DEVELOPMENT OF IOT-ENABLED REAL TIME MACHINE STATUS MONITORING APPROACH FOR CLOUD MANUFACTURING

MUHAMMAD FIZWAN HAKIMI BIN MOHAMED ISA
B091910464

BACHELOR OF MANUFACTURING ENGINEERING TECHNOLOGY (BMMW) WITH HONOURS

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Faculty of Mechanical and Manufacturing Engineering Technology

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MUHAMMAD FIZWAN HAKIMI BIN MOHAMED ISA

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DECLARATION

I declare that this thesis entitled " Development of IoT-Enabled Real-Time Machine Status Monitoring Approach For Cloud Manufacturing " is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : *Muhammad Fizwan Hakimi Bin Mohamed Isa*

Date : 11/01/2023

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 Manufacturing Engineering Technology (BMMW) with Honours.

Signature	:	....
Supervisor Name	:	*Ts Hassan Bin Attan*
Date	:	11/01/2023

DEDICATION

To my beloved parents, Ayah and Ibu, who always constantly support, love, encouragement, and prayers at all hours of the day and night and motivate me with words and encouragement, I dedicate this project to you.

Those who have lent a helping hand, such as my colleagues, thank you because you guys have been my best cheerleaders.

To my supervisor, a special thanks to you for always guide me and encourage me to complete my final year project.

ABSTRACT

Monitoring machine condition is critical. Machinery in this modern business must become more adaptable and autonomous. Machine must operate without failure in order to boost production, improve quality, and minimize costs. When a machine fails, it is critical to determine the causes as soon as feasible. Despite these rapid advances, developments in machine maintenance strategy and procedures have lagged behind the overall pattern of progress. This is cause for severe concern, as current maintenance procedures may be unable to meet growing demands. Machinery in the modern automated production process must become more versatile and flexible. A designed smart lathe machine approach to the classic lathe machine has been developed to overcome this issue. It employs sensors that are controlled by the microcontroller NodeMCU ESP8266 which that being processed then transfer to the cloud platform. As a result, transitioning from manual to smart lathe machines can dramatically enhance efficiency while simultaneously reducing investment costs, providing a much-needed boost to the manufacturing industry. Internet of Things (IoT) has attracted a lot of attention these recent years from both research and industrials. This project is a study of an Internet of Things (IoT) enabled real-time machine status monitoring platform. IoT technologies such as wireless communications are used for capturing real-time machines statuses. From that, data models that being processed is then appeared on the graphical dashboard over smart phones. To illustrate, a practically systems is proposed. Firstly, in this project, smart devices are deployed to capture machine data. Afterwards, by using designed cloud platforms services for making full use of the captured data to aid end-user. The way of the data is being processed is by captured data sensors that sent through the cloud which the interfaces displayed the processed data that is being done from the physical pins to virtual pins are connected simultaneously between both transitions.

ABSTRAK

Memantau keadaan mesin adalah kritikal. Jentera dalam perniagaan moden ini mesti menjadi lebih mudah disesuaikan dan berautonomi. Mesin mesti beroperasi tanpa kegagalan untuk meningkatkan pengeluaran, meningkatkan kualiti dan meminimumkan kos. Apabila mesin gagal, adalah penting untuk menentukan punca secepat mungkin. Walaupun kemajuan pesat ini, perkembangan dalam strategi dan prosedur penyelenggaraan mesin telah ketinggalan di belakang corak kemajuan keseluruhan. Ini menimbulkan kebimbangan yang teruk, kerana prosedur penyelenggaraan semasa mungkin tidak dapat memenuhi permintaan yang semakin meningkat. Jentera dalam proses pengeluaran automatik moden mesti menjadi lebih serba boleh dan fleksibel. Pendekatan mesin pelarik pintar yang direka bentuk kepada mesin pelarik klasik telah dibangunkan untuk mengatasi isu ini. Ia menggunakan penderia yang dikawal oleh mikropengawal NodeMCU ESP8266 yang sedang diproses kemudian dipindahkan ke platform awan. Akibatnya, peralihan daripada mesin pelarik manual kepada pintar boleh meningkatkan kecekapan secara mendadak sambil mengurangkan kos pelaburan secara serentak, memberikan rangsangan yang amat diperlukan kepada industri pembuatan. Internet Perkara (IoT) telah menarik banyak perhatian beberapa tahun kebelakangan ini daripada kedua-dua penyelidikan dan perindustrian. Projek ini adalah kajian tentang platform pemantauan status mesin masa nyata yang didayakan Internet of Things (IoT). Teknologi IoT seperti komunikasi tanpa wayar digunakan untuk menangkap status mesin masa nyata. Daripada itu, model data yang sedang diproses kemudiannya dipaparkan pada papan pemuka grafik melalui telefon pintar. Untuk menggambarkan, sistem praktikal dicadangkan. Pertama, dalam projek ini, peranti pintar digunakan untuk menangkap data mesin. Selepas itu, dengan menggunakan perkhidmatan platform awan yang direka bentuk untuk menggunakan sepenuhnya data yang ditangkap untuk membantu pengguna akhir. Cara data diproses adalah dengan penderia data yang ditangkap yang dihantar melalui awan yang mana antara muka memaparkan data yang diproses yang sedang dilakukan daripada pin fizikal ke pin maya disambungkan serentak antara kedua-dua peralihan.

