Fidelity : Jurnal Teknik Elektro
Vol. 2, No. 2, Mei 2020, page 30-33 p-ISSN: 2686-3650
e-ISSN: 2686-3642

Design and Implementation of an IoT-Based Electric Motor Vibration and Temperature Disruption Handling System

Aryo De Wibowo Muhammad Sidik
Electrical Engineering
Nusa Putra University
Sukabumi, Indonesia
aryo.dewibowo@nusaputra.ac.id

Ilman Himawan Kusumah
Electrical Engineering
Nusa Putra University
Sukabumi, Indonesia
Ilman.himawan@nusaputra.ac.id

Anang Suryana
Electrical Engineering
Nusa Putra University
Sukabumi, Indonesia
anang.suryana@nusaputra.ac.id

Edwinanto
Electrical Engineering
Nusa Putra University
Sukabumi, Indonesia
edwinanto@nusaputra.ac.id

Marina Artiyasa
Electrical Engineering
Nusa Putra University
Sukabumi, Indonesia
marina@nusaputra.ac.id

Anggy Pradiftha Junfithrana
Electrical Engineering
Nusa Putra University
Sukabumi, Indonesia
anggy.pradiftha@nusaputra.ac.id

***Abstract*—Faults in three-phase electric motors often occur in power plants. Unfortunately, the disturbances are unpredictable and reduce unit performance. This paper presents an Internet of Things (IoT) based intrusion handling system for secure and economic data communication in industrial fields. The build system can monitor and control with FLM (First Line Maintenance). FLM is a minor corrective maintenance activity carried out while the unit is operating with the provision of simple equipment. Device design and testing using the ESP8266 microcontroller module to obtain motor vibration, current, and temperature information for motor conditions supported by the application as a user interface. The result prevents further damage to the electric motor by adding an external fan and a grease pump that serves for additional engine cooling. This research contributes to improving the performance of the generator at PT. Indonesia Power UJP West Java II Palabuhanratu is one of the steam power plants in West Java, Indonesia.**

Kata Kunci—Electric Motor, Interference, IoT

I. Introduction

Three-phase electric motors are the most widely used motor in industry and power generation. The motor converts electrical energy into mechanical energy as a driving force. The electric motor commonly used in power generation is the three-phase induction motor. Considerations for using a three-phase induction motor have a simple construction to be easy to maintain, and the motor rotation is relatively constant with changes in load, low cost, high reliability, and has a significant power factor.

The performance of a three-phase motor depends on the engine's electrical, mechanical, and environmental parameters mentioned above. Therefore the control method for a high-performance three-phase motor is susceptible to the motor parameters. The traction motor drive system is an essential and critical component for electric vehicles. Traction motors must be efficient and reliable as they are required to provide speed and torque over a wide operating range while safely maintaining precise control of the motor drive. Better reliability and effective operation with an early warning with instant notification to prevent traction motor abnormality are desirable. Motor vibration, current, and temperature are practically three parameters well studied and widely accepted in detecting motor failure due to electrical and mechanical faults. Efforts are being made to maximize efficiency using Enterprise Resource Planning (ERP), especially in 7/24 production.

However, unexpected failures that are not predicted by the ERP system can cause disruptions in the production process. This study reads the temperature, current, voltage, cycle, speed, frequency, torque, and flux data of single and three-phase induction motors using TCP/IP protocol over Wi-Fi.

As an emerging technology in modern wireless telecommunications, the Internet of Things (IoT) has received much attention and is expected to bring benefits to many applications. The concept of the "Internet of Things" (IoT) provides the best way for Industrial automation through remote access. In IoT, every device or device that makes up a system will be able to communicate with other devices. Hence it leads to the exchange of relevant data, statistics, logs, and various additional parameter information between multiple devices to improve their performance, which will help the industry to have better productivity, management, and output improvement.

The actual location for the maintenance of the power plant cannot be reached due to the size of the plant and the limited equipment that is not on standby which makes it difficult for operators and technicians to control the performance of the motor. Hence the failure of the engine can no longer be denied. This system is intended to facilitate monitoring, control, and FLM on motor performance to keep it reliable.

II. Related Research

Many studies are correlated with this paper. The main focus on controlling and monitoring the motor using Raspberry pi as the main CPU center has been carried out [1]. Other research also builds a system for monitoring with heat and thermal sensors, which aims to determine the feasibility of the motor [2] and a vibration sensor as a control medium connected to Linux [3].

