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Fault Detection and IoT Monitoring System for Single-Phase Wiring

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Abstract: Fault detection and IoT monitoring are essential tools used in single phase wiring systems to ensure the smooth operation of electrical appliances and to detect any faults or anomalies in the system. The Internet of Things (IoT) enables real-time monitoring of the system, allowing for immediate detection of any issues that may arise. With fault detection and IoT monitoring, single phase wiring systems can operate reliably, providing uninterrupted power to homes and businesses. Failure is one of the consequences of a shorted circuit, in addition to the wire system. Furthermore, some issues can cause the system to be disrupted and fail to effectively supply energy to the loads, such as physical faults, which can be internal or external and generally include cable damage and leakage. As every form of power that is delivered to the consumer has flaws and issues, such a voltage supply to the consumer may be over or less. The proposed solution has significant potential to improve the operation and maintenance by develop a power monitoring and fault detection that controlled by the microcontroller and sensor to detect the input and output of the electricity distribution networks. Furthermore, this project proposes a power monitoring and fault detection system for electricity distribution networks. This system is capable to monitor and record the electrical parameter such as voltage and current consumption of the system. This project successfully developed a reliable fault detection and IoT monitoring system for single-phase wiring systems and send notifications to the user via Blynk application.

Keywords: IoT Monitoring, Sensor, Fault Detection, Single-Phase

1. Introduction

The Internet of Things (IoT) has revolutionized the concept of smart buildings with capability to monitor and control various parameters of a building from a remote location. One of the crucial parameters that require constant monitoring is power consumption in a building. With the increasing need for energy efficiency and cost reduction, the IoT-based power monitoring system is gaining popularity. The system continuously tracks the consumption of electrical energy across different

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sections of the building and analyzes to identify potential areas for energy savings. A good fault detection system provides an effective, reliable, fast, and secure way of a relaying operation [1] Figure 1.1 shows the connection of electrical component in the distribution box.

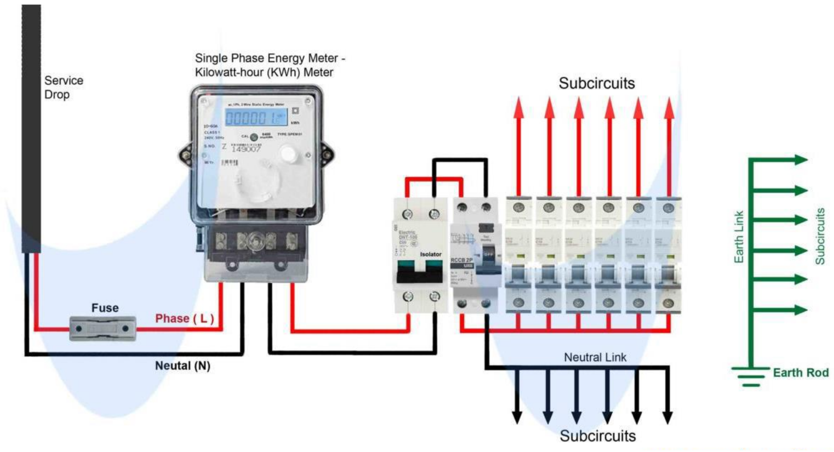


Figure 1.1: Residential wiring system for single-phase

The application of a monitoring technique could be useful in discriminating the faulty and healthy electrical power system. There are several types of wiring systems, such as single phase and three phase wiring system that have been classified by the Suruhanjaya Tenaga. A single-phase wiring system provides a variety of components and connections. The single phase consists of 2 pole main switch, MCB, RCCB and earthing. Single phase only uses single line and neutral to form a 230V supplies to consumer. The aim of this project is to develop fault detection and IoT monitoring system for single-phase wiring.

1.1 Problem Statement

Every form of power that is delivered to the consumer has flaws and issues, such a voltage supply to the consumer may be over or less. Failure is one of the consequences of a shorted circuit, in addition to the wire system. Furthermore, some issues can cause the system to be disrupted and fail to effectively supply energy to the loads, such as physical faults, which can be internal or external and generally include cable damage and leakage.

The proposed solution has significant potential to improve the operation and maintenance by develop a power monitoring and fault detection that controlled by the microcontroller and sensor to detect the input and output of the electricity distribution networks. Power monitoring are fundamental components of power management in both industrial and commercial environments. The ability to detect anomalies in the power system and alert operators in a timely fashion can prevent costly downtime and equipment damage. With the emergence of advanced sensing and analytics technologies, power monitoring and fault detection have become increasingly sophisticated and effective.

