INVESTIGATION OF CURRENT MONITORING SYSTEM FOR WATER PUMP

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION OF CURRENT MONITORING SYSTEM FOR WATER PUMP

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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I declare that this report entitled "Investigation of Current Monitoring System For Water Pump" is the result of my own work except for quotes as cited in the references.

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Signature   :   ………………………………….

Supervisor Name   :   …Encik Mazran bin Esro………

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DEDICATION

For my family and friends.

ABSTRACT

Centrifugal pumps are commonly used to transports fluids by converting the fluid flow energy from rotational kinetic energy to hydrodynamic energy[1]. When the driving motor of centrifugal pump draws excess current which exceed the normal power consumption, it is considered as overloaded. These overloaded pumps will negatively affect pump operation and pump life expectancy. This project has two objectives to be achieved which are to design and construct the current sensing circuit and to develop an IoT based current monitoring system. A current sensing circuit is built by using hall effect current sensor connecting to a microcontroller which enable user to monitor the current consumption of the pump. For second objective, current measurement of the centrifugal pump will be displayed on mobile application and warning notification will be sent to user once the pump is overload. The desired result is obtained when the user can monitor the current consumption through phone application and is prepared to handle an overload pump before serious problem such as pump failure occur.

ABSTRAK

Pam empar digunakan untuk mengangkut cecair dengan menukarkan tenaga aliran bendalir dari tenaga kinetik putaran kepada tenaga hidrodinamik. Apabila motor pemacu pam empar menarik lebihan arus yang melebihi penggunaan kuasa biasa, ia dianggap sebagai beban kepada operasi pam. Pam yang beroperasi melebihi beban yang boleh ditanggung akan mempengaruhi operasi dan memendekkan jangka hayat pam. Projek ini mempunyai dua matlamat iaitu merekabentuk dan membina litar sensor arus pam emparan dan membina sistem pemantauan sensor berasaskan IoT. Litar sensor arus dibina dengan menggunakan sensor berasaskan konsep 'hall effect' dan menyambungkan kepada pengawal mikro yang membolehkan pengguna memantau penggunaan arus pam. Untuk tujuan kedua, pengukuran arus pam emparan akan dipaparkan pada aplikasi mudah alih dan notifikasi amaran dikeluarkan kepada pengguna sebaik sahaja pam itu melebihi beban. Hasil yang diinginkan tercapai apabila pengguna dapat memantau penggunaan arus semasa melalui aplikasi telefon dan bersiap sedia untuk mengendalikan pam beban sebelum masalah serius seperti kegagalan pam terjadi.

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LIST OF SYMBOLS AND ABBREVIATIONS

DC   :   Direct Current

AC   :   Alternating Current

USB   :   Universal Serial Bus

IoT   :   Internet of Things

IDE   :   Integrated Development Environment

PCB   :   Printed Circuit Board

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CHAPTER 1

INTRODUCTION

This project is about the development of IoT based current monitoring system of water pump. The current values collected will be displayed in a mobile phone application. The current usage data from centrifugal pump can be used as predictive maintenance tool for detecting common faults at early stage. This can prevent the production outages and maintain the lifetime of the motor used. IoT based monitoring system brings great advantages in monitoring the operation of the pump through mobile phone application where it represents the pump status through the collected data.

1.1   Background of Project

The usage of Centrifugal pump is commonly used in many applications to support the fast-growing rate of urbanization and industrialization. It is widely used in water desalination and treatment plant, mining industry, petrochemical plants and more due to the high efficiency, easy to operate and require less maintenance. To maintain the pump performance, the current driven by the pump must be monitored. Precisely, there are plenty faults can be linked with overloaded centrifugal pump which means that the centrifugal pump draws excess current that exceed the power consumption a pump can bear such as high liquid viscosity, high liquid flow, worn or damaged bearings, bent shaft and more. Research shows that the current supply could be measured in four techniques based upon the physical principle which are Ohm's law of resistance, Faraday's law of induction, Magnetic field sensors and Faraday effect. There are various types of current sensors based upon these four principles available in the market that can be applied in several applications for current sensing, for instance monitoring and power management.

The implementation of Internet of Things (IoT) in current sensing technologies brings great benefits in improving the sensing quality of manufacturing industry. The Internet of Things provide a greater control, monitoring and sensing over regular domestic conditions where it interconnect user with a great number of physical devices such as smartphones, sensors, buildings while connecting to the internet. This project could ease the monitoring of water pump operation.

