Smart Energy Meter Based On Internet of Things (IoT)

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ABSTRACT: This project was proposed to design and develop a Smart energy meter based on the Internet of Things (IoT). A smart energy meter can monitor the pattern of the data electric consumption such as energy consumption on the types of lamps to give awareness to the consumers to save energy. Therefore, this project can read the data on energy consumption and manage the data in the cloud by using the IoT platform, it can also collect and analyze real-time energy consumption. A microcontroller of energy meters was proposed. This system consists of digital energy meters, NodeMCU ESP8266 (microcontroller), current sensor, and Wi-Fi module that was built in the ESP8266. ESP8266 receives the measured data from the sensor and sends calculated data to the IoT part. They used a platform called Blynk.

Keywords: *Smart meter; Energy consumption; IoT*

1. INTRODUCTION

The goal of Internet of things (IoT) is intended to improve the accessibility of the first edition of the Internet and make it more useful. Furthermore, users of IoT can share both the human-provided data contained in database systems and the information also given by things in the real world [1]. IoT system can be controlled and monitored the equipment or projects that are connected to the communications protocols for providing better services through intelligent data processing and analysis to various applications.

Demands of electrical energy for transport, industry, and also for national, rapidly rising in Malaysia, due to the large population and increased demand mainly from manufacturing, domestic industries. The increased electric energy has resulted in high electricity flows, which harm Malaysia municipal growth [2]. In doing so, the Malaysian Government has agreed to reduce greenhouse gas emissions by up to 40% by applying the concept of sustainable energy use and development [3].

In this project, proposed the design and develop a Smart energy meter (SEM) based on the IoT. It can monitor the pattern of the data electric consumption such as energy consumption on the types of lamps to give awareness to the consumers to save energy. Additional, it is able to read the data on energy consumption and manage the data in the cloud by using the IoT platform, collect and analyze real-time energy consumption. A microcontroller of energy meters was proposed consists of digital energy meters, NodeMCU ESP8266 (microcontroller), current sensor, and Wi-Fi module that was built in the ESP8266. ESP8266 receives themeasured data from the sensor and sends calculated data to the IoT part. They used a platform called Blynk.

2. DESIGN AND IMPLEMENTATION

A. Hardware System Design and Development

This section shows, explains, and discusses the results of the SEM based on the IoT system defined in section III of this research. This section is generally divided into two parts which is (a) Hardware system design and development and (b) software design and development. The hardware system design and development part shows the fully installed hardware, while the software design and development section explains the embedded software application as well as graphical user interface design and development for consumer applications. The hardware in this prototype is arranged as shown in the figures below. Figure 1 shows the assembly of smart energy meter system. The prototype consists of power supply, control system and lamp tester.

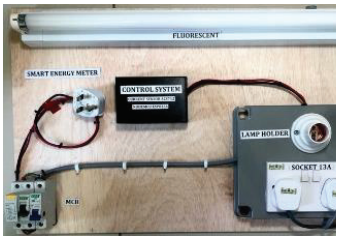

Figure 1 Hardware wiring circuit

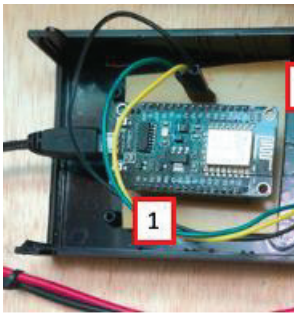

Figure 2 Control system box

Figure 2 shows the control system box. It consists of the main component for this prototype which is NodeMCU ESP8266 and Current Sensor ACS712 30 Amp. NodeMCU is a main microcontroller for this project to calculate the data according the code using Arduino IDE. Two components show such as (1) NodeMCU ESP8266 and (2) Current Sensor ACS712 30 Amp. Table 1 shows the Wi-Fi module specifications. In order to create wireless communication between the device and customers ESP8266 WIFI module is used since its low-cost standalone wireless transceiver that can be used for endpoint IoT developments. ESP8266WIFI module uses TCP/UDP communication protocol to communicate the microcontrollers data with client or server. The power calculated by the Arduino including time stamp will be transmitted to cloud server using this Wi-Fi module.

