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Development of An Electrical Energy Meter Monitoring System Using Dashboard MQTT Application

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Abstract

Due to the current revolution in quick technology use, which results in a decline in energy source, energy consumption is rising. The primary cause of this issue is the unchecked wasteful behavior of consumers when using electricity. The Rapid Application Development (RAD) model, Internet of Things (IoT) technology, the MQTT Dashboard application, AdaFruit IO software as a database of developed systems, a NodeMCU ESP8266 controller, and an ACS712 30A current sensor are all part of the methodology chosen to carry out this project. The ESP8266 NodeMCU microcontroller will interpret the data from the ACS712 current sensor and display it as a monitoring tool on the computer's AdaFruit IO software and the MQTT Dashboard app on the user's smartphone. This project's user-friendly features allow us to track the cost of electricity use over the course of a day and a month, regardless of where we are located. The advantages of this method can be summed up as being cost-effective, straightforward, and simple to maintain.

Keywords: - Electrical energy meter, monitoring system, MQTT dashboard, AdaFruit IO

1. Introduction

The electricity meter monitoring system using MQTT Dashboard application is developed based on the concept Internet of Things (IoT). The purpose of this product is to make it easier for consumers to monitor the electricity meter in the distance and prevent the occurrence of wastage of electricity. When we enter the new era, the internet will dominate many purposes, albeit humans will only make up a small portion of it. IoT is steadily growing in importance and is now pervasive throughout our daily lives. IoT is a technological advancement that combines a wide range of smart systems, frameworks, intelligent devices, and sensors (Kumar et al., 2019). It is obvious that the object will only be moved by the system. The primary energy source for the industrial, commercial, educational, agricultural, mining, and even domestic sectors is electricity. This energy source offers several advantages that improve socioeconomic conditions, particularly in Malaysia, and the quality of life. Yet, if people do not understand the value of energy-saving techniques, it will undoubtedly have an impact on how long future generations will live (Othman & Hanis, 2017).

The problem that often arises due to the high rate of consumption of electricity from consumers is that the monthly electricity bill is soaring that the money allocated for the month's electricity bill is insufficient. The problem that often arises due to the high rate of consumption of electricity from consumers is the monthly electricity bill is soaring that the money allocated for the month's electricity bill is insufficient. This system will provide users with indication of LED flash when they have high energy consumption. In addition, this system will display the used electricity readings as well as the bill price to be paid on the MQTT Dashboard application.

Electrical energy meter monitoring system using MQTT Dashboard application was developed to facilitate users monitor the readings of electricity meters remotely regardless of the location of the user's presence. This system uses the concept of Internet of Things (IoT).

Additionally, the purpose of this product development is to inform consumers about the rate of electricity usage that has been utilized through the LED flash so that users can take further steps to ensure that their monthly electricity bills are within the range of expenditures set by them during the month. Consequently, consumers can keep their electricity bills at a moderate level so that their monthly spending money can be saved.

Based on the purpose of this product development, several objectives have been identified. Among the objectives are to design an electric power meter monitoring system using MQTT Dashboard application. Secondly is to test the functionality of an Electric Power Meter Monitoring System using MQTT Dashboard application in accordance with the set criteria.

Based on the utilisation of certain of its capacities, the internet of things (IoT) can be viewed as a service that can meet many forms of demand. Due to their bright future and ability to facilitate the research and study of various elements, IoT has been able to push back other neighboring technologies. (Villamil et al., 2020). The fourth industrial revolution, also known as Industry 4.0, is distinguished by a wide range of cutting-edge applications and services, numerous interconnected devices, and revolutionary manufacturing processes (Maqbool et al., 2023). Industry 4.0 refers to a manufacturing environment that is highly integrated, digitalized, automated, autonomous, and productive. The manufacturing industry has experienced significant, previously unheard-of upheavals and hurdles as we approach the fourth industrial revolution (IR4.0). Workplace disruptions, high implementation costs, changes to organizational and operational procedures, security and privacy concerns, problems with regulatory compliance, and a lack of data management are just a few of the obstacles that must be overcome to keep up with the emergence of new technologies. The business world is facing increasing difficulties because of the growing global rivalry, particularly the adoption of IR4.0 in the manufacturing sector (Othman & Zaidi, 2021).