1.2   Problem Statement

In water treatment plant, centrifugal pumps are used to transport the fluid through the system. The pump will get overloaded when the driving motor of centrifugal pump draws current exceeding the normal consumption. An overloaded pump could be cause by oversized impeller installed, worn or damaged bearings and bent shaft. According to an engineer who worked at Syarikat Air Melaka Berhad, the overloading of pumps will negatively affect the operation and soon will affect the life expectancy of the pumps as shown in Figure 1.1. Centrifugal pump will draw in higher ampere due to a few reasons such as the high speed operation, impeller imbalance, driver alignment [1]. Overloaded pump will cause damages to the shaft where it leads to breakage and fatigue cracking. These damages are due to the reversal stresses produced in each revolution the shaft made where they have been operated beyond the rated design limits for load. If centrifugal pumps that can withstand high pressure and velocity fail to operate normally, it will affect the distribution of water supply to other related treatment plant. This problem could be avoided if operator is assigned to monitor the current usage of the centrifugal pump. In order to ease the monitoring process, IoT will be implemented and from the current data collected, operator could take action to prevent a more serious damage of the centrifugal pump.

Figure 1.1 Site visit at the pump station

1.3   Objective

- To design and construct the current sensing circuit

- To develop an IoT based current monitoring system

The first objective is to design and construct the current sensing circuit. This objective is about the development circuit to sense the current passes through the water pump. In this project the water pump is built with wire wound resistors as a representation of a small scale pump. The second objective to develop an IoT based current sensing circuit. This objective includes the implementation of IoT technology on the current sensing circuit to complete the project.

1.4   Scope of Project

This project focus on building a sensing and monitoring of the current of centrifugal pumping system. The analysis of the performance of the current sensor will be included in the project. The current data will be collected and from this the accuracy can be analyzed throughout the project. At the early stage, there will be a circuit drawn using Multisim as a guide before connecting the circuit. This circuit is used to combine electrically the current sensor to the microcontroller and let user to monitor the current measured by IoT based application. For this project, the microcontroller part, one unit of NodeMCU together with software such as integrated development environment (IDE) are involved. IDE brings many development-related tools together as a single framework, application or service. IDE also contains features such as programmable editors, object and data modeling, unit testing, a source code library and build automation tools. Furthermore, the current sensing part of the project will be using an invasive current sensor that uses the principle of magnetic field to measure the reading of current connecting to wires in power cords, ensuring a more accurate measurement process. After sensing the current, the microcontroller will read the current

measurement and sent to user for monitoring with mobile application with NodeMCU. The limitation of this project is to recreate the real-life pumping system of treatment plant as the component and parts is too expensive and involve high voltage and current.

1.5   Thesis Plan

This thesis is organized into five chapters to cover the research work that is related to the investigation on current monitoring system for water pump. The outlines of the thesis are described as follows. Chapter 2 presents the literature review of the investigation of current monitoring system and implement the system with IoT technology. These researches are separated into three categories which are background, theory and related work similar with the current measurement techniques and the analysis that have been done by other researches. Besides that, the diverse of method used to complete the project by other researchers will be discussed in order to make a comparison among the research chosen. Furthermore, chapter 3 is the methodology which concludes the research methodology of the whole project. The method used to complete each stage of the project are explained in detail throughout chapter three to have a more systematic and efficient design process. Flow chart and block diagram of the process in developing this system will be included and explained. Moreover, chapter 4 is results and discussion which will display the outcome of the project where it includes the current sensing of the water pump small scale model and the implementation of the IoT technology in the system. The testing on the current sensing circuit will be done. The obtained results is evaluated and discussed in this chapter. The last chapter is conclusion and future work which is the last chapter and it contains the summary and conclusion of the project. Other than this, future

improvement that can be done on this system is suggested, other related research will

be provided for future research. The objectives of this research are justified once again.

CHAPTER 2

BACKGROUND STUDY

This chapter will discuss about the existence of types current measurement technique and IoT related monitoring projects. Furthermore, this chapter will also include related researches done by others on current measurement technique and IoT based monitoring project. Other than this, the specification of current measurement discussed.

2.1   Project Background

A pump is a device commonly used to compress, raise or transfer fluid according to the types of the pump and requirement of different industries such as agriculture, municipal (wastewater plants), power generation plants and more. This project will be focusing on centrifugal pump which operates by applying a force known as centrifugal force to fluids with the help of the impellers. Centrifugal pumps are distinctive and