スマートメータリングシステムにおけるIoTの開発
Development of Internet of Things (IoT) in Smart Metering System

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1. Introduction

The combination of lower energy efficiency uptake and less demand optimization and flexibility will result in higher overall energy demands, and reliance on higher carbon energy sources before the application of smart energy management systems were widely used. Thus, it is necessary to improve the power management by implementing the smart energy management systems. As well as the direct CO_2 savings, this system enable consumers to be more aware of their energy use which allows them to make better informed decisions, and participate in a range of new services aimed at reducing CO_2 and cost[1]. The purposes of this study are to develop the Internet of Things (IoT) in smart metering system to monitor and control electronic, electrical and mechanical systems in homes and buildings in order to improve the performance of the metering system to be more efficient. In this system, the energy meter and temperature and humidity sensor are applied to measure the energy of the appliances and detect the surrounding's temperature and humidity.

2. Smart Metering System

2.1 Smart Meter

The current conventional energy meter only provides one-way communication which is conducting manual collection of data and the billing will be done by the consumers manually every month. However, with the development of technology, smart metering system is introduced which provides two way communications between the meter and utility. By having the smart metering system in a building, the loads can be controlled anywhere by the consumer to cut the electrical cost effectively. The temperature and humidity sensor is one of the examples of the components in smart metering system to enable the automatic switching on and off of the appliances in the building.

2.2 Smart Plug

In the market nowadays, two types of smart plug are available which are external and built in. External smart plug is in the form of device where placed between the wall power outlet and the appliance's power cord. Meanwhile, the built-in smart plug is invisible since it is integrated into the wall outlet itself. Besides, the current retailed product in the market have the smart plug with temperature and humidity sensor that need to be connected separately with the plug. A built in sensor in the smart plug is also one of the aim of this research. Based on analysis made in many external smart plug systems are available on the market nowadays but only small amount of built in smart plug are available [2].

With the rapid development of Wi-Fi technology, smart plug can secure the compatibility with other portable devices besides the guarantee on the power efficiency. Even though smart plug is connected with Wi-Fi, the users cannot control the power usage efficiently since it is hard to get the information and data from the appliances. By implementing smart meter in the smart plug, the smart plug can be controlled remotely with high efficiency because this kind of system will allow users to monitor all the power consumptions in their houses. Figure 1 shows the data process of a smart meter and smart plug which has been combined together.

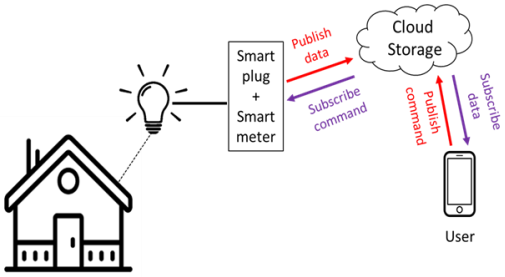

Figure 1 Data process of a smart meter and smart plug

3. Proposed Design

The proposed design used main measuring components as shown in Table 1. Besides, to make the design compactable and convenient for the user, a smaller size of smart plug is designed so that it can fit in the smart meter as shown in Figure 2.

Table 1 Main Components

Component	Function
Temperature and Humidity sensor (DHT22)	To detect the temperature and humidity of the surrounding
Energy Meter (HLW8012)	To measure the voltage, current and power of the load

Figure 2 Smart plug's outlet

Figure 3 shows the configuration of the smart metering system. The data from the energy meter is for the monitoring of the power usage of the home appliances. Other than that, the temperature and the humidity data also used as the reference to switch on or off the cooling system in the building. Moreover, AWS stands for Amazon Web Service. It is one of the MQTT Broker which is a cloud data that will stores all the data and publish and receive messages as a client can be done.

Thus, by having these applications in the smart meter we can control and monitor our home appliances and have more information about power consumption in the house.

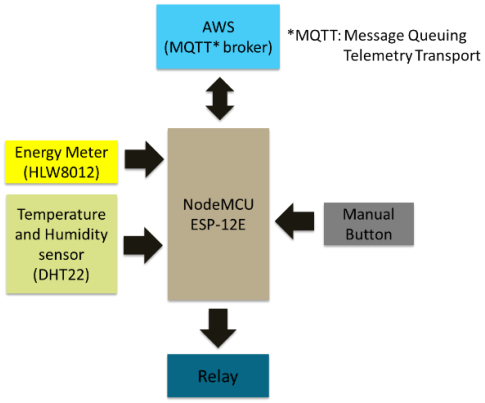

Figure 3 Configuration of the smart metering system

4. Experimental Test

The experiment is to measure the voltage and current by using the energy meter (HLW8012) and the temperature and humidity of surrounding by using DHT22 sensor.

Figure 4 shows the experimental circuit for smart meter. The energy meter and the temperature and humidity sensor are connected to NodeMCU ESP-12E which is the microcontroller or brain for the system as shown before in Figure 3. Type of load used in this experiment is 80 W/100 V light bulb. The measured data then will be displayed in the AWS.

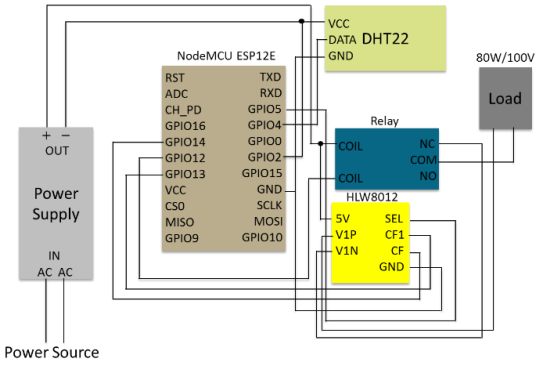

Figure 4 Experimental circuit

5. Results

Figure 5 shows the results of measuring data of the load and temperature and humidity of the surrounding in AWS. The temperature measured by the sensor also is the same as the real-time temperature of the surrounding as shown in Table 2.

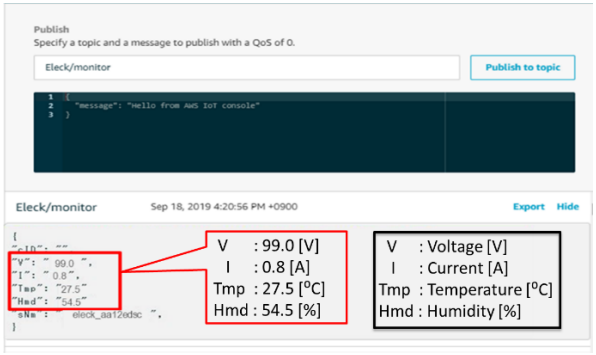

Figure 5 Measured data in AWS

Table 2 Real time data

Temperature [°C]	≥ 27
Humidity [%]	≥ 50

6. Conclusion and Future Works

From the experiment, the data from the energy meter and temperature and humidity sensor can be read successfully. In the future, the measured data from the energy meter and sensor can be used for many applications in order to reduce the electricity cost. Moreover, a smaller smart plug should be designed so it can match the market's socket plug specification. In conclusion, by having this smart metering system in a building, it can help in conserving the energy.

References

[1] Cross, E. M.; Turton A.; Trevithick D.; Kourtza E., "SMART METER BENEFITS: ROLE OF SMART METERS IN RESPONDING TO CLIMATE CHANGE", *A DELTA-EE VIEWPOINT*, MAY 2019

[2] Brenkus, J.; Stopjakova, V.; Zalusky, R.; Mihalov, J.; Majer, L.; Radioelektronika (RADIOELEKTRONIKA), 2015 25th International Conference, 21-22 April 2015.