Furthermore, this project proposes a power monitoring and fault detection system for electricity distribution networks. As every form of power that is delivered to the consumer has flaws and issues, such a voltage supply to the consumer may be over or less. Failure is one of the consequences of a shorted circuit, in addition to the wire system. With the increasing complexities of power systems and rising demands for reliability and efficiency, a comprehensive approach to power monitoring and fault detection is more critical than ever.

2. Materials and Methods

The system consists of two sensors; ACS712 current sensor and ZMPT101B voltage sensor, connected to the ESP32 module. The system starts by reading sensor data based on the required parameter. Then, the data be sent to the ESP32 and Blynk cloud platform to monitor the data. The data received also be displayed and send notification of fault to Blynk. All the components and software are listed in Table 2.1 respectively.

2.1 Materials

Table 2.1: List of components

Components	Quantity
ESP32	1
12V DC Power Supply	1
ACS712 Current Sensor	1
ZMPT101B	1
5V Relay Module	1
Buzzer	1
I2C OLED Display	1

2.2 System flowchart

By integrating an ESP32 kit module as the main microcontroller on the circuit, the input measurements from the sensors can be received, processed, and transferred to the IoT platform system and monitoring display. After the ESP32 implementation was successful, the software configuration of the Blynk application continued. After ensuring that no software or hardware errors occurred during the testing phase, the process was repeated for the complete hardware implementation. Finally, after receiving verification, the report and finished design were presented. The system flowchart for completing the project is depicted in Figure 2.1 below.

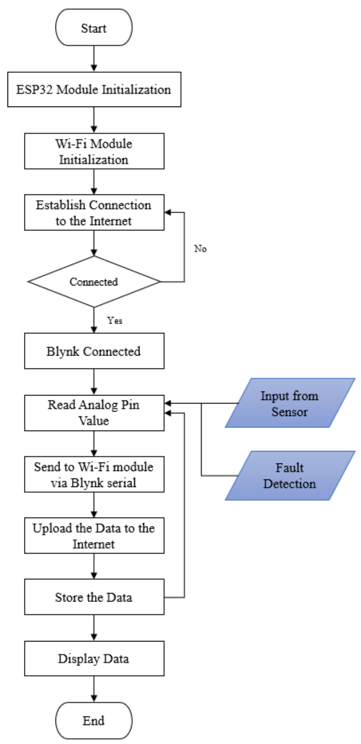


Figure 2.1: System flowchart

This project's flowchart is separated into two sections since was created for two systems: power monitoring and fault detection. The first portion, the power monitoring system, began to run when the ESP32 were linked to the internet through Wi-Fi, allowing the Blynk platform and microcontroller to interact. While the Wi-Fi module and the Blynk platform successfully interacted, the ESP32 interface was constructed concurrently utilising a serial communication approach that allows data to be delivered and received. To monitor the voltage and current flow via the wiring system, current and voltage sensors were fitted. A 5V relay module also fitted to control the circuit when there is a fault occurs. The relay turns into open circuit once detected any faulty occurs. Figure 3.2 show the flowchart for the wiring system.

2.3 Block Diagram of Project

This system consists of two parts which are the input and output sides. The input part includes sensors, while the output consists of a 5V relay module. ESP32 is the main microcontroller in this project system as intermediaries between provided and received signals.

The ACS712 current sensor, the ZMPT101B voltage sensor, 5V relay module are used and powered by 12V DC power supplies. The sensors are installed between each component to measure the voltage and current in the wiring circuit. To trigger faulty in the system in this project 5V relay module has been used. The faults are identified based on the parameter's value that has been determined.

The Blynk application serves as an IoT platform for storing and displaying data from sensing devices. Via a smartphone application connected to a Wi-Fi network, ESP32 data able be accessed. From that, the user of this smart system can monitor and notice if faults occur in the wiring system when operating. The pop-up notification interface has been created when faults are detected on the wiring circuit. Once the faults occur, user can control the 5V relay using the Blynk application to make the open circuit back to shorted circuit. This project used the Arduino IDE software to develop the code program for this system function. A block diagram is used to visualise the system's layout and structures. The project's block diagram is shown in Figure 2.2.

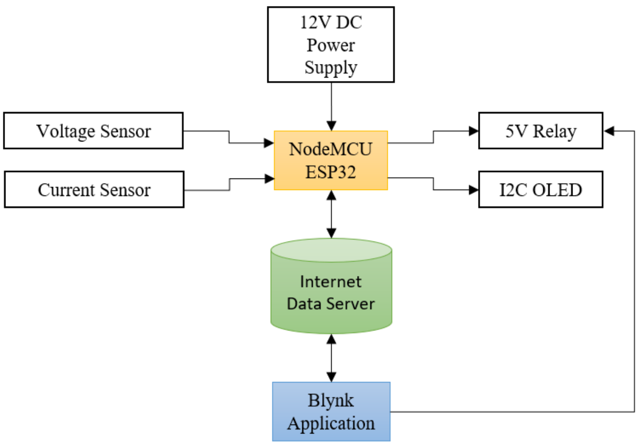


Figure 2.2: General block diagram of the system

3. Results and Discussion

The results were acquired and recorded once the methodological phase of the project testing was complete. In order to complete the project's functional functioning and help with issues that arose in the hardware and software stages, several tests were carried out. One of the solutions, the debugging process, was also carried out because the software issue occurred under a certain circumstance. Once the system is fully working and the data has been collected, a thorough analysis of the findings was done to make sure they support the project's goals. Figure 3.1 shows the complete circuit connection of the project.