By using smart machines and converting traditional production systems into smart factories, this new manufacturing paradigm places a strong emphasis on making smart goods and building smart processes. Smart factories are the result of integration through digitization, use of flexible and adaptive structures and strategies as well as artificial intelligence technologies, and they allow the development of intelligent production environments throughout the entire value chain (Pereira et al., 2019). This means that internal systems, wireless sensor networks, automation (intelligent automation for homes and buildings) and so on will contribute to the widespread and effective use of the Internet of Things (IoT) to humans. Energy management and smart metering installations are increasingly important in today's building automations that involve electrical energy systems. Field level integration in these kinds of projects may offer new options for monitoring building energy use and enhancing control performance (Zafar et al., 2020).

In Malaysia, Tenaga Nasional Berhad (TNB) companies are still using the manual method in which they will go from one home to another to read the kilowatt hours meter to issue a monthly rate payable by the user as shown in Fig. 1. This will result in an error when the meter reader takes a reading, resulting in high electricity bills (Gujarathi et al., 2021). It is the user's responsibility to clarify and correct any human errors after receiving an incorrect bill from the energy supply board. The customer will then need to locate the office, wait in line, and get it fixed. The issue is solely the result of human participation, even though these businesses frequently enhance their processes to reduce mistakes and difficulties (Hudemani et al., 2019). According to research by Suruhanjaya Tenaga, most power users have abandoned the tariff block (301-600 kWh), which has led to their high electricity bills (Idris, 2020). This occurred because of a lack of monitoring of the usage based on the kilowatt-hour meter readings.

Fig. 1. Monthly electricity bill rate

Due to the kilowatt-hour meter being tampered with using the switching control method with a receiver circuit board inserted illegally within the kilowatt-hour meter to circumvent the meter, the SESCo Berhad company, which operates in Sarawak, has experienced losses. The issue is that the kilowatt-hour meter only accurately measures a small portion of the real electricity utilised by the customer. Due to this, the monthly charge is low and does not reflect the amount used (Tugong, 2019). Nowadays, more service providers or products besides banking institutions, provide services or applications that provide deal details such as Grab and Touch 'n Go. Generally, smart meters as shown in Fig. 2 allow consumers to know their electricity usage every half hour.

Fig. 2. Smart electricity meter

Consequently, energy consumption can be saved by changing the consumption habits that waste electricity. Most of the time, energy use in the house goes unnoticed, and most of the energy-consuming behaviors we engage in are habitual and routine-based (Martiskainen, 2014). For example, not allowing the television to be connected to electricity overnight, even if not watching and installing air conditioners if necessary to reduce electricity bills. The concept of Internet of Things (IoT) is to connect all devices with the buttons 'ON' and 'OFF' to the Internet. These include mobile phones, washing machines, lights, and anything we can think of including machine components such as jet engines in airplanes and others. The journey of this IoT system can be translated into two situations that can be seen in Fig. 3.

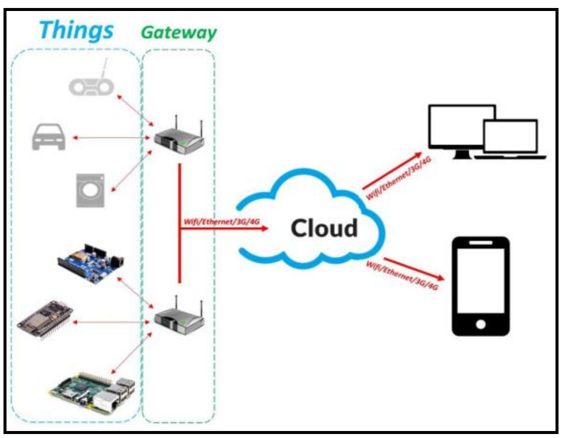

Fig. 3. Basic component distribution in IoT system

2. Methodology

The development of this product is made using a prototype methodology. Prototype is the initial phase of a system application and is the initial source of a system. This approach involves the process of detailing interim pre-interactions where every step of the work will be done repeatedly to ensure that the product developed meets the needs of the user. This approach has been recognized as an effective method of system development. The proposed Electricity Meter Monitoring System using the MQTT Dashboard application was developed using the Rapid Application Development (RAD) model that can be seen in Fig. 4.

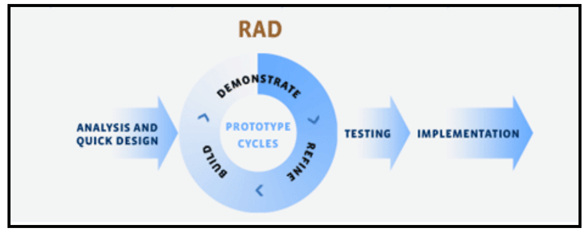

Fig. 4. Phase sequence of rapid application development model

The RAD model was introduced in the 90's and growing. This model is a system prototype concept developed with the emphasis on high product quality and through the process of collecting information from users (Nalendra, 2021). This methodology also enables researchers to interact with users when collecting product requirements, designs, and analysis. This model is more flexible in development cycles such as checking and screening until the development process expires. In producing this product, researchers chose the Rapid Application Development (RAD) model as the basis for the development of the Electricity Meter Monitoring System using the MQTT Dashboard application. The RAD model was chosen because of the systematic development of its system application and can be fully realized.

