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Book Review

Time Series Analysis Methods and Applications for Flight Data. By Jianye Zhang and Peng Zhang. Springer: Berlin, Heidelberg, Germany, 2017; pp. 1–240; ISBN: 978-3-662-53430-4

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1. Introduction and Aim of the Book

This book [1] aims to present the best application for managing and clearly representing the massive amount of Flight Data (FD) that exists. As the characteristics of FD correspond to a typical time series, the authors present different methods of analyzing it.

2. Outline of the Book

2.1. Chapter 1 (Introduction)

This chapter defines what is a flight data recorder (FDR) and provides its history by outlining the different types of FDR from pioneering type to the most recent one. The rest of this chapter provides an introduction to what will be discussed in the following chapters.

Key concepts and topics: history, flight data management system, flight data acquisition unit, solid state, and quick access recorder.

2.2. Chapter 2 (Preprocessing of Flight Data)

When raw flight data is collected from the FDR for analysis, it is not necessarily reliable because it may contain various errors. This chapter provides some mathematical/statistical models to detect errors from the collected data efficiently.

Key concepts and topics: outlier elimination, missing values, virtual sensing, amnesic fusion filtering, weighting data filling, phase space reconstruction, anomaly detection, and Kalman filters.

2.3. Chapter 3 (Typical Time Series Analysis of Flight Data Based on the ARMA Model)

Autoregressive Moving Average (ARMA) analysis is the go-to time series model. This chapter explains this statistical model in depth.

Key concepts and topics: trend parameter, AR, MA, steady state of aircraft, and rule reasoning machine.

2.4. Chapter 4 (Similarity Search for Flight Data)

A characteristic of flight data is that it varies depending on the flight. Two flights made by the same aircraft will not have the exact same time series for many reasons including weather conditions, turbulence, and equipment performance. Consequently, multiple time series are recorded in a database management system. How can an application compare one time series to another? This chapter explores different methods of comparing one time series to another, such as finding similarities in the slope distance, the angular distance, and the curvature.

Key concepts and topics: dimension reduction, discrete Fourier transform, single statistical analysis and multivariate statistical analysis.

2.5. Chapter 5 (Condition Monitoring and Trend Prediction Based on Fight Data)

Following the concept of similarity, this chapter provides some methods for monitoring or predicting the state of a parameter. Condition monitoring means to maintain constant knowledge of the health of an aircraft component, for instance, a rotor, so that it can be predicted when it needs to be replaced or repaired.

Key concepts and topics: support vector machine, fault diagnosis, flight guidance, maintenance assistant, cluster and expert system.

2.6. Chapter 6 (Design and Implementation of the Flight Data Mining System)

Following the thorough observations and findings of the previous chapters, the authors propose a data mining system aimed at improving flight data analysis. They created a prototype that can deal with multi-parameters as well as analyze massive FD and output this complex analysis to present it informatively and engagingly.

Key concepts: flight data application, prototype, design, data warehouse, patterns, and data mining.

3. Criticism

This book provides some resourceful information on how to analyze the information collected from a flight data recorder, a device that records different observations from the parameters of an aircraft. Throughout the book, the authors provide detailed examples of statistical models with time assessment and an explanation of each result. However, even though this book was translated into English, some screenshots, notably the one in the last chapter, contain information that is not translated. Moreover, some of the citations are not from English sources, thus preventing further explanation of significant topics. Nonetheless, it remains an important book for pioneering the statistical analysis of flight data.

4. Discussion and Further Analysis

Now that the book has established a prototype system, how can it be improved? With the currently proposed system, the performance of airborne equipment can be monitored. Nevertheless, it would be interesting to include a Geographic Information System (GIS) in the prototype to add more context to the visualization or the analysis so that the high performance of airborne equipment could be correlated with the topographical elevation of a region. One GIS system that could be added is called Flight Waypoint Visualization [2], which is used in an airplane mainly "to help the pilot recognize current flight status and avoid possible collision by analyzing flight path and geographic information" [3]. As Klous and Wielaard state in their book [4], "Data acquires value when you can understand the context." Finding correlation between the performance of airborne equipment and the topographical elevation may help to optimize aircraft routes as well as the life of airborne equipment.

5. Who Is This Book for

This book will be useful for anybody who has an interest in aircraft maintenance, aircraft management, and flight data recorder engineering. Even though the authors clearly explain the statistical or mathematical models used in this book, the reader does need to possess basic statistical knowledge to comprehend the content fully. This book provides formulae and some statistical figures that aim to help the understanding of each concept. The last chapter, the sixth, is the most important of the book because it displays the applications of the authors' findings. Ultimately, *Time Series Analysis Methods and Applications for Flight Data* is an excellent book worthy of a high recommendation.

Conflicts of Interest: The author declares no conflict of interest.

References

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