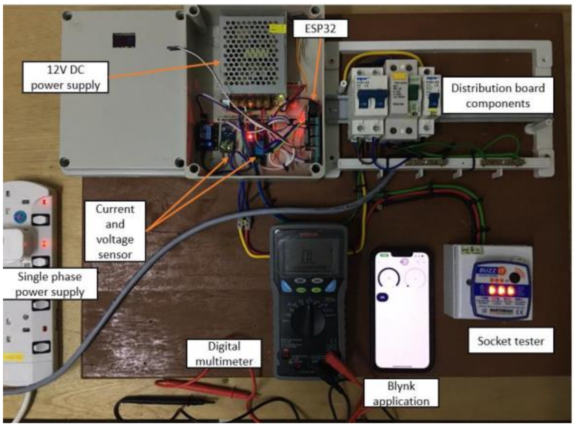


Figure 3.1: Circuit connection for wiring system

3.1 Results

This chapter contains the results of the project to identify the concepts of the development of this project including data on the objective of this project, such as the design of a basic circuit structure and the operation of the circuit connections.

3.1.1 Ground Fault Testing

When there is a shorted circuit between neutral and earth the system detect no voltage flow thru the voltage sensor by pressing the test button on the RCCB. The data analyzed by the ESP32 and show on Blynk application with notification. Figure 3.2 shows the ground fault notification on Blynk.

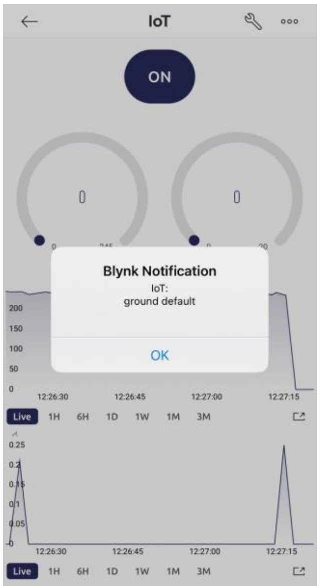


Figure 3.2: Ground fault notification on Blynk

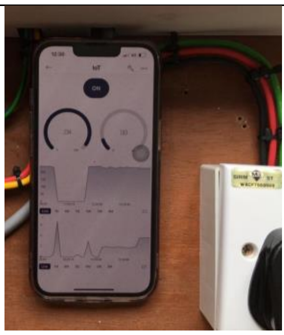
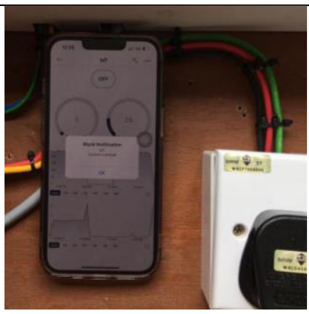
The system still running even the ground fault happen. The notification only to notify the user that there is a fault occur. The RCCB in open circuit condition and user need to push the RCCB toggle upwards to get a shorted circuit.

3.1.2 Overcurrent Fault

A short circuit or overcurrent fault in the high current AC circuit is a fault that can damage components and cables in the wiring system. As a precaution, because wiring system are exposed to high heat and misstep in connecting in distribution board components with the sensor. When overcurrent occurred, the 5V relay play role which is make the shorted circuit to open circuit with condition the current flow the system more than 2.5A that already been setup in the coding.

For the different load value, hair dryer was chosen to be an appliance that can cause the overloads current to the current sensor as the hair dryer is one of the heating appliances or having a coil that need more current and power to heat the coil. Table 3.1 shows the data of over current that used by the hair dryer with different level of the heating.

Table 3.1: Overloads data from hair dryer

No.	Figure	Current value / status
1.		Output value: 0.96A Status: Good
2.		Output value: 1.53A Status: Good
3.		Output value: 1.83A Status: Good
4.		Output value: 3.35A Status: Overcurrent

The monitoring system used in this project allows users to access information directly from the wiring system that is currently in operation. As a result, a widget function on the Blynk app was developed to notify users when faults occur in the system by sending a pop-up notification containing information about the type of fault through a smartphone. With the Blynk application, the Blynk app notifies the user of a fault at a wiring system. Figure 3.3 shows the graph where the peak current that make the 5V relay trigger from normally close (NC) to normally open (NO) because of exceed the limit of current that set to 2.5A.

