UNIVERSITI TEKNIKAL MALAYSIA MELAKA

RESEARCH AND DEVELOPMENT OF LOW-COST VIBRATION MONITORING SYSTEM WITH INTERNET OF THINGS (IOT)

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BACHELOR OF TECHNOLOGY MECHANICAL ENGINEERING (AUTOMOTIVE TECHNOLOGY) WITH HONOURS

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Faculty of Mechanical and Manufacturing Engineering Technology

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A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of mechanical Engineering Technology (Automotive Technology) with Honours

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DECLARATION

I declare that this Choose an item. entitled “Research And Development Of Low-Cost Vibration Monitoring System with Internet Of Things (IoT)” is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

Name : Nik Muhammad Faris Bin Nik Ebrhiam

Date : 9 January 2023

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours.

Signature : 

Supervisor Name : Ts. Dr. Ahmad Fuad Bin Ab Ghani

Date : 9 January 2023

DEDICATION

In Honor of My Father.

To provide an honest livelihood for us, to be a pillar of support, to provide the finest example possible for always doing one's best in one's life, and to inspire and motivate me to go much farther and to always put out maximum effort in everything I do.

The Mother of Me,

A courageous and sincere spirit that constantly encourages me in all I do, is there for me through the highs and lows of life, and never stops showing love and support for me.

My Treasured Brothers and Sisters,

For the Love, Support, and Encouragement They Gave Us While We Grew Up Together Successfully.

To Myself,

I want to thank you for having the confidence to know that you can prevail no matter how challenging the circumstances are and that there will always be a purpose and rewards for the things you do.

ABSTRACT

Vibration analysis in industry is a technique for detecting, predicting, and preventing mechanical failures. The presence of a number of prominent frequencies associated with the motion of various machine components is to be expected when analysing machine frequency vibrations (frequency analysis). Mechanics systems and structures can be damaged, stopped abnormally, or fail catastrophically if they are exposed to high levels of vibrations. To avoid these issues, vibration assessment is an essential countermeasure. A vibration monitoring system is a full system capable of gathering vibration signals according to pre-determined parameters, such as sampling frequency, vibration intensity and recording duration and intervals and frequency breadth. The method that using is component selection for the first step. Then circuit build up to program the microcontroller with coding make. Then setting the OBD interfaces such as blynk application. Then train the data and evaluate data for the project prototype with aid of coding software for microcontroller and sensors. Then, intergrate the system setting toward online monitoring applications to run and get the actual result and data. From this results it can be analysis from the data runing for system test. The main system using in this project are 5 components that is, Hibiscus Sense v1.0 ESP32, Ultrasonic Sensor HC-SR04, MPU6050 Vibration Sensor, Supply voltage and software platform monitoring system. There are 3 system have been created. The single vibration system is using only Hibiscus Sense v1.0 ESP32. This system stand alone to measure and carry out the acceleration 3 axis by MPU6050 inside the ESP32 microcontrollers and the temperature when vibrations occurs during system test. The single vibration with Ultrasonic sensor system includes Hibiscus sense ESP32 with Ultrasonic sensor. This system is to carry out the acceleration of 3 axis with temperature and distance. This double vibration system is to known the sustainability of both 3 axis accelerometer and to make comparison the diffenrence value of this vibration system. This system also can compare the temperature for ESP32 and MPU6050 sensor. The result was taken by using the Blynk applications with supporting guidance of coding motion detection to detection of vibration in several minutes to get the result shown in below figure. the interpreted data show of accelerometer gyroscope with aid of x, y, z axis of both ESP32 or MPU6050 sensor This data show to measure the sensitivity of vibration temperature and distance of some objects. It can be explained how IoT can help the condition monitoring and fault diagnosis of rotating machinery using vibration analysis. Further, vibration sensing has been investigated and the new generation of MEMS accelerometers has been introduced. This way the machine will be able to send its vibration status to the server and the maintenance engineers will be able to monitor it anytime, anywhere. The developed hardware has been evaluated by comparing the results of online and local data measurements at the same time. The results of the evaluation have been proved to be very precise. This paper will prove the concept of using IoT enabled sensors in predictive maintenance to overcome some gaps in the commonly used methods of condition monitoring of rotating machinery. The results can be extended to a larger scope of equipment, faults, and parameters.

