didier Theilliol, Jean-Christophe Ponsart, Abbas Chamseddine, 2009-07-30 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 parts 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 Control system design and technology continues to develop in many different directions One theme that the *Advances in Industrial Control* series is following is the application of nonlinear control design methods and the series has some interesting new commissions in progress However another theme of interest is how to endow the industrial controller with the ability to overcome faults and process degradation Fault detection and isolation is a broad field with a research literature spanning several decades This topic deals with three questions How is the presence of a fault detected What is the cause of the fault Where is it located However there has been less focus on the question of how to use the control system to accommodate and overcome the performance deterioration caused by the identified sensor or actuator fault **Fault-tolerant Flight Control**

**and Guidance Systems** Guillaume J. J. Ducard, 2009-05-14 This book offers a complete overview of fault tolerant flight control techniques Discussion covers the necessary equations for the modeling of small UAVs a complete system based on extended Kalman filters and a nonlinear flight control and guidance system

**Fault Identification for Real Time Flight Controller Reconfiguration** Jayalakshmi Nagam, 2023-01-14 Fault Identification for Real Time Flight Controller Reconfiguration refers to the process of detecting diagnosing and mitigating faults in a flight control system in real time This is crucial for ensuring the safety and performance of aircraft The process involves monitoring sensor data and analyzing it to detect any anomalies or failures in the system Once a fault is detected a diagnosis is performed to determine the cause of the fault and the appropriate reconfiguration strategy is implemented to mitigate its effects This can include switching to redundant systems adjusting control parameters or other adaptive control techniques The goal is to maintain the safe and stable operation of the aircraft while minimizing any impact on performance Flight controller reconfiguration refers to the process of adapting the control system of an aircraft to changing conditions or system failures The goal is to maintain the safe and stable operation of the aircraft while minimizing any impact on performance This can be achieved through a variety of methods such as switching to redundant systems adjusting control parameters or implementing other adaptive control techniques The process of reconfiguration may be triggered by a variety of factors including system failures changes in flight conditions or the need to optimize performance The reconfiguration process is typically performed in real time and can be based on both model based and data driven approaches A key aspect of flight controller reconfiguration is the ability to detect and diagnose faults in the system and to implement the appropriate reconfiguration strategy to mitigate their effects Fault Tolerant Flight Control FTFC systems deal with the detection and diagnosis of faults and look at the task of regaining control in the presence of the fault Some faults are difficult to detect with the onboard monitoring systems with the result that these faults endanger the safety and reliability of an aircraft The study of improvement in safety redundancy and adapting the Flight Control Laws FCL after the occurrence of faults has fascinated several investigators in the previous two decades The literature study illustrates different fault diagnosis and FTFC approaches The main research direction is to detect and isolate fault reliably carry out real time identification of the plant and real time control law CLAW reconfiguration The main contribution of this thesis is towards these aspects In this chapter the basic terminologies are explained The research work carried out in this thesis is in the area of FTFC systems

**Fault Diagnosis and Fault-Tolerant Control Strategies for Non-Linear Systems** Marcin Witczak, 2013-12-11 This book presents selected fault diagnosis and fault tolerant control strategies for non linear systems in a unified framework In particular starting from advanced state estimation strategies up to modern soft computing the discrete time description of the system is employed Part I of the book presents original research results regarding state estimation and neural networks for robust fault diagnosis Part II is devoted to the presentation of integrated fault diagnosis and fault tolerant systems It starts with a general fault tolerant control

