Fault Tolerant Flight Control A Benchmark Challenge

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Advances in Flight Control SystemFault Diagnosis and Fault-Tolerant Control and Guidance for Aerospace VehiclesPilot in Loop Assessment of Fault Tolerant Flight Control Schemes in a Motion Flight Simulator

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 estimator 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 21 flight tests were conducted with the aircraft; the flight data confirmed the potential of neural estimator 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.

Diagnosis and Fault-Tolerant Control

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 project comprises 14 contributions submitted by 38 authors from 11 different countries and areas. It covers most of the current 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.

Development of a fault tolerant flight control system

The research is concerned with developing a new approach to enhancing fault tolerance of flight control systems. The original motivation for fault-tolerant control comes from the need for safe operation of control elements (e.g. actuators) in the event of hardware failures in high reliability systems. One example is modern space vehicles subjected to actuator/sensor impairments. A major task in flight control is to revise the control policy to balance impairment detectability and to achieve sufficient robustness. This involves careful selection of types and parameters of the controllers and the impairment detecting filters used. It also involves a decision, upon the identification of some failures, on whether and how a control reconfiguration should take place in order to maintain a certain system performance level. In this project we deplore the evalupement flight condition is considered in which the effects of both ramp and jump faults are reflected. Calibration algorithms based on neural network and adaptive method are derived. The control algorithms are shown to be effective in dealing with uncertain dynamics due to external disturbances and unpredictable faults. The overall strategy is easy to set up and the computation 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 Gupta, Kajal (Technical Monitor) Armstrong Flight Research Center

HIERARCHICAL SPECIFICATION OF THE SIFT FAULT-TOLERANT FLIGHT CONTROL SYSTEM

Fault-Tolerant Control with Applications to Aircraft Using Linear Quadratic Design Framework

Fault Tolerant Flight Control Techniques with Application to a Quadrator UAV Tested

Fault Tolerant Flight Control Techniques with Application to a Quadrator UAV Tested

Fault Tolerant Flight Control

Data-driven Design of Fault Diagnosis and Fault-Tolerant Control Systems presents basic statistical process monitoring, fault diagnosis, and control methods and introduces advanced data-driven schemes for the design of fault diagnosis and fault-tolerant control systems catering to the needs of dynamic industrial processes. With ever increasing demands for reliability, availability and safety in technical processes and assets, process monitoring and fault-tolerance have become important issues and are essential to industry's competitiveness. This text takes the reader how, thanks to the rapid development of information technology, key techniques of data-driven and statistical process monitoring and control can now become widely used in industrial practice to address these issues. To allow for self-contained study and facilitate implementation in real applications, important mathematical and control theoretical knowledge and tools are included in this book. Major schemes are presented in algorithm form and demonstrated on industrial case studies. Data-driven Design of Fault Diagnosis and Fault-tolerant Control Systems will be of interest to process and control engineers, engineering students and researchers with a control engineering background.

Robust and Fault Tolerant Flight Control Design

Aircraft Control and Simulation

The book describes the state of the art and latest advancements in technologies for various areas of aircraft systems. In particular it covers wide variety of topics in aircraft structures and advanced materials, control systems, electrical systems,
Fault Tolerant Flight Control

The history of flight control is inseparably linked to the history of aviation itself. Since the early days, the concept of automatic flight control systems has evolved from mechanical control systems to highly advanced automatic fly-by-wire flight control systems, now commonly found in military jets and civil airliners. Even today, many research efforts are made for the further development of these flight control systems for various aspects. Recent new developments in this field focus on a wealth of different aspects. This book focuses on a selection of key research areas, such as inertial navigation, control of unmanned aircraft and helicopters, trajectory control of an unmanned space re-entry vehicle, aerocentric control, adaptive flight control, and fault tolerant flight control. This book consists of two major sections. The first section focuses on a literature review and some recent theoretical developments in flight control systems. The second section discusses some concepts of adaptive and fault-tolerant flight control systems. Each technique discussed in this book is illustrated by a relevant example.

Fault Detection and Fault-tolerant Controller Design

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Incorporated sensor or actuator fault.

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
Fault Tolerant Flight Control

Fault-tolerant Control Systems

Development and Evaluation of Fault-Tolerant Flight Control Systems

A Design of Fault Tolerant Flight Control Systems for Sensor and Actuator Failures Using On-line Learning Neural Networks

Integrated Flight Control

Systematic approaches for designing robust and fault-tolerant aircraft control systems are presented. The robust control design approach includes a robust LQ control system based on the technique presented by McFarlane and Glover, and also a weighted sensitivity K/square root(s) control system design. 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 modeling errors or unmodeled dynamics. The second part of the book presents an active FTC system to improve the fault-tolerant capability to account for control surface failure in an aircraft. An uncertainty model is formed for a specific fault condition 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.

Contribution to Fault Tolerant Flight Control Under Actuator Failures

Fault Diagnosis and Fault-Tolerant Control 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 is 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 toward the technological concerns of industry. Initial coverage of basic definitions and ideas and a literature review gives way to a treatment of system failures, including actuator, sensor, and other structural- and parameter-varying systems. Lastly recovery strategies appropriate to remaining actuator/sensor/communications resources are presented. 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 for Aerospace, will be of interest in both academic and aerospace-industrial circles.