The industrial wireless sensor network that transmits motor current and vibration is applied wirelessly, and its behavior at different loads is checked and also shows the motor condition by considering and calculating the temperature and vibration data [4] and amplified by monitoring the temperature on the motor rotor and stator [5].

An IoT-based monitoring system compares temperature, current, and vibration with normal and abnormal motors. [6] In the electric motor working system, very accurate protection is needed to avoid damage to the engine when the engine is subjected to high vibration. It can diagnose motor damage by looking at the vibration measurement spectrum, which helps take appropriate corrective action [7]] when the motor is experiencing high temperatures in the bearings, and windings can also be caused by choosing the wrong fan. It requires a fan that matches the type of motor so that cooling can be optimal [8]. With this fan, our goal is to make the paper the first action in dealing with if there is excessive heat and vibration. To detect motor faults, evaluations are carried out under no-load and full-charge conditions, and real-time motor currents and voltages are checked. [9].

Electrical devices are monitored via the wireless ZigBee network. Motor parameters include current, voltage, and torque. [10]. The condition of the motor is explored both mechanically and electrically. This study shows that readings obtained by monitoring motor parameters can reveal information about the engine. [11].

III. Methodology

The proposed system consists of a Wi-Fi-enabled microcontroller, temperature sensor, vibration sensor, humidity sensor, infrared sensor, current and voltage measurement circuit, and a three-phase motor. The system can monitor and control the engine via a web page or Android application using IoT. The system components and schematics are shown in Figure 1.

Figure 1. Components on The System Proposed

The temperature and vibration sensors in the motor provide an analog signal to the ESP 8266, which will provide information regarding the temperature and vibration of the engine. For the safety scheme, the motor is added to the external fan because the cooling of the motor bearings for temperature monitoring does not exceed 85°C, and the motor winding does not exceed 105°C. In addition, pump grease serves as motor lubrication to indicate abnormal noise in competing motors. If the engine is at a specific temperature, it will inform the mobile app via WIFI; hence the user can immediately monitor it and control the fan cooling to turn on or off, and the grease pump is added if the temperature and lubrication are not optimal.

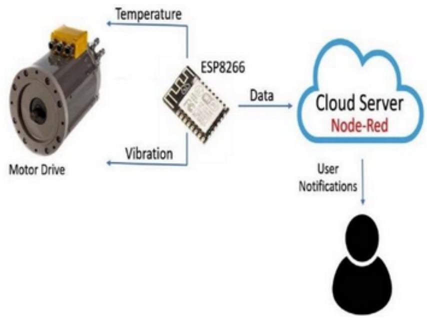

Figure 2. Monitoring Scheme using ESP8266 to Wifi Network

The three-axis accelerometer (ADXL345) is used to measure the vibration while the current sensor (ACS712) is used to measure the current sensor, and the temperature sensor (DS18B20) is used to measure the temperature of the motor housing or in the bearing area. All three sensors are connected to the ESP8266 IoT Wi-Fi chip powered by a small Lithium-ion battery in the system diagram illustrated in Fig. 3. The ESP8266 is a single-chip device with built-in 4MB flash memory capable of connecting to the internet via the built-in Wi-Fi module (IEEE 802.11 b/g/n). The chip is small, low cost, low power, and capable of establishing TCP/IP connections using simple Hayesstyle commands, making it perfect for battery-powered wireless applications. In addition, 16 general-purpose input/output (GPIO) pins are available on the board, which is more than adequate for our application.