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LIST OF SYMBOLS AND ABBREVIATIONS

CMfg	-	Cloud Manufacturing
CC	-	Cloud Computing
SP	-	Service Platform
CAD	-	Computer Aided Design
M2M	-	machine-to-machine
IP	-	Internet Protocol
MM	-	Machine Monitoring
PLC	-	Programmable Logic Controller
CNC	-	Computer Numerical Control
AI	-	Artificial Intelligent
RUL	-	Personal Computer
KB	-	KiloByte
MB	-	MegaByte
Hz	-	Hertz
RPM	-	Revolution per minute
Volt	-	Voltage

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

The expansion of Internet of Things (IoT) technology has been particularly beneficial to the industrial manufacturing business. IoT network administration enables authentication, provisioning, configuration, monitoring, routing, and device software maintenance. In an IoT scenario, these capabilities allow high network performance and are often provided as a network service. This refers to a network of linked devices that exchange data.

Machine monitoring is any way of connecting equipment data streams to the internet to offer real-time production monitoring and sophisticated production data analytics, a system that entails installing internet-enabled sensors on each manufacturing machine. The data acquired by these sensors on the machine is then shown on a mobile device application.

This helps individuals to take control and make better decisions to improve overall efficiency. Furthermore, by utilizing a machine monitoring system, they can monitor minor and big concerns such as component failure or downtime and inform the owner via mobile to perform necessary adjustments. Machine monitoring allows to track work-in-progress throughout the value chain. From the dashboards it can detect the vibration of electric motor and the speed of spindle. With the information provided from the data, they make better plan work of maintenance and can ensure that successfully repair before it become worse. Thus, the goal of this project monitoring system is to display data status on the web dashboard and mobile device application using Blynk. Thereafter, individuals can make a proper decision with the maintenance.

1.2 Problem Statement

As an individual user of a conventional lathe machine, it is important to regularly maintain the machine to ensure that it is operating at optimal efficiency and to reduce the risk of unexpected breakdowns. One aspect of maintenance is the analysis of vibrations in the machine, particularly in the electric motor.

The problem that are addressing is the difficulty in monitoring the health condition of lathe machines where no computer is used. Without computer monitoring, individuals find it hard to know if several problems may occur, and productivity can be interrupted. This is a major concern for manufacturers, as unplanned downtime due to machine breakdowns can lead to delays in production and increased costs. Additionally, without computer monitoring, it can be difficult to detect potential issues before they become critical, which can lead to more extensive repairs and increased maintenance costs.

The lack of computer monitoring also makes it difficult to analyze the performance of the machine, which can make it difficult to identify areas for improvement. As a result, the machine may not be used to its full potential, and productivity may suffer. Additionally, without computer monitoring, it can be difficult to identify patterns in the machine's behavior, which can make it difficult to predict when maintenance is needed. This can lead to over-maintenance or under-maintenance, both of which can have a negative impact on the machine's lifespan and productivity.

Thus, without computer monitoring, it can be difficult to track the machine's performance over time, which can make it difficult to identify trends and patterns. This can make it difficult to detect any decline in the machine's performance, which can lead to unexpected downtime and increased costs. Even minor flaws might result in increased losses, such as decreased efficiency. Although small symptoms may occur, machine faults result in poorer efficiency, higher energy consumption, and long-term degeneration.