framework which is then extended by introducing robustness with respect to various uncertainties Finally it is shown how to implement the proposed framework for fuzzy systems described by the well known Takagi Sugeno models This research monograph is intended for researchers engineers and advanced postgraduate students in control and electrical engineering computer science as well as mechanical and chemical engineering     Algorithms and Architectures for Real-Time Control 1991 P.J. Fleming,D.I. Jones,2014-07-22 Computer scientists have long appreciated that the relationship between algorithms and architecture is crucial Broadly speaking the more specialized the architecture is to a particular algorithm then the more efficient will be the computation The penalty is that the architecture will become useless for computing anything other than that algorithm This message holds for the algorithms used in real time automatic control as much as any other field These Proceedings will provide researchers in this field with a useful up to date reference source of recent developments     *Fault Detection, Supervision and Safety of Technical Processes 2003 (SAFEPROCESS 2003)* Marcel Staroswiecki,Eva Wu,2004-02-27 A three volume work bringing together papers presented at SAFEPROCESS 2003 including four plenary papers on statistical physical model based and logical model based approaches to fault detection and diagnosis as well as 178 regular papers     *Fault Tolerant Flight Control* Christopher Edwards,Thomas Lombaerts,Hafid Smaili,2010-04-18 Written by leading experts in the field this book provides the state of the art in terms of fault tolerant control applicable to civil aircraft The book consists of five parts and includes online material     **Fault Detection and Fault-Tolerant Control Using Sliding Modes** Halim Alwi,Christopher Edwards,Chee Pin Tan,2011-06-07 Fault Detection and Fault tolerant Control Using Sliding Modes is the first text dedicated to showing the latest developments in the use of sliding mode concepts for fault detection and isolation FDI and fault tolerant control in dynamical engineering systems It begins with an introduction to the basic concepts of sliding modes to provide a background to the field This is followed by chapters that describe the use and design of sliding mode observers for FDI using robust fault reconstruction The development of a class of sliding mode observers is described from first principles through to the latest schemes that circumvent minimum phase and relative degree conditions Recent developments have shown that the field of fault tolerant control is a natural application of the well known robustness properties of sliding mode control A family of sliding mode control designs incorporating control allocation which can deal with actuator failures directly by exploiting redundancy is presented Various realistic case studies specifically highlighting aircraft systems and including results from the implementation of these designs on a motion flight simulator are described A reference and guide for researchers in fault detection and fault tolerant control this book will also be of interest to graduate students working with nonlinear systems and with sliding modes in particular Advances in Industrial Control aims to report and encourage the transfer of technology in control engineering The rapid development of control technology has an impact on all areas of the control discipline The series offers an opportunity for researchers to present an extended exposition of new work in all aspects of industrial control     *Co-design Approaches to Dependable Networked Control*

*Systems* Daniel Simon,Ye-Qiong Song,Christophe Aubrun,2013-03-04 Networked Control Systems NCS is a growing field of application and calls for the development of integrated approaches requiring multidisciplinary skills in control real time computing and communication protocols This book describes co design approaches and establishes the links between the QoC Quality of Control and QoS Quality of Service of the network and computing resources The methods and tools described in this book take into account at design level various parameters and properties that must be satisfied by systems controlled through a network Among the important network properties examined are the QoC the dependability of the system and the feasibility of the real time scheduling of tasks and messages Correct exploitation of these approaches allows for efficient design diagnosis and implementation of the NCS This book will be of great interest to researchers and advanced students in automatic control real time computing and networking domains and to engineers tasked with development of NCS as well as those working in related network design and engineering fields Fault Tolerant Attitude Estimation for Small Satellites

Chingiz Hajiyeu, Halil Ersin Soken, 2020-12-22 Small satellites use commercial off the shelf sensors and actuators for attitude determination and control ADC to reduce the cost These sensors and actuators are usually not as robust as the available more expensive space proven equipment As a result the ADC system of small satellites is more vulnerable to any fault compared to a system for larger competitors This book aims to present useful solutions for fault tolerance in ADC systems of small satellites The contents of the book can be divided into two categories fault tolerant attitude filtering algorithms for small satellites and sensor calibration methods to compensate the sensor errors MATLAB will be used to demonstrate simulations Presents fault tolerant attitude estimation algorithms for small satellites with an emphasis on algorithms practicability and applicability Incorporates fundamental knowledge about the attitude determination methods at large Discusses comprehensive information about attitude sensors for small satellites Reviews calibration algorithms for small satellite magnetometers with simulated examples Supports theory with MATLAB simulation results which can be easily understood by individuals without a comprehensive background in this field Covers up to date discussions for small satellite attitude systems design Dr Chingiz Hajiyeu is a professor at the Faculty of Aeronautics and Astronautics Istanbul Technical University Istanbul Turkey Dr Halil Ersin Soken is an assistant professor at the Aerospace Engineering Department Middle East Technical University Ankara Turkey *Fault Diagnosis and Fault-Tolerant Control and Guidance for Aerospace*

