Book Review

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Aircraft and Rotorcraft System Identification, Engineering Methods with Flight Test Examples
by: Mark B. Tischler, with Robert K. Remple
Second Edition
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1 Introduction

Over the past three decades, frequency-response identification methods have proven themselves indispensable to many applications including modern control design and simulation.

The second edition of *Aircraft and Rotorcraft System Identification* by M.B. Tischler and Robert K. Remple (AIAA, 2012) is an important contribution to the identification literature in that it provides a comprehensive account of the frequency domain technique by the investigators who lead its development and maturation.

Their book clearly showcases the benefits gained and the range of experiences applying the technique, and establishing the necessary theoretical framework that has made it successful and efficient for the user. The book provides an excellent balance between the theoretical background and the engineering aspects of the technique.

Frequency response identification gained sophistication through its application to the unique challenges of rotorcraft modelling. Since then, frequency response techniques have proven effective within a range of aircraft and other applications. The technique has also been crucial to more specialised applications, such as handling qualities and human pilot modelling.

One of the multiple reasons why frequency response techniques have been successful is that they are practical to implement and, at the same time, are grounded in the frequency response framework used in control design and analysis. In this respect this book provides a necessary complement for control engineers.

The following provides a brief description of the scope of the material covered in the book, the clarity of presentation and accessibility, and finally the relevance and usability for the engineering application.

2 Scope

The second edition addresses the entire process of aircraft and rotorcraft system identification from instrumentation and flight testing to model determination, validation, and application of the results. It also includes several new chapters detailing extended model structures and identification results for large flexible transport aircraft, as well as the complete methodology needed to develop a continuous full flight envelope simulation model from individual system identification models and trim test data.

The book is divided into two parts. The first part covers essential frequency identification concepts, including flight testing, single and multi-input systems, and closed-loop identification. It also provides results for non-linear systems, and transfer function models. These topics represent the necessary educational foundations and hence are valuable for students but also for practitioners who care about having a more detailed background.

The second part of *Aircraft and Rotorcraft System Identification* covers more specialised topics, including model structure development from first principles, time-domain verification, higher-order models arising from coupled rotor-fuselage dynamics, models for large flexible aircraft, and the development of full-flight envelope models. These topics are relevant to both practitioners and researchers.

3 Clarity and accessibility

The book combines theory, practical guidelines, and real-world flight-test results for a wide range of state-of-the-art flight vehicles, including aircraft and rotorcraft.

The subject matter is presented in an accessible form with all necessary background material as well as extensive bibliographical references, making it a comparatively complete, self-contained manuscript. The identification framework is introduced within a clear conceptual perspective with historical references.

The detailed flight-test examples included in the book illustrate the wide-ranging roles that system identification plays, including the analysis of flight mechanics, feedback control, handling qualities, subsystem dynamics, structural analysis, higher-order models for aircraft and rotorcraft, and simulation.

Tischler and Remple have also included a broad range of problem sets at the end of each chapter. These provide opportunities to gain hands-on experience with system identification methods. The interpretation of the results accompanying these problems promotes valuable engineering insights. The book has two features that are highly beneficial for its use as a textbook, including a complete solutions manual, which is available from the publisher, and a free student version of CIFER, which is available for download.

4 Relevance to practitioner

The frequency-response method has proven itself to be of great practical value for a variety of flight vehicles and other vehicle and systems. My personal experience is in modelling miniature helicopters of a range of scales from the mid-size R-50, small-size X-Cell, to mini- and micro-scale Blade CX and Blade mCX, respectively. More recently it was applied to modelling a miniature fixed-wing Ultra-Stick UAV. In all of these examples, the frequency response method has made it possible to achieve excellent model accuracy, and also helped to gain valuable insights about the physical and unique characteristics of the dynamics. These insights have proven essential for the proper design of control systems.

My personal experience has made me appreciate the many factors that impact the successful application of identification methods. In this respect, the book delivers many detailed guidelines covering flight testing, data analysis, and the proper selection of model structure complexity. These important experimental and practical considerations are addressed through the abundant flight-test examples.

Aircraft and Rotorcraft System Identification distils many years of practical experience covering a range of problems from the more standard ones to the more challenging ones, such as the identification of unstable aircraft, closed loop systems and systems affected by the presence of measurement noise. The book also clearly distinguishes itself by the emphasis on physical insight in model development and applications.

5 Summary

In summary *Aircraft and Rotorcraft System Identification* by M.B. Tischler and Robert K. Remple is meant not only for modelling specialists, it is essential for those who are serious about aerospace control applications. It condenses several decades of experience in a comprehensive and accessible form, providing the theoretical background as well as essential insights and guidelines for practitioners.

The book comes with extensive examples that are suited to the preparation of aerospace and control engineers. It provides an essential companion for users of the CIFER software, in that it provides the theoretical background for the functions implemented in the software, as well as the execution of flight experiments or other data collection experiments.

In summary, the book is a unique and valuable resource for the practising engineer as well as researchers needing a sound practical perspective on important aspects of modern control and simulation problems and students involved in research projects requiring accurate models of complex systems.