1.3 Research Objective

The main aim of this research is to use the concept of Internet of Things (IoT) in machine monitoring status visualized though applications. Specifically, the objectives are as follows:

a) To deploy IoT concept to capture machine data

b) To upgrade conventional lathe machine into smart lathe machine with the application of IoT

c) To propose a visualized of machine data through application

1.4 Scope of Research

Main scope of this project was to create an IoT based real-time monitoring system using cloud platform. This project focus more on how to establish an IoT to a conventional lathe machine to make a smart machine. The piezoelectric sensor works as measure the signal vibration coming from conventional lathe machine's electric motor. While infrared sensor is to measure the speed of lathe machine spindle. At the end of this project, student need to develop an Internet of Things (IoT) by constructing the hardware that monitor through the cloud platform. As summary, the scope of the project focuses on the hardware such as microcontroller board, sensors, Arduino Software, and cloud platform.

1.5 Significance of Study

This project will demonstrate concepts of monitoring real-time IoT-based of data collection by deploying at conventional lathe machine. This demonstration leads to the detection of fault bearing in the engine motor from the conventional lathe machine, like this case sensors are deployed and the signal from sensors is passed to cloud which can be accessed anywhere using smart phones with internet connection.

1.6 Thesis Arrangement

First chapter of this report introduced background, pointed out the problem statement, listed out the objectives, stated the scope and discussed about the significance of this study.

Second chapter of this report discussed about the structure on building on an IoT, as the first layer is perception layer, second layer is sensors, third layer is connectivity, and fourth layer is application layer. Next, the study of IoT in industrial 4.0 which is discussed about the cloud manufacturing and industry 4.0. Furthermore, a vibration analysis finding to monitor the fault of electric motor. Lastly, an overview of past research of the implementation of IoT on machine.

Third chapter of this report is about the overall project planning, a flow chart has been drawn and pin diagram input/output to visualize it. Then, overview of this study also was plotted in flow chart to visualize it. Lastly but not least, research methodology had been discussed in orderly manner about every step in the overview of study.

Fourth chapter of this report is discussed about the proposal of a new framework to show the function of IoT that deployed on conventional lathe machine. An analysis discussion data that have been shown on the Blynk platform. Lastly, the discussion about the implementation on IoT on conventional lathe machine which turns it into smart machine has been done.

Fifth chapter of this report discussed about the conclusion of this study. Some recommendation also been done for further improvement.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Communication in these past years, has taken place wirelessly to a remote information analytics centre in the event of a risk situation, to assess and interpret process behavior and make the proper decision. Internet of Things (IoT) has created a promising opportunity for the development of harnessing the rising ubiquity of radio-frequency identification (RFID), wireless, mobile, and sensor devices to create powerful industrial systems and applications. To this day and for many years to come, a wide range of industrial IoT applications have been developed and deployed. Currently, Industrial Revolution 4.0 is underway, and it includes a slew of recent technologies such as, IoT, AI, Big Data and data exchanges. Design principles, challenges, and impact of Industry 4.0 are then discussed. A few of the principals involved in designing information transparency, decentralized decision making, and technical assistance are hallmarks of Industry 4.0. A few types of manufacturing are listed, and the difference is explained. Then, approach, method and advantages of digital manufacturing are studied.

2.2 Internet of Things

The notion of the Internet of Things (IoT) discloses the concept of integrating all digital and electronic equipment into the information world, which is advocated for increasing human life quality and exploring applications that go beyond traditional conceptions. The objective is for numerous devices to communicate seamlessly and constantly in order to provide correct identification and timing for each object (Chen et al., 2022).

In this modern era, the Internet has changed industry and personal life, and it continues to do so. (Al-Saedi et al., 2017) proposed that the Internet of Things (IoT) provides the ability to integrate sensors and things by using the internet as a communication medium, giving developers a broad range of applications. According to (Aboubakar et al., 2021), the Internet of Things intent to make our daily lives more pleasant, connected, and productive.

The Internet of Things (IoT) on upcoming years, virtual computing entities, and involves environmental sensing, network communication, and data analysis methodologies and methodologies context-awareness bridges the interconnection between the physical world (Liu et al., 2020). (Chernick, 2001) describes smart energy systems, smart buildings, intelligent healthcare systems, and smart transport unified IoT networks architecture includes smart IoT-based applications services which the underlying IoT sensors networks that enables the advancement IoT applications.

The application of Internet of Things (IoT) technologies in manufacturing brings to Industrial Internet of Things (IIoT). (Alexakos et al., 2018) proposed a new method for the implementation of IoT devices in the industrial process. The proposed framework can efficiently collect data from the machine. When an anomaly is found, manufacturing automation is used to address the problem. (Chang & Martin, 2021) has shown that data collected from gadgets can be valuable for interested parties in making crucial decisions.