ABSTRAK

Analisis getaran dalam industri ialah teknik untuk mengesan, meramal dan mencegah kegagalan mekanikal. Kehadiran beberapa frekuensi menonjol yang dikaitkan dengan gerakan pelbagai komponen mesin adalah dijangka apabila menganalisis getaran frekuensi mesin (analisis frekuensi). Sistem dan struktur mekanik boleh rosak, dihentikan secara tidak normal, atau gagal secara besar-besaran jika terdedah kepada tahap getaran yang tinggi. Untuk mengelakkan isu ini, penilaian getaran adalah langkah balas yang penting. Sistem pemantauan getaran ialah sistem penuh yang mampu mengumpul isyarat getaran mengikut parameter yang telah ditetapkan, seperti kekerapan pensampelan, keamatan getaran dan tempoh rakaman dan selang serta keluasan frekuensi. Kaedah yang digunakan ialah pemilihan komponen untuk langkah pertama. Kemudian bina litar untuk memprogramkan mikropengawal dengan pembuatan pengekodan. Kemudian tetapkan antara muka OBD seperti aplikasi blynk. Kemudian melatih data dan menilai data untuk prototaip projek dengan bantuan perisian pengekodan untuk mikropengawal dan penderia. Kemudian, integrasikan tetapan sistem ke arah aplikasi pemantauan dalam talian untuk dijalankan dan mendapatkan hasil dan data sebenar. Daripada keputusan ini bolehlah analisis daripada data yang dijalankan untuk ujian sistem. Sistem utama yang digunakan dalam projek ini ialah 5 komponen iaitu Hibiscus Sense v1.0 ESP32, Ultrasonic Sensor HC-SR04, MPU6050 Vibration Sensor, Voltan bekalan dan sistem pemantauan platform perisian. Terdapat 3 sistem telah dibuat. Sistem getaran tunggal hanya menggunakan Hibiscus Sense v1.0 ESP32. Sistem ini berdiri sendiri untuk mengukur dan menjalankan pecutan 3 paksi oleh MPU6050 di dalam mikropengawal ESP32 dan suhu apabila getaran berlaku semasa ujian sistem. Getaran tunggal dengan sistem penderia Ultrasonik termasuk deria Hibiscus ESP32 dengan penderia Ultrasonik. Sistem ini adalah untuk menjalankan pecutan 3 paksi dengan suhu dan jarak. Sistem getaran berganda ini adalah untuk mengetahui kemampanan kedua-dua pecutan 3 paksi dan untuk membuat perbandingan nilai perbezaan sistem getaran ini. Sistem ini juga boleh membandingkan suhu untuk penderia ESP32 dan MPU6050. Hasilnya diambil dengan menggunakan aplikasi Blynk dengan panduan sokongan pengesanan gerakan pengekodan untuk pengesanan getaran dalam beberapa minit untuk mendapatkan hasil yang ditunjukkan dalam rajah di bawah. data yang ditafsirkan menunjukkan giroskop pecutan dengan bantuan paksi x, y, z kedua-dua penderia ESP32 atau MPU6050 Data ini menunjukkan untuk mengukur kepekaan suhu getaran dan jarak beberapa objek. Ia boleh dijelaskan bagaimana IoT boleh membantu pemantauan keadaan dan diagnosis kerosakan jentera berputar menggunakan analisis getaran. Selanjutnya, penderiaan getaran telah disiasat dan generasi baharu pecutan MEMS telah diperkenalkan. Dengan cara ini mesin akan dapat menghantar status getarannya kepada pelayan dan jurutera penyelenggaraan akan dapat memantaunya pada bila-bila masa, di mana sahaja. Perkakasan yang dibangunkan telah dinilai dengan membandingkan hasil pengukuran data dalam talian dan tempatan pada masa yang sama. Keputusan penilaian telah terbukti sangat tepat. Makalah ini akan membuktikan konsep penggunaan penderia didayakan IoT dalam penyelenggaraan ramalan untuk mengatasi beberapa jurang dalam kaedah pemantauan keadaan yang biasa digunakan bagi jentera berputar. Hasilnya boleh diperluaskan kepada skop peralatan, kerosakan dan parameter yang lebih besar.