This model also emphasizes the development cycle short, short, and fast. Short time is an important limitation for this model. Customer satisfaction is a priority for product developers where every aspect will be tested to avoid any unfathered issues when reaching the user's hands. The RAD model uses a recurring method of developing a system where the system works the is built at the beginning of the development stage with the goal of setting user requirements and then being removed.

3. Result and Discussion

This test is done using two different powers of lamps. Electrical energy meter monitoring system using MQTT Dashboard application could measure current, power used, cost of use in a day and usage costs in a month.

Fig. 5 shows the power reading and side bill using MQTT dashboard on smartphones. The data is taken every five seconds. At the time of the 30th, the display of values in “Power” will change to 0.13 watts. When the value of “Power” reaches 0.92 watts, reading “Bill” will increase to RM0.01.

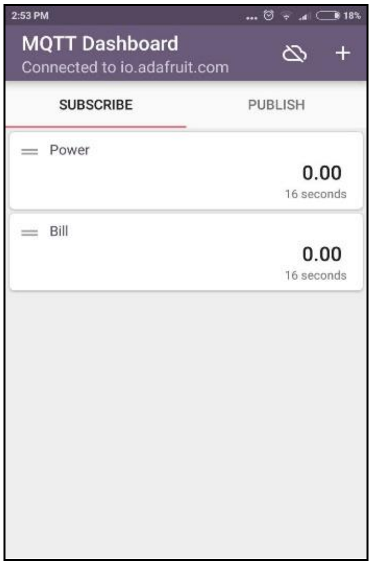

Fig. 5. Basic component distribution in IoT system

Fig. 6 shows the “Power” value next displays a quick upgrade compared to the “Power” value for the use of bulbs (60 watts). The value of 'Bill' increased rapidly in line with the increase in the value of “Power”.

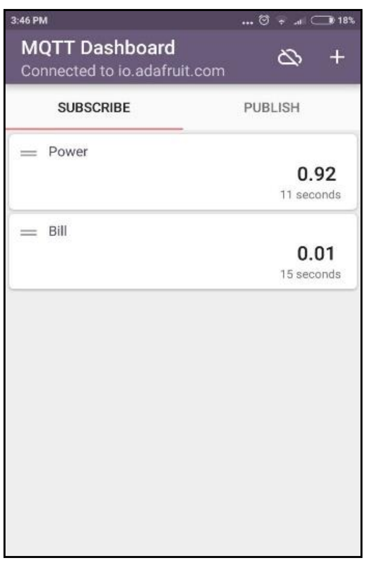

Fig. 6. Power and bill reading on the MQTT dashboard application using 100 watt bulb

Fig. 7 shows the 'Power' and 'Bill' readings on the side are the data displayed on the AdaFruit IO software on the computer. This reading is available in the 'Feeds' section. Read 'Power' and 'Bill' are the same as reading on the MQTT Dashboard.

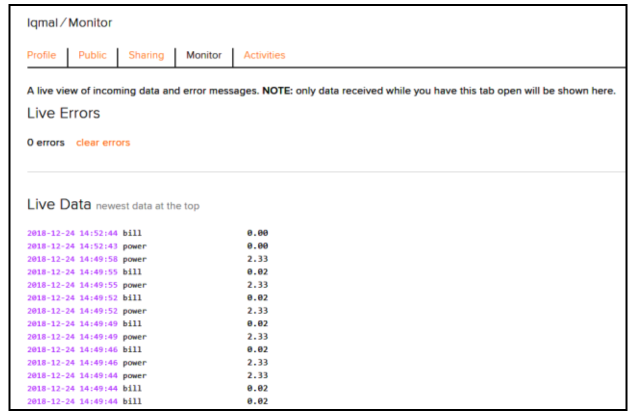

Fig. 7. Power and bill reading on AdaFruit IO software using 60 watt bulb

Fig. 8 shows the graph next to shows the data collected for 'Power' and 'Bill' readings. Graphs were plots based on date and reading values for 'Power' and 'Bill'.

