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CONDITION MONITORING OF HELICAL GEARS USING AUTOMATED SELECTION OF FEATURES AND SENSORS

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ABSTRACT

The selection of most sensitive sensors and signal processing methods is essential process for the design of condition monitoring and intelligent fault diagnosis and prognostic systems. Normally, sensory data includes high level of noise and irrelevant or redundant information which makes the selection of the most sensitive sensor and signal processing method a difficult task. This paper introduces a new application of the Automated Sensor and Signal Processing Approach (ASPS), for the design of condition monitoring systems for developing an effective monitoring system for gearbox fault diagnosis. The approach is based on using Taguchi's orthogonal arrays, combined with automated selection of sensory characteristic features, to provide economically effective and optimal selection of sensors and signal processing methods with reduced experimental work. Multi- sensory signals such as acoustic emission, vibration, speed and torque are collected from the gearbox test rig under different health and operating conditions. Time and frequency domain signal processing methods are utilised to assess the suggested approach. The experiments investigate a single stage gearbox system with three level of damage in a helical gear to evaluate the proposed approach. Two different classification models are employed using neural networks to evaluate the methodology. The results have shown that the suggested approach can be applied to the design of condition monitoring systems of gearbox monitoring without the need for implementing pattern recognition tools during the design phase; where the pattern recognition can be implemented as part of decision making for diagnostics. The suggested system has a wide range of applications including industrial machinery as well as wind turbines for renewable energy applications.

Keywords: Condition monitoring; Gearbox; ASPS; Taguchi's method; Acoustic emission; Vibration analysis; Wavelet; Wind energy.

1 INTRODUCTION:

This paper introduces a novel application of the Automated Sensor and Signal Processing Approach (ASPS) [1], for the design of condition monitoring systems for developing an effective monitoring system for gearbox fault diagnosis. A gearbox system is one of the most significant components in rotating machinery and has been widely used in many industrial applications to transfer speed and power to other parts of the power train in high efficiency, this includes industrial machinery as well as wind turbines for renewable energy applications. A gearbox system is subject to many influencing factors that have negative impact on its performance such as improper installation, lack of lubrication, material fatigue and damage caused by wear and catastrophic breakage. These negative factors could lead to progressive deteriorations of the health condition of rotating machines and increase in energy consumption, causing an unexpected machine down time which may lead to substantial economic losses [2]. The industrial community aspires to get effective and reliable sensing tools to monitor the health conditions of machinery and capture structural defects at their initial stages to provide suitable diagnostics and prognostics. Sensors, such as vibration and sound, are usually used to provide the