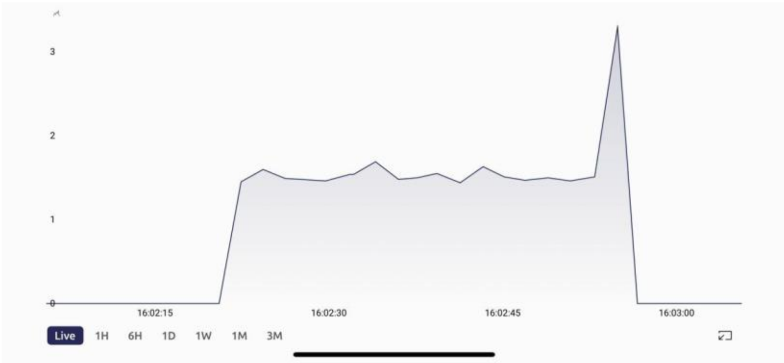


Figure 3.3: Current output graph

The value of the current flow that have been verified via Blynk application and multimeter having a minor differences value. The causes of the different output value by Blynk application and multimeter are the calibration of the current sensor in the coding. Next, electronics components also one of the effect the output value having a different value as there are losses occur at the components.

3.2 Discussions

Based on the data collected, the fault detection and IoT monitoring system made in the project is made to be an independent device that can track the possible wiring system in an area. Overcurrent have been major problems to society as can cause fire to wiring system and affected the house or industrial warehouse. In both circumstances, a monitoring system could be quite valuable.

Aside from preventive measures, the most effective strategy to limit the damage caused by overcurrent or any fault is early discovery and rapid response. As a result, significant attempts are made to achieve early fault detection. Based on the prototype made, the efficiency of the sensors is reliable to detect fault on a small scale. There is a lot of room for improvement to increase the detection scale.

4. Conclusion

In conclusion, monitoring and fault detection have been chosen as the primary focus for developing an effective system to make sure our wiring system more safety and updated. Several ideas and observations have been made to support the progress of this project, such as searches for previous projects that related to this project's title.

The fault and power monitoring successfully implemented in the system. Based on the first objective, to investigate fault detection and power monitoring for the single-phase wiring are successful. There are several faults in the wiring system and ground fault and overcurrent faults are successfully implemented in the wiring system.

Besides, the second objective is to develop a power monitoring and fault detection system for single-phase wiring. This project successfully gave an output that the system needed. Such as fault detection notification to user, voltage, and current output. In other words, for the single-phase wiring system successfully to be applied in this project.

Lastly, for the third objective which is monitor and verify the wiring, fault detection functionality and efficiency of the proposed system via experimental setup. The third objective have been successful where all the output, fault detection and monitoring can be done in the system. This can be verified by Blynk application and multimeter to see the difference between the output using different devices.

Acknowledgement

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References

[1] Jamil, M., Sharma, S. K., & Singh, R. (2015, July 9). Fault detection and classification in Electrical Power Transmission System using artificial neural network - springerplus. SpringerOpen. Retrieved November 3, 2022

[2] Gillis, A. S. (2022, March 4). What is IOT (internet of things) and how does it work? definition from techtarget.com. IoT Agenda. Retrieved November 3, 2022

[3] Selvaraj, T., & Zulkifli, M. (2021). IOT Based Power Monitoring Device (Distribution Box). Progress in Engineering Application and Technology

[4] Kurien Raju, Neel Rajan, Sneha Mariam John, Arathi R Kumar, Blessy A Rahiman and Sreerenjini K, Smart Fault Detection in Distribution System, International Journal of Electrical Engineering & Technology, 11(2), 2020, pp. 54-61.

[5] Khan, F., Siddiqui, M. A. B., Rehman, A. U., Khan, J., Asad, M. T. S. A., & Asad, A. (2020, February). IoT Based Power Monitoring System for Smart Grid Applications. 2020 International Conference on Engineering and Emerging Technologies (ICEET).

[6] D., B., J., R., Rajagopal, M., K., S., & K., J. (2023). An IoT-Based System for Fault Detection and Diagnosis in Solar PV Panels. E3S Web of Conferences, 387, 05009.

[7] A. Y. Devadhanishini, R. K. Malasri, N. Nandinipriya, V. Subashini and P. G. Padma Gowri, "Smart Power Monitoring System Using Iot," 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS), Coimbatore, India, 2019, pp. 813-816, doi: 10.1109/ICACCS.2019.8728311.