UNIVERSITI TEKNIKAL MALAYSIA MELAKA

AN INVESTIGATION ON GASOLINE ENGINE MISFIRE FAULT USING MULTI SENSORS AND ANALYZING WITH VIBRATION SIGNAL ANALYSIS

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours.

by

A'BDUL RAHMAN BIN AWANG

B071510661

940428025787

FACULTY OF MECHANICAL AND MANUFACTURING ENGINEERING TECHNOLOGY

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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours. The member of the supervisory is as follow:

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Co-supervisor: Ts AHMAD FUAD BIN AB GHANI

ABSTRAK

Pemantauan keadaan digunakan untuk enjin petrol, meningkatkan keselamatan, produktiviti, mengurangkan kos penyelenggaraan dan meningkatkan kebolehpasaran. Terdapat banyak diagnosis kerosakan di mesin berputar iaitu enjin kenderaan, jentera berat dan perlu diselidik melalui pelbagai jenis kajian berdasarkan kajian isyarat. Berdasarkan journal sebelum ini, semua journal mengatakan bahawa analisis isyarat getaran (VSA) adalah yang paling tepat untuk menganalisis pendekatan yang efektif. Penyelidikan ini menyiasat dan menganalisis kerosakan enjin petrol BMW D1 N43B20 yang menggunakan dua sensor yang berbeza iaitu piezo film dan accelerometer yang dipasang di dinding enjin berhampiran enjin pembakaran dalaman.

Penerapan Fast Fourier Transform (FFT), MatLAb dicadangkan sebagai metodologi pengekstrakan utama untuk mencari data yang tepat. Analisa isyarat getaran itu mencadangkan kuadrat rata, sisihan piawai, skewness dan kurtosis untuk memilih salah satu ciri terbaik untuk mencari kesalahan kerosakan dalam enjin pembakaran dalaman. Ia juga untuk meramalkan sama ada enjin atau ICE berfungsi secara sihat berdasarkan ciri-ciri yang dipilih dan jenis kesalahan dalam enjin. Dengan membandingkan hasil yang berbeza dengan usaha yang sama dalam literatur membuktikan kesahihan cadangan yang dicadangkan.

Kajian semula sumber VSA dalam enjin petrol dan bagaimana untuk mewakili isyarat VSA yang dihasilkan dibentangkan. Terdapat empat kaedah analisa digunakan analisis

domain, domain masa menggunakan parameter seperti Root Mean Square (RMS), Standard Deviation, Skewness dan Kurtosis. Analisis domain kekerapan yang bergantung pada amplitud komponen yang diberikan.

Dalam kajian ini, data telah diperolehi daripada ujian pada enjin petrol BMW D1 N43B20, di mana kelajuan enjin, suhu dan jenis kesalahan yang menjadi keburukan di setiap silinder telah berubah. Ia boleh dipantau isyarat dan perbezaannya daripada yang diperolehi untuk keadaan enjin biasa dikenali sebagai kesalahan yang boleh digunakan untuk pengesanan kesalahan dan diagnosis / penyiasatan.

ABSTRACT

A condition monitoring applied to gasoline engines, improves safety, productivity, reduces maintenance costs and increases serviceability. There are many fault diagnosis at the rotary machine which the vehicle engine, heavy duty machine and need to investigated through the different kinds of signals. Base on the literature, all literature says that vibration signal analysis (VSA) is the most accurately to analyses effective approach. This research was investigate and analyses the BMW D1 N43B20 gasoline engine fault which is misfire fault using the two different sensor accelerometer and piezo film was mounted at the engine wall near the internal combustion engine.

The application of the Fast Fourier Transform (FFT), MatLAb is proposed as a main extraction methodology to find the accurate data. The vibration signal analysis was propose root mean square, standard deviation, skewness and kurtosis to select which one the best features to find the misfire fault in the internal combustion engine. It also to predict if the engine or ICE works healthily based on the selected features and, if not, what kind of faults is in the engine. By comparing the different result with the similar efforts in the literature proves the validity of the proposed

A review of the VSA sources in gasoline engines and how to represent the VSA signals generated is presented. There are four analysis methods were used time-domain analysis using parameters such as Root Mean Square (RMS), Standard Deviation, Skewness and

Kurtosis. The frequency-domain analysis which relied on the amplitudes of the frequency components.

In this researches, data has been obtained from tests on a BMW D1 N43B20 gasoline engine, where the engine speed, temperature and the type of fault which is the misfire at every cylinder were changed. It can be monitored signal and its difference from that obtained for normal engine conditions was well-known as a fault signature that could be used for fault detection and diagnosis/investigate.

DEDICATION

To my beloved parent Meriam Bt Ibrahim for your patience and absolutely everything with love. To my brother Mahyuddin Bin Awang and my sister Siti Aieshah Bt Awang, for their continuous support and encouragement, while I have been away from home.

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Hz	-	Hertz
$\sum$	-	Sum
x	-	Displacement
σ	-	Standard Deviation
N	-	Number of Samples
X	-	Mean Value of Sample
$\mathbf{X_i}$	-	Individual Sample
mm	-	Millimetre
kW	-	Kilowatt
Nm	-	Newton meter
[º]	-	Degree
Hz	-	Hertz
$\sum$	-	Sum
x	-	Displacement
σ	-	Standard Deviation
N	-	Number of Samples
X	-	Mean Value of Sample

LIST OF ABBREVIATIONS

MatLab	Matrix Laboratory
ICE	Internal Combustion Engine
VSA	Vibration Statistical Analysis
DAQ	Data Acquisition
CBM	Condition Based Monitoring
MFC	Macro Fiber Composite
CM	Condition Monitoring
LabView	Laboratory Virtual Instrumentation Engineering Workbench
SI	Spark Ignition
TF	Time Frequency
FFT	Fast Fourier Transform
CI	Compression Ignition
WT	Wavelet Transform
STFT	Short Time Fast Fourier

CHAPTER 1

INTRODUCTION

1.1 Background

Vibration is an oscillating or another periodic movement of an object as it is forced out of a state of equilibrium. In the workplace, machines, tools, and other powered devices may produce vibrations to which an employee is exposed. Vibration is the movement of a body around a fixed point. According to previous research, each machine has a specific vibration signature linked to the construction and the state of the machine (Aherwar & Khalid, 2012). Vibrations can be either customary or arbitrary in the occasion. Machines usually produce regular vibrations. Vibrations are calculating in terms of the intensity and frequency (force and speed) of the change movement. According to previous research, fatigue failure which is harmful to forces and thus large stresses, which can cause both vibrations and early failure of the mechanism (Ahirrao, Bhosle, & Nehete, 2018). Noise and vibrations which produce on the inside of vehicle lessen the client's ride comfort. As the quality and intensity are the most important in the present vehicle industry, it is important to investigate, diagnose and analyze the main causes of the noise and vibrations.

Data from several studies suggest that internal combustion engines are devices that generate work using the products of combustion as the working fluid rather than as a heat transfer medium (Flagan & Seinfeld, 1988). One of the most noticeable stylistic aspects the combustion is completed in a way that produces high-pressure combustion items that can be widely used in a turbine or cylinder. The internal combustion engine,