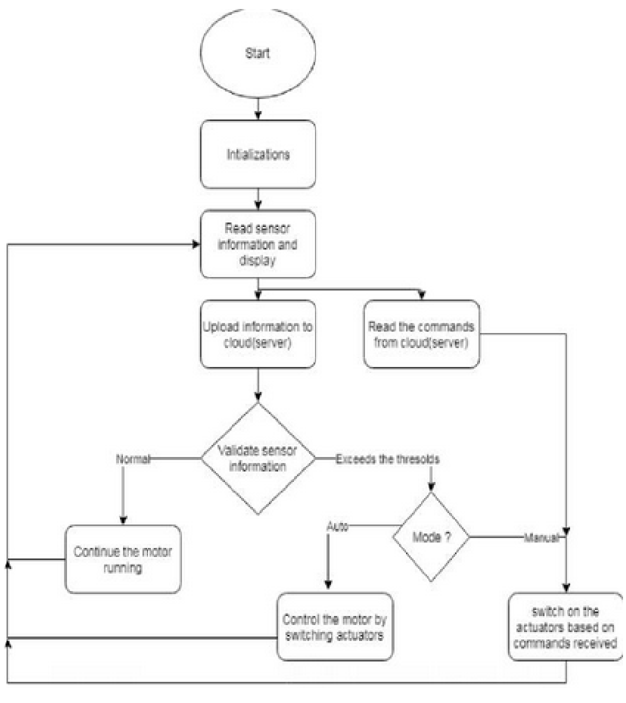

Figure 3. Flowchart of System

The proposed system receives data from sensor nodes via the internet and then collects, manages, and analyzes the data into profiles in a cloud database. This profile is then compared with a pre-existing standard operating profile. Any motor abnormality detection is then flagged and sent to the operator notification module, which has excellent flexibility due to the many community modules available.

IV. Results and Discussion

The 3-phase motor is monitored using the MCU or ESP6288 node and several sensors to obtain temperature or vibration parameter data viewed via mobile phones. The result is to prevent further damage to the electric motor by adding an external fan and a grease pump that serves for additional engine cooling. The build system can improve motor drive performance in the generator and minimize damage or tripping of the electric motor. This system is being tested at PT. Indonesia Power UJP West Java II Palafruitratu is one of the steam power plants in West Java, Indonesia. The following data shows that the measurement results for 30 days show several measurement points on the electric motor.

A. Temperature Measurement Results

Days	Temperature	Vibration	Indicator	Control
1	40 °C	0,3 mm/s	Green	Off
2	40 °C	0,3 mm/s	Green	Off
3	40 °C	0,3 mm/s	Green	Off
4	40 °C	0,3 mm/s	Green	Off
5	40 °C	0,4 mm/s	Green	Off
6	40 °C	0,4 mm/s	Green	Off
7	42 °C	0,4 mm/s	Green	Off
8	43 °C	0,5 mm/s	Green	Off
9	45 °C	0,7 mm/s	Green	Off
10	48 °C	0,8 mm/s	Green	Off
11	52 °C	1,01 mm/s	Yellow	Alarm
12	55 °C	2,33 mm/s	Yellow	Alarm
13	63 °C	3,09 mm/s	Yellow	Alarm
14	71 °C	4,31 mm/s	Red	On
15	73 °C	4,95 mm/s	Red	On
16	73 °C	4,99 mm/s	Red	On
17	70 °C	4,55 mm/s	Red	On
18	69 °C	4,13 mm/s	Red	On
19	66 °C	3,97 mm/s	Red	On
20	63 °C	3,55 mm/s	Yellow	Alarm
21	59 °C	3,17 mm/s	Yellow	Alarm
22	54 °C	3,03 mm/s	Yellow	Alarm
23	51 °C	3 mm/s	Yellow	Alarm
24	49 °C	2,89 mm/s	Green	Off
25	49 °C	2,55 mm/s	Green	Off
26	47 °C	2,45 mm/s	Green	Off
27	47 °C	2,14 mm/s	Green	Off
28	45 °C	2,09 mm/s	Green	Off
29	45 °C	1,45 mm/s	Green	Off
30	45 °C	1,35 mm/s	Green	Off

Figure 4. Trial results data for 30 days

This data is divided into three categories: Normal value, Alarm value, and critical value. In addition, this data contains limitations: temperature of 50 ° C in the standard value category, 50-65° C in the alarm value category, and 66°C in the critical value.

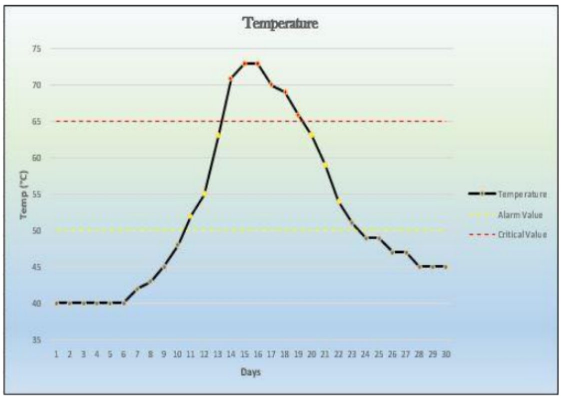

Figure 5. Bearing temperature rise graph.

The temperature sensor can detect an abnormal rise in the temperature of a three-phase motor with a resolution of one-fifth of a° Celsius when we put the temperature sensor on the motor casing and the front bearing housing of the motor area, like a motor running under average load it will be seen that the temperature rises slowly and falls by about 65°c.

