Fault Tolerant Flight Control

Fault Tolerant Flight Control and Guidance Systems: Guillaume J. Ducard 2009-05-14 This book offers a complete overview of fault-tolerant flight control techniques. It starts by reviewing 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 Tolerant Flight Control of Unmanned Aerial Vehicles: Sinan Sadeghzadeh 2015 Safety, reliability and acceptable level of performance of dynamic control systems are the major keys in all control systems especially in safety-critical control systems. A controller should be capable of handling noises and uncertainties imposed to the controlled process. A fault-tolerant controller should be able to control a system with guaranteed stability and good and acceptable performance not only in normal operation conditions but also in the presence of partial faults or total failures that can be occurred in the system of the fault. When a fault occurs in a system, it suddenly starts to behave in an unanticipated manner. Thereby, a fault-tolerant controller should be designed for being able to handle the fault and guarantee system stability and acceptable performance in the presence of fault-tolerance. This shows the importance and necessity of Fault-Tolerant Control (FTC) to safety-critical and even for some new and non-safety-critical systems. During recent years, Unmanned Aerial Vehicles (UAVs) have proved to play a significant role in military and civil applications. The success of UAVs in different missions guarantees the growing number of UAVs to be considerable in future. Reliability of flight control systems is one of the most important factors for ensuring flight safety. UAVs and their components have the reliability importance of UAVs is implied in the acknowledgement of the Office of the Secretary of Defense in the UAV Roadmap 2005-2030 by stating that, improving UAVs reliability is the simplest most immediate and long-reaching need to ensure their success. This statement gives a wide future scenario of safety, reliability and Fault-Tolerant Flight Control (FTFC) systems of UAVs. The main objective of this thesis is to investigate and compare some aspects of fault-tolerant flight control techniques such as robustness, performance and capability of handling the faults and failures during the flight of UAVs. Several control techniques have been proposed and tested on two main platforms at Concordia University for fault-tolerant flight control and guidance system development. These platforms are the quadrotor helicopter for fault-free conditions and quadrotor flying UAV for the presence of a stuck or failure sensor. The development of a class of sliding-mode observers is described from the use of these observers for FDI using robust fault reconstruction. The development of a class of sliding-mode observers is described from the development and implementation of these observers based on neural network and adaptive model is derived. The control algorithms are shown to be effective and dealing with uncertain dynamics due to external disturbances and unpredictable faults. The overall strategy is set to up and the compilation involved is much less as compared with other strategies. Computer simulation software is developed. A series of simulation studies have been conducted with varying flight conditions. Song, Yong D. and Guajardo, J. (Technical Monitor) "Armstrong Flight Research Center


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Fault Tolerant Flight Control: Thomas Jan Josef Lomwarta 2010

Fault Detection and Fault-Tolerant Control Using Sliding Modes: Halim Abl 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 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. This is followed by the latest schemes that represent minimum-phase and relative-degree designs. Recent developments have shown that the fault 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 easily cope with actuator failures directly by exploiting redundancy, is presented. Various realistic aircraft cases, specifically high-lift 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.

Development of a fault-tolerant flight control system: Cary Benjamin Feldstein 2004

Automatic Fault Tolerant Flight Control Systems


Fault Diagnosis and Fault-Tolerant Flight Control and Guidance for Aerospace Vehicles-Ali Zolghadri 2010-08-07 Fault Diagnosis and Fault-Tolerant Control and Guidance for Aerospace Vehicles 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 capacity, evaluation of worst-case performance, robustness in hard environments and externalities, and extendibility 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. The 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 described. The authors' expertise 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 Vehicles, will be of interest to both academic and aerospace-industrial milieux.


Trajectory Tracking with Fault-Tolerant Flight Control System: Faisal Andrade de Almeida 2009

Contribution to Fault Tolerant Flight Control Under Actuator Failures: Luming Zhou 2014 The objective of this thesis is to optimize the use of redundant actuators for a transportation aircraft once some actuators failure occurs during the flight. Here, the fault-tolerant ability resulting from the redundant actuators is mainly considered. Different classical concepts and methods related to a fault-tolerant flight control channel are first reviewed and new concepts useful for the required analysis are introduced. The problem which is tackled here is to develop a design methodology for fault-tolerant flight control in the case of a partial actuator failure which will allow the aircraft to continue safely the intended maneuver. Two stages control approach is proposed and applied to both the remaining maneuverability and fault-tolerant flight control. The effects of uncertain flight conditions is considered, in which the effects of both actuator failures are reflected. Stabilization algorithms based on linear network and adaptive model are derived. The algorithms are shown to be effective and dealing with uncertain dynamics due to external disturbances and unpredictable faults. The overall strategy is set to up and the compilation involved is much less as compared with other strategies. Computer simulation software is developed. A series of simulation studies have been conducted with varying flight conditions. Song, Yong D. and Guajardo, J. (Technical Monitor) "Armstrong Flight Research Center

Fault Tolerant Flight Control System Design with Application to a Bell-205 Helicopter: Mohamad F. Al-Malki 2004

Design and Implementation of a TMR-Based Fault-tolerant Flight-control System: 1999

Fault Tolerant Flight Control Techniques with Application to a Quadrotor UAV Testbed: Yumin Zhang 2012 Fault Tolerant Flight Control Techniques with Application to a Quadrotor UAV Testbed.