Die Kirchen-Litanei der evangelischen Brüdergemeine

Fault-tolerant Flight Control and Guidance Systems for a Small Unmanned Aerial Vehicle

Written by leading experts in the field, this book provides the state-of-the-art in 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

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 requirements for nonlinear system models in solving technical problems in various fields and the need to find more practical approaches for control problems led researchers to develop new methods. Further, there is a growing interest in the application of nonlinear control techniques in aeronautical engineering. This book will provide an introduction to sliding mode control and nonlinear control design techniques with problems arising in flight control systems. It is useful for graduate students, researchers, and engineers in the fields of aerospace and control systems.

Automatic Flight Control Systems

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 to fault tolerant flight control under actuator failure in the case of a partial actuator failure which will allow the flight control to continue safely the intended maneuver. A two stages control approach is proposed and applied to both the remaining maneuverable and a fault tolerant control structure design. In the first case, an offline handling quality assessment method based on Model Predictive Control is proposed. In the second case, a fault tolerant control structure based on Nonlinear Inverse Control and online actuator reassignment is developed. In both cases, a Linear Quadratic (LQ) programming problem is formulated and failure cases are considered when an aircraft performs a classical maneuver. Three numerical examples are studied and applied to the offline and online solutions of the resulting LQ problems.

Recent Advances in Aircraft Technology

Safety is one of the major concerns in the aviation community for both manned aircraft and unmanned aerial vehicles (UAVs). The safety issue of manned aircraft, such as commercial aircraft, has drawn great attention especially after a series of disasters in recent decades. Safety and reliability issues of UAVs have also attracted significant attention due to their highly autonomous feature towards their future civilian applications. Focusing on the improvement of safety and reliability of aircraft, a fault-tolerant control (FTC) system is demanded to utilize the configured redundancy in an effective and efficient manner to increase the survivability of aircraft in the presence of faults/failures. This thesis aims to develop an effective online FTC system for aircraft safety and survivability considering the transient performance of the post-fault system is obtained through state-augmented extended Kalman filter (SAEKF), which is a combined technique with state and parameter estimation. In terms of reconfiguration capability, FTC is considered as a favorable active FTC strategy. In addition to FTC framework, the improvement of on-line computational efficiency estimates MFC to be used to perform fault-tolerant flight control. Furthermore, a Laplace-function-based MFC (LF-MFC) is presented to enhance the on-line fault-tolerant capability. The modification is based on a series of Laplace functions to make the control trajectory with few parameters. In consequence, the computation load is reduced, which improves the real-time fault-tolerant capability in the framework of MFC. The FTC capability is further improved for accommodating the performance degradation during the transient period before the control reconfiguration. This approach is inspired by exponentially increasing weighting matrix LQ technique and is designed with SAEKF. The evaluation is conducted under the task of trajectory tracking in the presence of loss of control effectiveness (LOE) faults of actuators. The modified MFC is utilized to synthesize an active FTC system to accommodate the elevators fault tolerance benchmark model. The exponential weighting matrix LQ-based FTC framework is designed to improve the fault-tolerant capability before the control reconfiguration. A time delayed FDI is integrated into the evaluation process to prevent the effectiveness of the proposed FTC strategies. The designed FTC system is evaluated under the emergency landing task in the event of failure of elevators.

Fault Tolerant Flight Control of Unmanned Aerial Vehicles
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.

Trajectory Tracking with Fault-tolerant Flight Control System

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Avionics Design for a Sub-Scale Fault- Tolerant Flight Control Test-Bed

Get a complete understanding of aircraft control and simulation Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, Third Edition is a comprehensive guide to aircraft control and simulation. This updated text covers flight control systems, flight dynamics, aircraft modeling, and flight simulation from both classical design and modern perspectives, as well as two new chapters on the modeling, simulation, and adaptive control of unmanned aerial vehicles. With detailed examples, including relevant MATLAB calculations and FORTRAN codes, this approachable yet detailed reference also provides access to supplementary materials, including chapter problems and an instructor’s solution manual. Aircraft control, as a subject area, combines an understanding of aerodynamics with knowledge of the physical systems of an aircraft. The ability to analyze the performance of an aircraft both in the real world and in computer-simulated flight is essential to maintaining proper control and function of the aircraft. Keeping up with the skills necessary to perform this analysis is critical for you to thrive in the aircraft control field. Explore a steadily progressing list of topics, including equations of motion and aerodynamics, classical controls, and more advanced control methods. Consider detailed control design examples using computer numerical tools and simulation examples. Understand control design methods as they are applied to aircraft nonlinear math models. Access updated content about unmanned aircraft (UAVs). Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, Third Edition is an essential reference for engineers and designers involved in the development of aircraft and aerospace systems and computer-based flight simulations, as well as upper-level undergraduate and graduate students studying mechanical and aerospace engineering.

Aircraft Parameter Identification for Application Within a Fault-tolerant Flight Control System

Fault-tolerant Flight Control and Guidance Systems

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