There are four critical levels in every IoT ecosystem or environment. The first layer consists of the employment of numerous sensors and actuators to perceive data or information in order to accomplish various functions. Based on this, the second layer a communication network is utilised in the second layer to relay the acquired data. The third layer, known as a middleware layer, is used by the majority of growing IoT applications to operate as a bridge between the network and application layers. Finally, on the fourth layer, there are numerous end-to-end IoT-based applications such as smart grids, smart transportation, smart industries, and so on. All four levels are connected by numerous gateways, which aid in data transfer (Chamola et al., 2019) To sum up below are the four layers in IoT ecosystem:

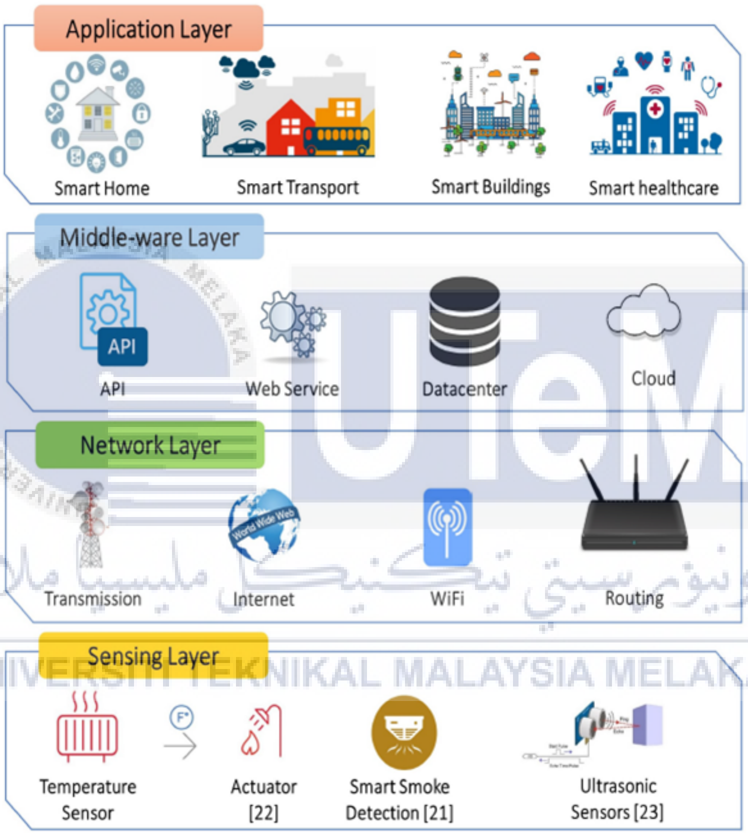

Figure 2.1 Layers in IoT system (Threats, 2019).

2.2.1 Perception Layer (smart things)

The perception layer comprises of physical objects that are monitored/controlled by sensors and actuators devices, with the primary goal being sensor data collecting and command actuation.

2.2.1.1 Sensors

According to (SCME, 2014), a sensor is a device that receives and reacts to a signal. They capture physical factors such as temperature or humidity, convert them to electrical impulses, and transmit them to the IoT system. IoT sensors are often compact and power efficient. Table 2.2.1 and Figure 2.2.1 shows (Renuga Devi et al., 2022) listed some IoT sensors that are use industrial:

Table 2.1 Sensors list and it's applications

Sensors	Applications
Accelerometer sensor	An accelerometer sensor is a device that measures the acceleration of a body or object in its instantaneous rest frame, or the rate at which the item's velocity changes over time. Accelerometer sensors are found in a variety of electrical products, smartphones, and wearable devices, etc.
Vibration sensor	A vibration sensor is a device that detects the magnitude and frequency of vibration in a system, machine, or piece of machinery. These metrics can be used to spot asset imbalances or other problems, as well as predict future failures.
Temperature sensor	Temperature sensors detect temperature changes and translate them to data by measuring the quantity of heat energy present in a source.
Infrared sensor	Infrared sensors measure the amount of heat emitted by things. Infrared sensors are employed in a range of IoT projects, including healthcare.
Pressure sensor	Pressure sensor changes in gases and liquids are detected by a pressure sensor. The sensor monitors changes in pressure and conveys them to connected systems when they occur.
Voltage sensor	A voltage sensor is a sensor that determines and keeps track of an object's voltage level. Voltage sensors can identify the level of either AC or DC voltage. This sensor receives voltage as its input, and it outputs switches, analogue voltage signals, current signals, or aural signals.