International Conference
on Industrial Engineering and Systems Management

IESM' 2009

May 13 - 15, 2009

MONTREAL - CANADA

Development and Evaluation of Prognostics Algorithms for Driveshafts *

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Abstract

In this paper, a number of effective prognostics algorithms to predict remaining useful life for driveshafts are presented. The first algorithm is developed based on the assumption that a linear relationship between logarithmic transformation of the remaining useful life and vibration features can be built on a base operating condition. This relationship remains unchanged as the operating condition changes. Therefore, the prognostic algorithm for any other operating conditions can be obtained by adding a constant to the base relationship. This constant can be determined by changing the combination of operation conditions such as torque and rotational speed. The base relationship can be generated by polynomial curve fitting. Other prognostic algorithms are developed based on well-known data mining methods. They are multiple linear regression, K-nearest neighbours, regression tree and multilayer feedforward neural networks. In these algorithms, the operating conditions such as torque and speed are treated as independent input variables the same as vibration features. The data used in developing and evaluating these prognostics algorithms are generated using a recently developed damage dynamic simulation tool that integrates shaft dynamic models and shaft life models to simulate the life progression of a damaged drive shaft. The tests compare the performance of the developed prognostic algorithms and show that the prognostic algorithms developed only using the first shaft order and operating conditions (torque, rotational speed) can be effective for prediction of the remaining useful life of a driveshaft.

Key words: Driveshaft, Prognostics, Damage Dynamic Simulation

1 Introduction

A drivetrain transmission system is one of the most fundamental and important parts of many manufacturing and production equipment. Driveshafts are critical components of drivetrain transmission system to transfer torque or rotational force from motor to turn the rotors. Therefore, the ability to monitor the health of shafts accurately can significantly enhance condition-based maintenance task of a drivetrain transmission system to avoid unnecessary failures. Diagnostics and prognostics are two major capabilities to detect and predict the health status of a component or system, such as a driveshaft. However, up to now, none of the developed systems incorporates the trustworthy capability of prognostics compared to powerful diagnosis capability although great efforts have been devoted to developing reliable prognostic systems for various applications including aircraft [5], gas turbine engines [7], shipboard machinery [4], and automobiles [6]. For instance, the Integrated Mechanical Diagnostics Health and Usage Monitoring System (IMD HUMS) is the first successful commercial health monitoring system developed by Goodrich Corporation. It provides a complete suite of helicopter

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