*Vehicles* Ali Zolghadri, David Henry, Jérôme Cieslak, Denis Efimov, Philippe Goupil, 2013-10-07 Fault Diagnosis and Fault Tolerant Control and Guidance for Aerospace demonstrates the attractive potential of recent developments in control for resolving such issues as flight performance self protection and extended life structures Importantly the text deals with a number of practically significant considerations tuning complexity of design real time capability evaluation of worst case performance robustness in harsh environments and extensibility when development or adaptation is required Coverage of such issues helps to draw the advanced concepts arising from academic research back towards the technological concerns of

industry Initial coverage of basic definitions and ideas and a literature review gives way to a treatment of electrical flight control system failures oscillatory failure runaway and jamming Advanced fault detection and diagnosis for linear and linear parameter varying systems are described Lastly recovery strategies appropriate to remaining actuator sensor communications resources are developed The authors exploit experience gained in research collaboration with academic and major industrial partners to validate advanced fault diagnosis and fault tolerant control techniques with realistic benchmarks or real world aeronautical and space systems Consequently the results presented in Fault Diagnosis and Fault Tolerant Control and Guidance for Aerospace will be of interest in both academic and aerospace industrial milieux **Situation**

**Assessment in Aviation** Jitendra R. Raol, Sudesh K. Kashyap, Lakshmi Shrinivasan, 2024-02-29 Situation Assessment in Aviation focuses on new aspects of soft computing technologies for the evaluation and assessment of situations in aviation scenarios It considers technologies emerging from multisensory data fusion MSDF Bayesian networks BN and fuzzy logic FL to assist pilots in their decision making Studying MSDF BN and FL from the perspective of their applications to the problem of situation assessment the book discusses the development of certain soft technologies that can be further used for devising more sophisticated technologies for a pilot's decision making when performing certain tasks airplane monitoring pair formation attack and threat It explains the concepts of situation awareness data fusion decision fusion Bayesian networks fuzzy logic type 1 and interval type 2 fuzzy logic The book also presents a hybrid technique by using BN and FL and a unique approach to the problem of situation assessment beyond visual range and air to air combat by utilizing building blocks of artificial intelligence AI for the future development of more advanced automated systems especially using commercial software The book is intended for aerospace R D engineers systems engineers aeronautical engineers and aviation training professionals It will also be useful for aerospace and electrical engineering students taking courses in Air Traffic Management Aviation Management Aviation Operations and Aviation Safety Systems **Fault Detection, Supervision and**

**Safety of Technical Processes 2006** Hong-Yue Zhang, 2007-03-01 The safe and reliable operation of technical systems is of great significance for the protection of human life and health the environment and of the vested economic value The correct functioning of those systems has a profound impact also on production cost and product quality The early detection of faults is critical in avoiding performance degradation and damage to the machinery or human life Accurate diagnosis then helps to make the right decisions on emergency actions and repairs Fault detection and diagnosis FDD has developed into a major area of research at the intersection of systems and control engineering artificial intelligence applied mathematics and statistics and such application fields as chemical electrical mechanical and aerospace engineering IFAC has recognized the significance of FDD by launching a triennial symposium series dedicated to the subject The SAFEPROCESS Symposium is organized every three years since the first symposium held in Baden Baden in 1991 SAFEPROCESS 2006 the 6th IFAC Symposium on Fault Detection Supervision and Safety of Technical Processes was held in Beijing PR China The program

included three plenary papers two semi plenary papers two industrial talks by internationally recognized experts and 258 regular papers which have been selected out of a total of 387 regular and invited papers submitted Discusses the developments and future challenges in all aspects of fault diagnosis and fault tolerant control 8 invited and 36 contributed sessions included with a special session on the demonstration of process monitoring and diagnostic software tools

