Low Cost Smart Meter Technology Development

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ABSTRACT

This paper presents a low cost smart metering design for energy measurement using an implementation methodology for wirelessless meter reading systems using WiFi networks and microcontrollers. Cheap smart meter design are designed not only to measure and monitoring power generation but also to enable and support new operation and control functions in power generation. In addition, this meter facilitates the user to read the energy meter even when the user is far away from the appliance. The purposed method consist of hardware and software parts. With the availability of internet access the energy data can be read quickly and easily through user's smartphone without using any wires to PC or remote devices. It is based on open source hardware ie ESP-12E and ACS712. This smart meter uses ACS 721 current sensor to detect the current. NodeMCU take most important data such as voltage, current, and active power so that all further calculations can be made by the center of the system. Smart meter can be used as a metering energy or as a quality meter power to provide the user with the ability to monitor the power value as well as current value. Accuracy in the readings of electric use is highly recommended to ensure electrical savings and control can be made.

Keywords: Microcontroller, ACS 712, ESP-12E, Smart meter

ABSTRAK

Makalah ini membentangkan reka bentuk meter pintar kos rendah untuk pengukuran tenaga menggunakan metodologi pelaksanaan untuk sistem bacaan meter tanpa wayar dengan menggunakan rangkaian WiFi dan mikrokawalan. Reka bentuk meter pintar murah direka bukan sahaja untuk mengukur dan mengawasi penjanaan kuasa tetapi juga untuk membolehkan dan menyokong fungsi operasi dan kawalan baru dalam penjanaan kuasa. Di samping itu, meter ini memudahkan pengguna membaca meter tenaga walaupun pengguna jauh dari perkakas. Kaedah ini terdiri daripada dua bahagian iaitu bahagian perkakasan dan bahagian perisian. Dengan adanya akses internet data tenaga boleh dibaca dengan cepat dan mudah melalui telefon pintar pengguna tanpa menggunakan sebarang wayar ke PC atau peranti jauh. Ia berdasarkan pada perkakasan sumber terbuka iaitu ESP-12E dan ACS712. Meter pintar ini menggunakan sensor arus ACS 721 untuk mengesan arus. NodeMCU mengambil data yang penting seperti voltan, arus, dan kuasa aktif supaya semua pengiraan selanjutnya boleh dibuat oleh pusat sistem. Meter pintar boleh digunakan sebagai tenaga pengukur atau sebagai kuasa meter kualiti untuk memberikan kemudahan kepada pengguna dalam mengawasi nilai kuasa dan juga nilai arus. Ketepatan dalam pembacaan penggunaan elektrik sangat disyorkan untuk memastikan penjimatan dan kawalan elektrik boleh dibuat.

Kata kunci: Mikrokawalan, Arduino, ADE7753, ESP826, Meter pintar

INTRODUCTION

Electricity has become an inseparable needs of modern human life. Most sophisticated and modern equipment and facilities currently use electricity as a source of energy. Besides being an essential requirement in individual lives, electricity is also a catalyst for national development. Total energy use in the world is increasing in equal with technological developments, besides to increased competition for economic upgrades and development in their respective countries. Hence, production, ownership and control of energy resources are an important issue for a country to ensure its smoothness in development and to ensure that it can continue to compete globally. The development of the technology world requires efficient management techniques and methods such as the use or discharge of energy in various forms of home, industry or shopping. In the industrial field, their main investment includes raw materials, water and so on. To monitor all these aspects, remote monitoring and less dependence on human power is important for reducing overall cost use. With that, to achieve this goal the smart meter approach can assist in the process of reading, data analysis and energy consumption data feedback of residential, industrial and shopping areas.

Smart meters are electronic devices and advanced power meters that measure and record energy usage in the indefinite period, make and provide additional information to utilities by using

a two-way communication scheme to stakeholders by using the network interface. Smart meters can instantly impact on one's energy consumption, which greatly reduces the readability of setter values, supports the introduction of time-based energy tariffs, and may support quick access to switch or turn off energy flow. Given information on energy consumption, consumers can make better decisions on energy saving and energy use in their area. The system using a one-way communication to collect the data is called as an automatic meter reading. Although systems that use two-way communication with the ability to control and monitor meters are referred to as advanced metering infrastructure systems. The combination of automatic reading and two-way communication is the reason why called the smart meter and there is also a difference between the common energy meter and the smart meter energy.

Automatic meter reading is a technology idea to automatically and accurately measure meters. The benefit of automated meter readings is to reduce the cost of the meter to the user and billing to the user for actual meter reading can be made, it can improve the accuracy and repeat reading according to the desired frequency. Smart meters can transmit readings through communication lines to activate or deactivate internal modules. To have that capability, automatic meter reading requires a special infrastructure that makes it two-way. Such infrastructure is called the advanced metering infrastructure system. In addition to being a device used for energy flow monitoring, smart meters can also be a major component of the future, autonomous energy systems, for example, smart microgrids with local energy production that need to be monitored and coordinated. To support this application, there are several requirements for metering units that can monitor quantities of measurements such as voltage, current, active and reactive power.

The power consumption of the measuring device itself should be low in order to conserve energy consumption. The purpose of this paper is to design a low cost smart meter in order to develop a new technology to measure electrical consumption with the ability to monitor the energy meter even the user is far from the applicant.