Table 1 Wi-Fi NodeMCU Specification

Model	NodeMCU
CPU	ESP8266
Memory	128kBytes
GPIO	10
Baud rate	9600
CPU Frequency	80MHz

Other than that, based on table 2 shows specifications of current sensor. For this project purpose the current sensor used is Generic Hall Effect Current Sensor Module ACS712 30A Model. This sensor is chosen for this project purpose since its low cost and easily interface with microcontroller.

Table 2: Current Sensor Specification

Model	ACS712
Measure	DC/AC
Current Range	30A
Sensitivity	66mV per Amp

B. Software System Design and Development

The coding for this project, programming the NodeMCU ESP8266 platform. The main aim of writing this coding is to allow the NodeMCU to communicate with the current sensor in order to calculate the power and total energy consumption and display to the Blynk application. It is smartphone application that works on Android and iOS smartphones that allows users to operate any IoT-based application. It enables to design user IoT application's graphical user interface.

For the SEM source code, in this project, started with the necessary libraries for ESP8266 Board. Then, ACS712 is in charge of retrieving data from both sensors and calculating current and power values using NodeMCU. The software is integrated with the Blynk apps using BlynkSimpleEsp8266.

The energy meter is designed; current sensor calibration factors are established for variant 30A with the sensitivity is 66mV. The Blynk timer object is constructed to manage data transferring to the Blynk apps (phone). Local Wi-Fi network's SSID and password are defined, as well as the authentication code from the Blynk.

All the variables are defined of formula that used in this project and the values from the sensors are being retrieved & calculated. Using ACS712 the current, power, total energy, are being calculated. Furthermore, use Blynk.virtualWrite to send the data to Blynk based on the virtual pins set. The function of (millis (0) – Old timers > 1000) is to run in 1 second for the loop and this going to read the value from sensor and calculate the max value and the min value. So, basically in that 1 second it going to store the min value of the current and the max value of the current. Lastly, to get the result it is the different between the max value and min value and all this calculation need to convert ADC value.

C. Embedded IoT (Internet of Thing) Platform

Figure 3 shows the Blynk IoT Platform is used in the development of this system to display the data transferred from the Wi-Fi in microcontroller of this project. On the dashboard, users can check the current in ampere, billing data shows the cost of the energy consumption and the power that will show watts of load by looking at the dashboard of this system through their mobile devices using the Internet. The energy consumption will calculated by the NodeMCU from read current by sensors and will trigger the NodeMCU to transfer the data to the dashboard via the Internet. In this process, Wi-Fi is required for data transmission.

Figure 3 Blynk Application Interface

D. Types of Lamps

The objective of SEM is to monitor and analyses the data of energy consumption. Therefore, for this project has analyses 3 types of lamps which to know their efficiency of energy consumption. The lamps that been chosen for this experiment is Incandescent lamp (IL), Fluorescent lamp (FL), and Light Emitting Diode (LED). These types of lamps are usually used for indoor lighting.

3. CONCLUSION

In this project, the data energy consumption (kWh) for each types of lamp were successfully monitor by using SEM based on IoT. This research conducted about the current produced on types of lamp, power output and total energy consumption. Additionally, the cumulative energy consumption has been influenced by the current and power that have been recorded for 1 hour, and all data has been saved in the cloud server based on IoT using NodeMCU. Thus, using the results from the Blynk platform the research may determine that LED lights are significantly more energy efficient than equivalent incandescent bulbs, and they can be more efficient than fluorescent bulbs. In conclusion, the purpose of this project is to design the SEM based on IoT that able monitor the data in Blynk application was successfully achieved.

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