# Applied Condition Monitoring

Volume 4

**Series editors**

Mohamed Haddar, National School of Engineers of Sfax, Tunisia

Walter Bartelmus, Wrocław University of Technology, Poland

Fakher Chaari, National School of Engineers of Sfax, Tunisia
e-mail: fakher.chaari@gmail.com

Radoslaw Zimroz, Wrocław University of Technology, Poland

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The book series Applied Condition Monitoring publishes the latest research and developments in the field of condition monitoring, with a special focus on industrial applications. It covers both theoretical and experimental approaches, as well as a range of monitoring conditioning techniques and new trends and challenges in the field. Topics of interest include, but are not limited to: vibration measurement and analysis; infrared thermography; oil analysis and tribology; acoustic emissions and ultrasonics; and motor current analysis. Books published in the series deal with root cause analysis, failure and degradation scenarios, proactive and predictive techniques, and many other aspects related to condition monitoring. Applications concern different industrial sectors: automotive engineering, power engineering, civil engineering, geoengineering, bioengineering, etc. The series publishes monographs, edited books, and selected conference proceedings, as well as textbooks for advanced students.

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Fakher Chaari · Radoslaw Zimroz
Walter Bartelmus · Mohamed Haddar
Editors

# Advances in Condition Monitoring of Machinery in Non-Stationary Operations

Proceedings of the Fourth International Conference on Condition Monitoring of Machinery in Non-Stationary Operations, CMMNO'2014, Lyon, France December 15–17

Springer

*Editors*
Fakher Chaari
National School of Engineers of Sfax
Sfax
Tunisia

Radoslaw Zimroz
Diagnostics and Vibro-Acoustics Science Laboratory, Institute of Mining Engineering
Wrocław University of Technology
Wroclaw
Poland

Walter Bartelmus
Diagnostics and Vibro-Acoustics Science Laboratory, Institute of Mining Engineering
Wrocław University of Technology
Wroclaw
Poland

Mohamed Haddar
Mechanical Engineering Department
National School of Engineers of Sfax
Sfax
Tunisia

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# Preface

This book presents the proceedings of the 4th edition of the conference on Condition Monitoring of Machinery in Non-stationary Operations CMMNO'2014 held in Lyon-France from 15 to 17 December 2014. This conference series follows three other successful conferences which took place in Ferrara (Italy) in 2013, Hammamet (Tunisia) in 2012 and Wroclaw (Poland) in 2011. This edition of the conference attracted about 70 participants who had the opportunity to discuss a number of important topics in the field condition monitoring of machinery in non-stationary operations.

To simplify problem of condition monitoring of machines, many researches a priori assumes several critical conditions: test rig with simple design (one stage gearbox), single damage artificially introduced in the system and constant loading conditions (or even no load is applied in the system). Such assumption might be good to clearly present new signal processing technique etc, however, to validate new findings in industrial applications probably more complex signals should be considered. Last decade brought many papers proving that this rough assumptions are no longer valid since in reality machines are subjected to complex condition such us variable loads, speed, multiple faults, severe operations, etc.

The objectives of CMMNO'2014 conference is to offer a forum for researchers to present and discuss their latest advances with theoretical and applied development of methods and techniques related to the condition monitoring of machinery in such complex conditions.

The papers presented in this book are classified into 3 mains topics that were discussed during CMMNO'2014: Condition monitoring techniques (in general) and two special sections focused on key steps in Condition monitoring, namely Signal processing for condition monitoring and Data mining for condition monitoring.

In Part I (Signal Processing) several topics are discussed. In modern condition monitoring there is an active group of researchers focused on electrical signals analysis for fault detection. In the book, among others, authors combine two directions, electrical signals and angular speed approach. Recently, Instantaneous Angular Speed Measurement is very promising direction for condition monitoring of rotating machines.

In this part also identification of vibration signals, especially for complex systems (bearings damage in gearbox, bearings in presence of non-Gaussian noise) is discussed. It was noticed by researchers, that automatic processing and robustness of techniques is very important for industrial applications. Often techniques should not require extra information that requires being blind, adaptive or data-driven as EMD. For complex system a decision might be based on multidimensional data analysis.

Also tracking issue of non-stationary signal's components is noticed by using time frequency method. All these mentioned issues are discussed in Part I—signal processing for condition monitoring.

Due to intensive data acquisition systems development, one might say that it is relatively easy to acquire data from industrial systems nowadays. Unfortunately, problem of data analysis from such systems still exists and even maybe it is more critical (due to number of available data) then before. Part II in the book contains methodologies of how to deal with such problems. It might be related directly to SCADA data analysis, as well as fundamental issues for condition monitoring as for example an optimal threshold or decision boundaries selection.

Very often to classify/recognize data there is a need to use advanced tools based on artificial intelligence including neural network, genetic algorithm etc. However, industrial application would be interested in whole systems rather than single procedures, so example of expert system shell for mining industry is also presented.

Part III of this book will be dedicated to latest advances in techniques used for condition monitoring of machinery in non-stationary operations including model-based approaches. Several case studies concerning methods and techniques for detection of defects in machinery were presented. Papers on bearing fault diagnosis in wind turbines generators, planetary gearbox will show implementation of amplitude and phase demodulation techniques, acoustic emission and adaptive vibration diagnostic techniques for complicated machinery. Fatigue life estimation of bearings running under non-stationary conditions will also discussed. Other interesting case studies will be presented concerning crack identification in structures, influence of sensors mounting on condition monitoring of aircraft engine rotor. Two other papers will be interested to conveyor belts behavior, maintenance and safety. Three papers will be interested to dynamic models of transmission running under non-stationary operating conditions. They will discuss gear systems and elevators.

The chapters presented in this book were peer reviewed. The editors would like to thank all the members of the organizing committee, the scientific committee and the referees, for their efforts in keeping high scientific level for CMMNO conference. The editors are also grateful to Springer for continuous support to this conference.

Fakher Chaari
Radoslaw Zimroz
Walter Bartelmus
Mohamed Haddar

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