Pilot-in-Loop Assessment of Fault Tolerant Flight Control Schemes in a Motion Flight Simulator: Girdhar Kumar Sapan 2008

Fault Tolerant Flight Control: Christopher Edwards 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.

Aircraft Parameter Identification for Use within a Fault-Tolerant Flight Control System: Kerri B. Phillips 2011

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Advances in Flight Control Systems-Maria Agneta Balint 2011-04-11 Nonlinear problems in flight control have stimulated cooperation among engineers and scientists from a range of disciplines. Developments in computer technology allowed for numerical solutions of nonlinear control problems, while industrial recognition and applications of nonlinear mathematical models in solving technological problems is increasing. The aim of the book Advances in Flight Control Systems is to bring together reputable researchers from different countries in order to provide a comprehensive coverage of advanced and modern topics in flight control not yet reflected by other books. This product comprises 14 contributions submitted by 38 authors from 11 different countries and areas. It covers most of the currents main streams of flight control researches, ranging from adaptive flight control mechanism, fault tolerant flight control, acceleration based flight control, helicopter flight control, comparison of flight control systems and fundamentals. According to these themes the contributions are grouped in six categories, corresponding to six parts of the book.

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Requirements for Fault Tolerant Systems-Bayou D. Kirk 1984

Fault Tolerant Control Schemes Using Integral Sliding Modes-Mirco Tariq Hamayum 2016-04-29 The key attribute of a Fault Tolerant Control (FTC) system is its ability to maintain overall system stability and acceptable performance in the face of faults and failures within the feedback system. This book Integral Sliding Mode (ISM) Control Allocation (CA) schemes for FTC are described, which have the potential to maintain overall system stability and acceptable performance in the face of faults and failures within the feedback system. In this work a controller is formulated for the case of a simultaneous lock-in-place failure of both the ailerons and the rudder control surfaces. The results presented in this work show good time response performance while increasing the robustness to parametric uncertainties substantially. The second part of the work presents an ISM [infinity] control design methodology to account for control surface faults in an aircraft. An uncertainty model is formed for a specific fault configuration using an additive loop around the model's input matrices. In this work a controller is formulated for the case of a simultaneous lock-in-place failure of both the ailerons and the rudder control surfaces. Through simulation it is shown that the fault tolerant controller design is able to stabilize the aircraft both with and without the presence of the faults while maintaining acceptable performance.

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Design and Simulation of Advanced Fault Tolerant Flight Control Schemes-Srikanth Gururajan 2006

Recent Advances in Aircraft Technology-Ramesh K. Aparai 2012-02-24 This book describes the state of the art and latest advancements in technologies for various areas of aircraft systems. In particular it covers wide topics of interest in aircraft structures and advanced materials, control systems, electrical systems, inspection and maintenance, avionics and radar and some miscellaneous topics such as green aviation. The authors are leading experts in their fields. Both the researchers and the students should find the material useful in their work.

Die Kirchen-Litanei der evangelischen Brüdergemeinen - 1877

YF22 Model With On-Board On-Line Learning Microprocessors-Based Neural Algorithms for Autopilot and Fault-Tolerant Flight Control Systems - 2002 This project focused on investigating the potential of On-line Learning ‘hardware-based’ neural approximators and controllers to provide fault tolerance capabilities following sensor and actuator failures. Following a phase of simulation studies a set of selected architectures for neural estimators and neural controllers were flown on a semi-scale YF-22 aircraft model. The YF-22 model was designed, built, and flown at research facilities at West Virginia University. Additionally, a customized electronic payload featuring these fault tolerant schemes was designed, built, tested and interfaced with the YF-22 flight control system. A series of 33 flight tests were conducted with the aircraft, the flight data confirmed the potential of neural estimators and controllers for fault tolerance purposes. Another research objective was to start addressing system requirements leading to the problem of software validation and verification for this new class of algorithms for fault tolerant flight control systems.

Fault Diagnosis and Reconfiguration in Flight Control Systems-C. Hajiyev 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 IF AC World Congresses (San Francisco-1996, Beijing-1999, and Barcelona-2002) and IEMO World Congresses (Tampere-1997, Osaka-1999, Vienna-2000), and also in the international conferences on fault diagnosis such as SAFEPROCESS Conferences (Hull-1997, Budapest-2008). 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 these 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. So 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.


Robust and Fault Tolerant Flight Control Design-Dena Lee Griffin 2003 Systematic approaches for designing robust and fault tolerant aircraft control systems are presented. The robust control design approaches include a robust LQG control system based on the technique presented by M. Farhadi and Glover, and also a weighed sensitivity [infinity] control system design methods. These methods allow the designer to increase the robustness of an aircraft control system to parametric uncertainties that are within the aircraft model due to either modelling errors or accumulated dynamics. The results presented in this work show good time response performance while increasing the robustness to parametric uncertainties substantially. The second part of the work presents an [infinity] control design methodology to account for control surface faults in an aircraft. An uncertainty model is formed for a specific fault configuration using an additive loop around the model's input matrices. In this work a controller is formulated for the case of a simultaneous lock-in-place failure of both the ailerons and the rudder control surfaces. Through simulation it is shown that the fault tolerant controller design is able to stabilize the aircraft both with and without the presence of the faults while maintaining acceptable performance.