METHODOLOGY

In this project, the development of smart meter contain hardware and software part. The smart meter is built for ac connection. The voltage used is 220V. There are several types of components used such as ESP-12E NodeMCU with built in ESP8266, Blynk apps and mobile phones that has operating system of Android or IOS. The ESP-12E NodeMCU will read a list of energy value and data transmitted to the coordination device by using ESP8266 Wi-Fi module. Data were obtain by the current sensor. The Blynk application will receive data send by ESP8266 and display it on the android or iOS mobile system screen.

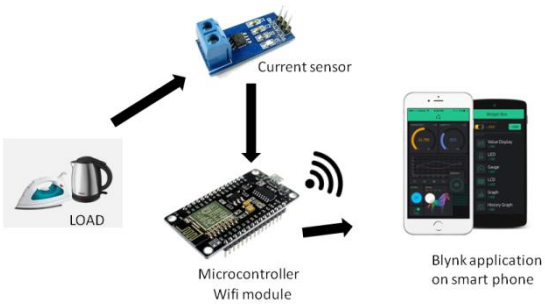

FIGURE 1. Smart meter system flow

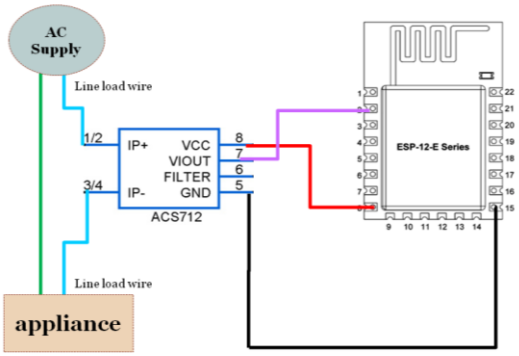

FIGURE 2. Schematic diagram of hardware

Current Sensor

Output pin of the current sensor connected to the A0 of the microcontroller and both of the input is connected with life wire of the load. The current sensor of ACS712 is sensing based on the principle of hall-effect. A voltage generated across its edge perpendicular to the direction of both current and the magnetic field when a current carrying conductor go through the magnetic field. When the current sensor get the value from the load, the data was send to the NodeMCU.

Wifi Sheild

The ESP-12E with built in ESP8266 module is a low-cost Wi-Fi chip. ESP8266 Wi-Fi model is a SOC contained in the order of integrated TCP / IP protocols that can provide any microcontroller access to WiFi networks. ESP8266 is able to either host the application or unload all WiFi network functionality from other application processors. Each ESP8266 module has been pre-programmed with the firm firmware AT set, which means it can only connect this device to Arduino devices and gain more WiFi capability as a WiFi shield. This module has the capability of processing and storage

that is in the board that allows it to be integrated with sensors and other application-specific devices through GPIOs with minimum development and minimum loading during processing. In this project ESP8266 ESP-12E NodeMCU was connected to the ACS712 to collect the data and transmit the energy data to the mobile application, Blynk.

Blynk Application

Blynk is a platform with iOS and Android apps to control Arduino and Raspberry Pi. It has a digital dashboard where users can build graphic interfaces for projects by adding the widget into their dashboard. It's require a specific coding to transfer the data from arduino. Blynk apps very easy to fix everything and can be played in less than 5 minutes. Blynk is not tied to certain boards or shields. Instead, it supports the optional gear. Blynk supports 400 more platforms and key connection types such as Arduino or Raspberry Pi associated with the internet via WiFi, Ethernet or the new ESP8266 chip. In this project, the data of power energy collected was transfer to the cloud using wifi module and the data from the cloud then transmit to the Blynk application.

RESULT

The value of current (A), power (W), power consumption (W) and voltage was taken in one minute from one example electrical appliances which is shoes heater. The data show in FIGURE 3 below show an example data collected from a shoe heater after connected to the current sensor and data was send through a Wi-Fi from ESP-12E NodeMcu.

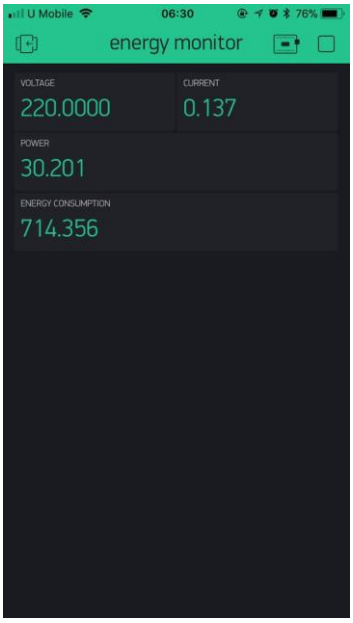

FIGURE 3. Visual from Blynk Apps

Data of meter reading			
Load	Voltage (V)	Current (mA)	Power (mW)
Shoe heater	220	0.137	30.201

TABLE 1. Data of energy

DISCUSSION

Every electrical appliances has different operation with specific current consumption. The main aim of this project is to built low cost smart meter. Costing required to built this smart meter has shown in TABLE 2 below.

Material	Cost (RM)
ESP-12E	20.90
ACS712	8.90
Total	29.80

TABLE 2. Cost of material

CONCLUSION

As a conclusion, an attempt to build low cost smart meter has been made. The described example costs less than Rm100. This includes all measurement and connection of the hardware. Compare to smart meter at market price exceed more than Rm200-RM400. So the main objective can be considered as fulfilled. The propagated model is used to calculate the energy consumption of the appliance. This smart meter also provide wirelessly data transmit to the user. It is more efficient, less man power to monitoring power consumption and flexible.

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