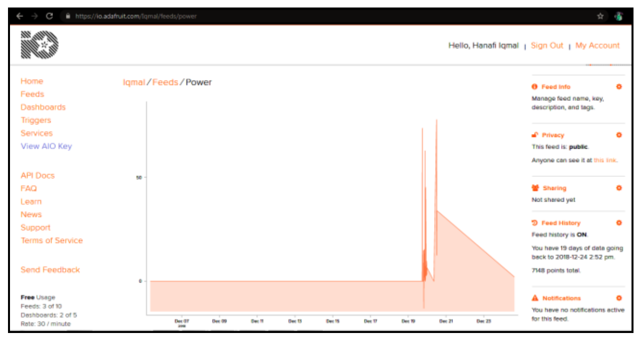

Fig. 8. Power and bill reading on AdaFruit IO software using 60 watt bulb

Fig. 9 shows the data view next to can be found in the 'Dashboards' section. The shape of the display will allow users to see the use of electricity. When the value of 'Bill' reaches the set level of RM0.02, the LED will blink.

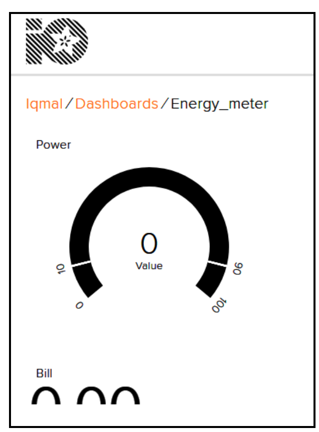

Fig. 9. Power and bill reading on AdaFruit IO software using 60 watt bulb

Fig. 10 shows the reading that is available in the 'Feeds' section. The value reading for 'Power' quickly increases to 0.92 watts. The value reading for 'Bill' also increased to RM0.01 when the value of 'Power' reached 0.92 watts.

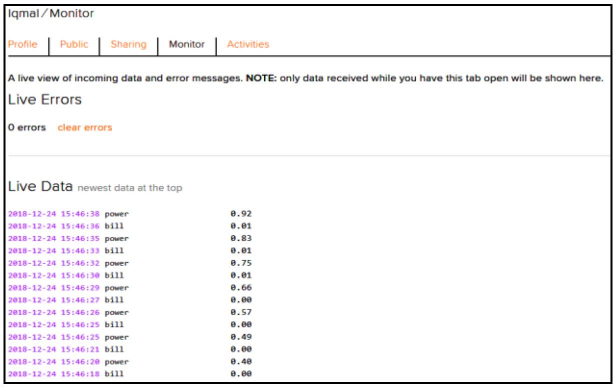

Fig. 10. Power and bill reading on AdaFruit IO software using 100 watt bulb

Fig. 11 shows the graph next to shows the data collected for 'Power' and 'Bill' readings. Graphs on plots based on date and reading values for 'Power' and 'Bill'.

Fig. 11. Power and bill reading on AdaFruit IO software using 100 watt bulb

Fig. 12 shows the data view next to can be found in the 'Dashboards' section. When the value of 'Bill' reaches the set level of RM0.02, the LED will blink.

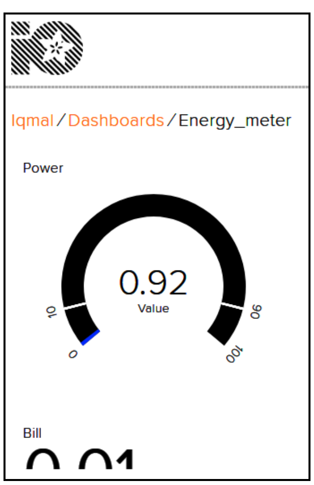

Fig. 12. Power and bill reading on AdaFruit IO software using 100 watt bulb

4. Conclusion

The purpose of develop the Electrical Energy Meter Monitoring System using the MQTT Dashboard application is to help consumers know the amount of power used and the cost of using electricity to prevent further wastage of consumers to plan their monthly expenses. This product succeeds in achieving all the objectives stated earlier.

At the design stage, the selection of appropriate materials and devices is performed to ensure the success of the product. The development phase includes developing a circuit and developing prototype hardware. This phase takes quite a while and needs to emphasize safety aspects during the development of this prototype. Overall, the development of this product gives a positive exposure.

The testing phase is done by testing some things like supply input to ACS712 30A current detector, Wifi module ESP8266 and Arduino Uno. Although the resulting product has achieved its objective, this product still needs to be improved in terms of hardware design and circuit design. Overall, the prototypes that have been produced and certified by experts have achieved the stated objectives.

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