



## Rotating machines diagnostics with use of LabView

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### 1 Introduction

Presented work deals with rotating machines diagnostics, namely wind turbines. The paper provides information about the configuration of specific offshore wind turbines placed in the wind farm Alpha Ventus. Further, the meaning of condition-based maintenance is explained and the general structure of health monitoring system is described as well as the most common faults in conjunction with their symptoms.

The following part explains the data processing with a view to feature extraction from vibration data and feature reduction to identify the most relevant ones. Based on introduced knowledge, a technique for fault diagnostics is suggested.

In the practical part, the experimental vibration data are examined and a case study based on real data is presented and the proposed diagnostic approach is tested. Finally, a guide to the application implemented in LabView, which provided the data analysis, is introduced.

### 2 Alpha Ventus Wind Farm

Alpha Ventus (also known as Borkum West) is the first offshore wind farm built in Germany. It is situated in the North Sea north of the island Borkum and it was commissioned on April 27, 2010. The park consists of twelve wind turbines of which six turbines are 5 MW Areva Multibrid M5000. The farm is controlled via the control centre in the town of Nordern. The rated output of the wind farm is 60 MW.

The Alpha Ventus offshore wind farm is located in the open sea with a water depth of about 30 meters and a distance from the coast of 60 kilometres. This location guarantees excellent wind condition, however, the water depths, the aggressive salt-laden air, the strong and often gusty winds and the swell together add up to extreme demands on the installation logistics, construction, operation and as well maintenance.

### 3 Conditional-based maintenance

Conditional-based maintenance enables high equipment reliability and low maintenance costs by eliminating the need for unnecessary overhaul activities while simultaneously allowing repairs to be performed on a planned basis. Detection of faults in their early stages provides an opportunity to order parts, schedule personnel, shutdown the equipment before serious damage occurs, and minimize downtime. However, this strategy requires having access to reliable condition monitoring techniques, which not only are able to determine current condition, but also give reasonable predictions of remaining useful life [3].

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## 4 Feature extraction

Usually, any types of defects or damage will influence the machinery behaviour which is measured by transducers and converted to electrical signals. These raw data signals are conditioned or preprocessed and after that, various types of method are used to extract features, which are required to be ideally more stable and well behaved than the raw signal itself.

## 5 Feature reduction

In layman's terms, it seems the more features is extracted during the measurement the more accurate the fault detection will be. However, this idea is not correct because most machine learning techniques, which include fault detection algorithms, may not be effective for high dimensional data.

Feature reduction is possible due to information redundancy in the data because many of the features may be correlated with each other. Moreover, many of the features will have a variation smaller than the measurement noise and thus will be irrelevant. Hence, a new set of the most representative features should be found.

## 6 Fault detection

The fault detection is usually carried out by making a comparison between present descriptors of a machine and reference (baseline) values. Two main approaches defined in ISO standard ISO13379-1 can be used for diagnosing the condition of the machine.

**Data-driven** approaches are generally automated and do not require deep knowledge of the mechanism of fault initiation and propagation, but do require training the algorithm using a large set of observed fault data.

**Knowledge-base** approaches, which rely on an explicit representation fault behaviour or symptoms through, for example, fault models, correct behaviour models or case description [1].

## 7 Pattern classification

Pattern classification belongs to the statistical data analysis methods for the fault detection as mentioned above. In general, classification solves the problem of identifying to which class (category) a new data sample belongs. The most common statistic classification method is based on Bayes's theorem which is well known and described e.g. in [2]. In case of this work, the goal is to realize unsupervised pattern classification, which means that the input patterns (data) are not associated with any specific situation (fault).

## Literatura

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