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LIST OF SYMBOLS AND ABBREVIATIONS

D,d	-	Diameter
f	-	frequency
RMS	-	Root Mean Square
CPM	-	Cycle Per Minute
Hz	-	Hertz
IDE	-	integrated development environment
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LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of study

Vibration analysis in industry is a technique for detecting, predicting, and preventing mechanical failures. The presence of a number of prominent frequencies associated with the motion of various machine components is to be expected when analysing machine frequency vibrations (frequency analysis). Mechanics systems and structures can be damaged, stopped abnormally, or fail catastrophically if they are exposed to high levels of vibrations. To avoid these issues, vibration assessment is an essential countermeasure.

Displacement, velocity, and acceleration are the three major metrics used to characterise the vibration characteristics of any dynamic piece of equipment. Mechanical looseness, gear drive problems, defective roller bearings or sleeve bearings are only some of the common causes of vibration in rotating machinery that may be detected by vibration analysis.

When the frequency of data collection does not correspond to the maintenance strategy, the ultimate goal of vibration analysis is to find flaws in rotating equipment and alert employees to the need for corrective action. In order to minimise downtime and improve plant dependability, vibration analysis can be used to detect these faults before they occur.

1.2 Problem Statement

There are several technical applications where vibration is an issue. Mechanical, civil, and aeronautical engineers often deal with a wide range of vibration issues. Vibration is the periodic movement or movement of a component or structure. Occasionally, structural deformation or failure can occur as a result of significant stresses or resonances in a component. The study of vibrations in mechanical, structural, and acoustic systems has therefore become standard practise.

This system works a combination with programming software by microcontroller and vibration sensor with aid of IoT (Internet of Things) to show the data of an object through the computer screen. Due to low cost specific we are able to swiftly screen and take action because of the low cost specificity. Adding condition monitoring technologies to your maintenance programme will provide you with deeper insights and more actionable data, allowing you to make data-driven choices.Other than that, to identify the potential early failure and the most important to reduce cost maintenance

1.3 Objective

When creating a prototype, it is a good idea to set some goals and objectives.The purposes of this project are:

i. To program, monitors the levels and patterns of vibration signals within a component, machinery or structure show data with aid of IoT (Internet of Things).

ii. To test the vibration monitoring system on machine with low cost system method

1.4 Project Scope

The project's scope is as follows:

i. Monitoring the vibration from the laptop screen for the machine

ii. The frequency range that can be detected is 1kHz to 8kHz

iii. Arduino IDE software and Blynk application will be use to program and interprete the data or graph

1.5 Report Outline

The vibration monitoring system final report is divided into five chapters, each of which contains and elaborateson a different topic, such as the Introduction, Literature Review, Results and Analysis, and Conclusion. The following is a full description of the thesis outline for each chapter:

Chapter 1: The project's introduction. The project's clarification will be given in generalterms. The project objectives will be described in detail. It is supported by an explanation of the project's scope.

Chapter 2: A literature review was conducted in preparation as the vital element during the implementation of a vibration sensor device. This chapter goes into the project's literature review in detail. This entire part will be based on theory and conceptual ideas that will focus on the previous model of sensor that hasbeen studied.

Chapter 3: The methodology for the project. This chapter discusses the overall planning to this project, as well as the component and circuitry development.

Chapter 4: The outcome and the analysis. This chapter discusses the vibrating monitoring system's performance and the results received.

Chapter 5: Conclusion and Discussion. Costing and commercialization, as well as potential recommendations, were addressed in this chapter. Lastly, the project's conclusion also is being discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Throughout the project, a literature review was conducted to acquire information and develop skills required to complete the project. This project's primary sources include previous related efforts, research theses, books, journals, and articles. This chapter will focus on the vital concepts and theories that are essential to this project scope.

