Jihong Yan

Machinery Prognostics and Prognosis Oriented Maintenance Management

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About the Author

Jihong Yan is a full-time Professor (since 2005) in Advanced Manufacturing at Harbin Institute of Technology (HIT), China and is head of the Department of Industrial Engineering, who received her Ph.D. degree in Control Engineering from HIT in 1999. Professor Yan has been working in the area of intelligent maintenance for over 10 years, starting from 2001 when she worked for the Centre for Intelligent Maintenance Systems (IMS) funded by NSF in the US as a researcher for 3 years, mainly focused on prognosis algorithm development and application. Then she joined Pennsylvania State University in 2004 to work on personnel working performance related topics. As a Principal Investigator, she has worked on and completed more than 10 projects in the maintenance-related area, funded by the NSF of China, National High-tech "973" project, the Advanced Research Foundation of the General Armament Department, the Astronautics Supporting Technology Foundation, High-tech funding from industries, and so on. Specifically, her research is focused on the area of advanced maintenance of machinery, such as online condition monitoring, signal data pre-processing, feature extraction, reliability and performance evaluation, fault diagnosis, fault prognosis and remaining useful life prediction, maintenance scheduling, and sustainability-based maintenance management. She has authored and co-authored over 80 research papers and edited 2 books.

Preface

Prognostics-based maintenance, which is a typical pattern of predictive maintenance (PdM) has been developed rapidly in recent years. Prognosis, which is defined as a systematic approach that can continuously track health indicators to predict risks of unacceptable behavior over time, can serve the purpose of assessing the degradation of a facility's quality based on acquired online condition monitoring data. The existing prognostics models can be divided into two main categories, mechanism-based models and data-driven models. Although the real-life system mechanism is often too stochastic and complex to model, a physics-based model might not be the most practical solution. Artificial intelligence based algorithms are currently the most commonly found data-driven technique in prognostics research.

Prognostics provides the basic information for a maintenance management system where the maintenance decision is made by predicting the time when reliability or remaining life of a facility reaches the maintenance threshold. However, inappropriate maintenance time will result in waste of energy and a heavier environmental load. Nowadays, more efficient maintenance strategies, such as sustainability-oriented maintenance management are put forward. Sustainability-based maintenance management not only benefits manufacturers and customers economically but also improves environmental performance. Therefore, from both environmental and economic perspectives, improving the energy efficiency of maintenance management is instrumental for sustainable manufacturing. Sustainability-based maintenance management will be one of the important strategies for sustainable development.

This book aims to present a state-of-the-art survey of theories and methods of machinery prognostics and prognosis-oriented maintenance management, and to reflect current hot topics: feature fusion, on-line monitoring, residual life prediction, prognosis-based maintenance and decision-making, as well as related case studies.

The book is intended for engineers and qualified technicians working in the fields of maintenance, systems management, and shop floor production line maintenance. Topics selected to be included in this book cover a wide range of issues in the area of prognostics and maintenance management to cater for all those interested in maintenance, whether practitioners or researchers. It is also suitable for use as a textbook for postgraduate programs in maintenance, industrial engineering, and applied mathematics.

This book contains eight chapters covering a wide range of topics related to prognostics and maintenance management, and is organized as introduced briefly below.

Chapter 1 presents a systems view of prognostic- and sustainability-based maintenance management.
Chapter 2 introduces widely used probability distribution functions, such as uniform distribution, geometric distribution, normal distribution, and binomial distribution, for processing discrete data, and is illustrated with several examples.
Chapter 3 presents a systematic and in-depth study of signal processing and the application to mechanical condition monitoring and fault identification.
Chapter 4 introduces the reader to the health monitoring concept. In addition, the degradation process, the main parts of a typical real-time monitoring system, and fault prognosis and the methods for remaining useful life prediction are discussed.
Chapter 5 addresses different prediction methods in machine prognosis.
Chapter 6 focuses on maintenance planning and scheduling techniques, including maintenance scheduling modeling, grouping technology (GT) based maintenance, and so on.
Chapter 7 provides an overview of prognosis-oriented maintenance decision-making issues and shows how the prognosis plays an important role in the development of maintenance management.
Chapter 8 presents five significant case studies on prognostics and maintenance management to demonstrate the application of the contents of the previous chapters. These are extracted from some published papers of the author's research group.

This book is a valuable addition to the literature and will be useful to both practitioners and researchers. It is hoped that this book will open new views and ideas to researchers and industry on how to proceed in the direction of sustainability-based maintenance management. I hope the readers find this book informative and useful.

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