B. Vibration Measurement Results

The vibration sensor is sensitive enough, and the sampling rate of the sensor nodes is fast enough to detect potential vibrations that could potentially damage the operation of the electric motor. Therefore, safe limits (safety limits) when the engine operates at a maximum of 4.00 mm/s when the motor bearing vibration exceeds the amount in a prolonged period will result in abnormal motor bearings causing severe damage and failed operation.

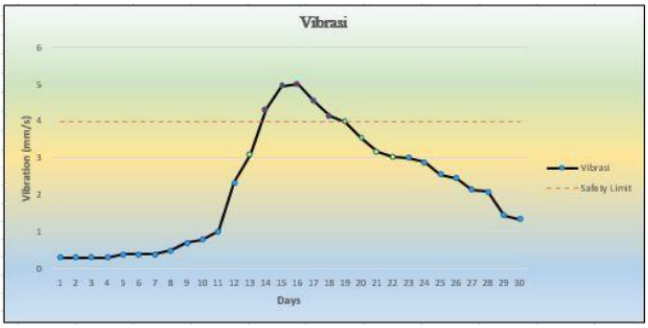

Figure 6. Vibration graph for 30 days

C. Experiment Results Comparison of Temperature and Vibration

With the increase detected by the heat (temperature) and vibration (vibration) sensors, seen in Figure 8, it can be concluded that the temperature increase can affect the vibration motor. For example, at a temperature of 55°C, the vibration rises at a point of 1.01 mm / s, marked with a sign on the alarm value. And it tends to increase to enter a critical value, namely at a temperature of 71 ° C and a vibration of 4.31 mm / s, which will inform our cellphone to run the fan (Fan cooling) immediately and if the temperature continues to rise then the grease pump will be executed to helps the process of reducing the temperature of the motor.

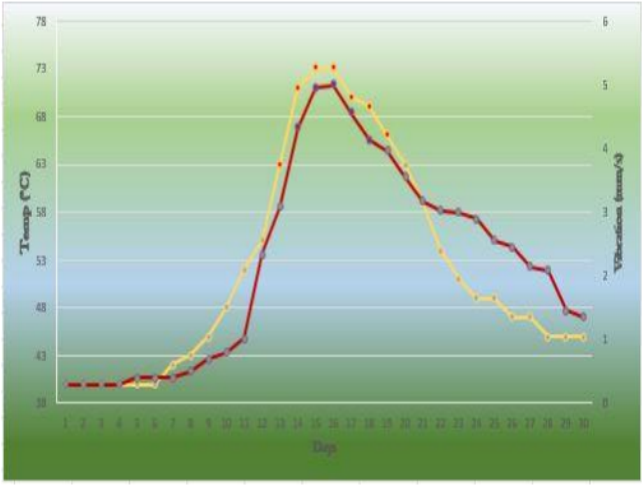

Figure 7. Comparison chart between temperature and vibration

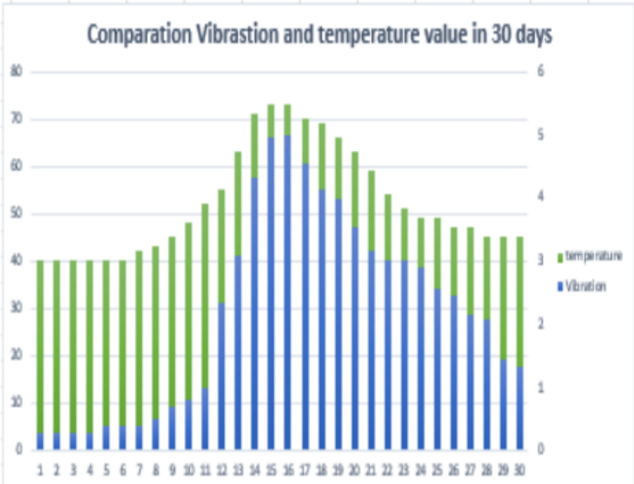

Figure 8. Bar chart comparison between temperature and vibration.