Integrated Computer Technologies in Mechanical Engineering - 2021 Mykola Nechyporuk,Vladimir Pavlikov,Dmitriy Kritskiy,2022-02-21 The International Scientific and Technical Conference Integrated Computer Technologies in Mechanical Engineering Synergetic Engineering ICTM was established by National Aerospace University Kharkiv Aviation Institute The Conference ICTM 2021 was held in Kharkiv Ukraine during October 28 29 2021 During this conference technical exchanges between the research community were carried out in the forms of keynote speeches panel discussions as well as special session In addition participants were treated to a series of receptions which forge collaborations among fellow researchers ICTM 2021 received 203 papers submissions from different countries Target Groups ICTM was formed to bring together outstanding researchers and practitioners in the field of information technology in the design and manufacture of engines creation of rocket space systems aerospace engineering from all over the world to share their experience and expertise

Bio-Inspired Collaborative Intelligent Control and Optimization Yongsheng Ding,Lei Chen,Kuangrong Hao,2017-11-06 This book presents state of the art research advances in the field of biologically inspired cooperative control theories and their applications It describes various biologically inspired cooperative control and optimization approaches and highlights real world examples in complex industrial processes Multidisciplinary in nature and closely integrating theory and practice the book will be of interest to all university researchers control engineers and graduate students in intelligent systems and control who wish to learn the core principles methods algorithms and applications **Kalman Filter** Víctor M. Moreno,Alberto Pigazo,2009-04-01 The aim of this book is to provide an overview of recent developments in Kalman filter theory and their applications in engineering and scientific fields The book is divided into 24 chapters and organized in five blocks corresponding to recent advances in Kalman filtering theory applications in medical and biological sciences tracking and positioning systems electrical engineering and finally industrial processes and communication networks *Robust Integration of Model-Based Fault Estimation and Fault-Tolerant Control* Jianglin Lan,Ronald J. Patton,2020-12-11 Robust Integration of Model Based Fault Estimation and Fault Tolerant Control is a systematic examination of methods used to overcome the inevitable system uncertainties arising when a fault estimation FE function and a fault tolerant controller interact as they are employed together to compensate for system faults and maintain robustly acceptable system performance It covers the important subject of robust integration of FE and FTC with the aim of guaranteeing closed loop stability The reader s understanding of the theory is supported by the extensive use of tutorial examples including some MATLAB based material available from the Springer website and by industrial applications based material The text is



structured into three parts Part I examines the basic concepts of FE and FTC providing extensive insight into the importance of and challenges involved in their integration Part II describes five effective strategies for the integration of FE and FTC sequential iterative simultaneous adaptive decoupling and robust decoupling and Part III begins to extend the proposed strategies to nonlinear and large scale systems and covers their application in the fields of renewable energy robotics and networked systems The strategies presented are applicable to a broad range of control problems because in the absence of faults the FE based FTC naturally reverts to conventional observer based control The book is a useful resource for researchers and engineers working in the area of fault tolerant control systems and supplementary material for a graduate or postgraduate level course on fault diagnosis and FTC Advances in Industrial Control reports and encourages the transfer of technology in control engineering The rapid development of control technology has an impact on all areas of the control discipline The series offers an opportunity for researchers to present an extended exposition of new work in all aspects of industrial control

**Advances in Gain-Scheduling and Fault Tolerant Control Techniques** Damiano Rotondo, 2017-10-14 This thesis reports on novel methods for gain scheduling and fault tolerant control FTC It begins by analyzing the connection between the linear parameter varying LPV and Takagi Sugeno TS paradigms This is then followed by a detailed description of the design of robust and shifting state feedback controllers for these systems Furthermore it presents two approaches to fault tolerant control the first is based on a robust polytopic controller design while the second involves a reconfiguration of the reference model and the addition of virtual actuators into the loop In addition the thesis offers a thorough review of the state of the art in gain scheduling and fault tolerant control with a special emphasis on LPV and TS systems

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