2.2 Vibrations

Some vibrations are beyond our comprehension. As a result, several novel technologies for monitoring and analyzing it have emerged. So, what precisely is vibration? It refers to the movement of a machine or its components from one location to another. This vibration may be created for a specific purpose in some circumstances, while in others, it may cause damage to the machine. As a result of the vibrations, money and time are lost. Here, we're largely concerned with unintentional machine vibrations. Machine lifespan is inversely related to vibration. Low vibratory forces indicate low vibration levels, which leads to extended machine life. Machine vibration increases when the dynamic forces created by the machine get more intense or the physical integrity of the machine is damaged, depending on the state of a machine's performance at the time. Exciting force, mass of vibrating system, rigidity of vibrating system, and damping qualities are all factors in determining vibration characteristics. The first component causes vibration, whereas the other three factors are designed to lessen or avoid it.(Kv 2015)

2.2.1 Causes of vibrations

A. Repeating forces

It's the frequency with which a pattern is repeated that determines its intensity. When a machine is subjected to a constant force, it will vibrate. Recurring strains are caused by malfunctioning, damaged, or misplaced machine components. 30 percent of the problem is due to imbalance; 20 percent is due to misalignment; ten percent is due to resonance; and the remaining 40 percent is due to other problems. Errors in machining, material density variations, and other factors may all contribute to unevenness. As a result of mismatched pieces and bending moments, repetitive stresses are formed. Misalignment may be caused by a variety of factors, including faulty assembly, thermal expansion, and more.. (Kv 2015)

B. Looseness

Vibration may result from loose machine components. Because of loose components, there may be a lot of vibration. Non-rotating and rotating equipment may produce vibrations. The looseness is caused by loose bolts, uneven components, and other issues.. (Kv 2015)

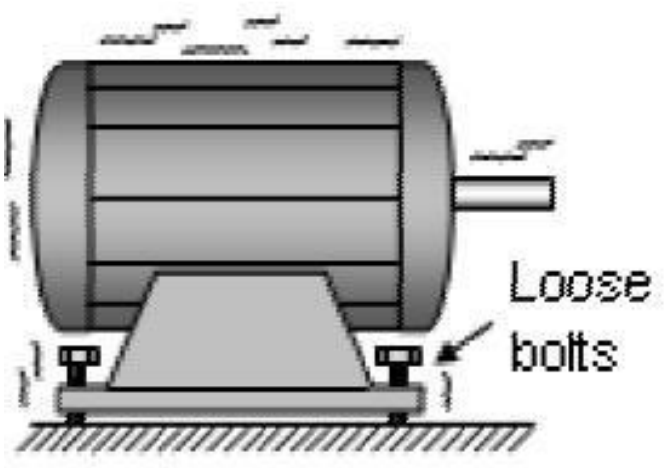

Figure 2.1 looseness of bolt when vibration occur

C. Resonance

When an external force is added to a machine's inherent oscillation rate, extra vibrations are generated. Adding these alien vibrations together creates the resonance. The frequency of natural oscillations increases as the complexity of the machine increases. Avoid the resonance at all costs since it has the potential to be quite harmful. Soldiers marching in lockstep over a bridge have caused it to collapse on many occasions.(Kv 2015)

2.2.2 Describing and observation of vibrations

Amplitude and frequency are two crucial numerical qualities. Machines with bigger amplitudes are more vulnerable to vibrations since amplitude defines the intensity of the vibration. Representation of overall vibration data in rms is a common practice. It is possible to quantify the vibration's energy using the root mean square amplitude (rms amplitude). The root mean square amplitude of the vibrational energy is inversely proportional to this energy. RMS value should never be larger than maximum peak intensity. To gauge the entire noise level, the above-mentioned function comes in handy.

It provides a good sense of the system's imbalance. The rate at which a machine component oscillates is known as its vibration frequency or oscillation. The frequency of vibration is used to characterize the pace at which it oscillates. The quicker the machine oscillates, the greater the vibration frequency. Cycles per second (cps), cycles per minute (cpm), and Hertz (Hz) are all ways to represent frequency (Hz).

1 Hz equals 1 cps equals 60 cpm.