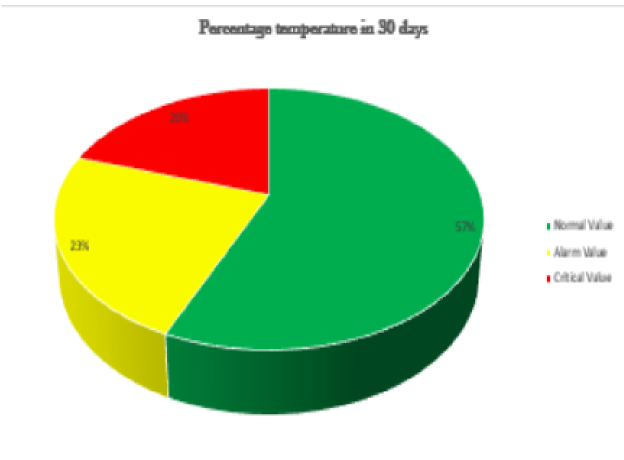

Figure 9. Pie charts for 30 days trial period

From this data, it can be concluded that in the 30-day interval of the experimental period, the percentage of adding a cooling fan and an external lubricant pump that can reduce the temperature and vibration of the motor if an abnormality occurs is obtained acquiring 20%. Thus the existence of this tool will be able to prevent damage to the engine and even more failed operations (strike). At least it can last long enough until the scheduled time for a motor inspection. However, the data above cannot be used as a reference for a successful tool to secure the motor because the differences in each type of motor specification will affect the work of these tools and can also be influenced by external factors, namely the load on the motor moves with disturbances.

V. Conclusion

This paper proposes a device to deal with disturbances in three-phase motors based on IoT. The build system uses three sensors and the ESP8266 CPU as a central unit that can be directly connected to the internet network. The system has been designed to combine various parameter measurements in real-time, increasing the palatability of multiple errors. The monitoring of the motor system provides a measure of different parameters, namely vibration, temperature, and current consumption. This system can facilitate maintenance work in controlling effort and routine motor maintenance in power plants. The system has high autonomy, easy installation, and low maintenance costs. The experimental results confirm the feasibility of implementing the plan. This research contributes to improving the performance of the generator at PT. Indonesia Power UJP West Java II Palafruitratu is one of the steam power plants in West Java, Indonesia.

Referensi

[1] V.S.D Rekha and Dr. K.Srinivasa Ravi "Induction Motor Condition Monitoring and Controlling Based on IoT" IJEECS, September 2017

[2] Martin Ganchev, Bernhard Kubicek, Hansjoerg Kappeler," Rotor Temperature Monitoring System", XIX International Conference on Electrical Machines - ICEM 2010, Rome,2010

[3] D.Ganga and V. Ramachandran,"IoT based Vibration Analytics of Electrical Machines",IEEE,2017

[4] S. S. Goundar, M. R. Pillai, K. A. Mamun, F.R.Islam, R. Deo,"Real Time Condition Monitoring System for Indutrial Motors", School of Engineering and Physics, Faculty of Science, Technology and Environment The University of the South Pacific Suva, Fuji, 2015

[5] H. Hafezi, A. Jalilian, " Design and Contruction of Induction Motor Thermal Monitoring System", Iran University of Science and Technology, Tehran, Iran, 2006

[6] Jakkrit Kunthong1, Tirasak Sapaklom1, Mongkol Konghirun1, Cherdchai Prapanavarat1, Piyasawat Navaratana Na Ayudhya1, Ekkachai Mujjalinvimut1, and Sampast Boonjeed2, "IoT-Based Traction Motor Drive Condition Monitoring in Electric Vehicles: Part 1", 1Department of Electrical Engineering, King Mongkut's University of Technology Thonburi, Thailand 2Technology Leamchabang College, Chonburi, Thailand, IEEE PEDS 2017, Honolulu, USA

[7] Mehmet GUNKAS, Ramazan AKKAYA, Ali OZTURK, " Protection of AC Motors by Means of Microcontrollers", Student Member IEEE

[8] Xiao Qijun, Luo Zhonghui*, "Early Fault Diagnosis of the Rolling Bearing Based on the Weak Signal Detection Technology", dept. Faculty of Electronic Information and Mechanical & Electrical Engineering Zhaoqing University Zhaoqing, China, dept. Faculty of Mechanical and Electronic Guangdong Polytechnic Normal University Guangzhou, China, 2016 14th International Conference on Control, Automation, Robotics & Vision, Phuket, Thailand, 13-15th November 2016 (ICARCV 2016), 2016

[9] Michele Roffi, Fernando J. T. E. Ferreira, Aníbal T. De Almeida, "Comparison of Different Cooling Fan Designs for Electric Motors", Institute of Systems and Robotics, Department of Electrical and Computer Engineering, University of Coimbra, Portugal, 2017.

[10] M. R. Mikhov et al. An application of wireless standards for remote monitoring of electric drive systems. International Journal of Engineering Research and Development 2.12 (2012): 30-36