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IoT Based Smart Energy Meter using NodeMCU

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Article Info
Volume 82
Page Number: 4297 - 4301
Publication Issue:
January-February 2020

Article History
Article Received: *18 May 2019*
Revised: *14 July 2019*
Accepted: *22 December 2019*
Publication: *21 January 2020*

Abstract

The current electricity billing system with reference to the electricity meter reading has many drawbacks like extra bill amount, notification from electricity board even after paying the bills etc. This paper will discuss the idea of smart energy meter based on Internet-of-Things (IoT). This smart meter is able to absolutely remove the involvement of any other party between the service provider and customer. Moreover, it can allow an individual to observe the consumption of energy at anytime and anywhere via internet. The use of Wi-Fi module provides the notification through mail. The meter reading with total fare can be spotted on the web page. In the proposed method, Atmel microcontroller is used as it is energy efficient, faster and has two Universal Asynchronous Receiver-Transmitters (UARTs).

Keywords: *Arduino Uno, Internet-of Things (IoT), Smart billing system, Smart energy meter, NodeMCU, Web-server, Wi-Fi.*

I. INTRODUCTION

Internet of things (IoT) allows the different kinds of gadgets or machines to connect among themselves via the internet. The devices that are linked through Internet-of-Things may be managed through a remote location. The idea of IoT allows us to connect the physical world to computer based system [1].Wi-fi module may be used to connect the physical devices with internet and it enables the device to transfer its data over the internet that enables the continuous monitoring and controlling of that device [2]. Since the demand of the electricity is rapidly increasing over the years, so for the proper and accurate measurement of the usage the improvement in billing system is needed. The proposed system provides the massive improvement over the current billing system using IoT. There are also other issues like meter terming and power theft that lead to the economic loss for the nation [3].

he current billing system used in India requires a lot of inclusion of human beings. The invoice needs a person to visit our homes and compute the readings and according to that, electricity bill is generated. This is a time-consuming process and requires much labour. To overcome all these constraints, a set-up on the basis of Internet-of-Things technology has been developed here [4].

Smart energy meter is a device by using which electric energy utilization from anywhere may be monitored at anytimeand an SMS/E-mail is received whenever this utilization reaches a particular value called threshold that is decided by the consumer [5]. The data from the smart energy meter are unveiled on a webpage that can be examined by either of the consumer and service provider. This system is designed on Arduino Uno microcontroller and IoT platform NodeMCU (that is a type of firmware using Lua scripting language) is used to transfer the data on the webpage in-built

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ESP 8266 Wi-fi module. To examine the utilization of electricity over the internet, a message queuing telemetry transport (MQTT) dashboard has been used and to connect Wi-Fi to SMS/E-mail notifications, a software platform IFTTT (i.e. If This Then That) has been used. The Arduino micro-controller is programmed by the Arduino software IDE that is an absolutely mandatory requirement to operate on the Arduino board. Its code is derived from the C- language [1].

II. DESCRIPTION

A. Arduino Uno

Arduino Uno is a microcontroller board based on a dual inline package ATmega328 AVR microcontroller. It has 6 number of inputs (that are analog) and 14 input/output pins (that are digital) and 16 MHZ frequency crystal oscillator. It also has a power supply and a USB port to burn the code. An In-Circuit Serial Programming (ICSP) header and a reset button to reset the microcontroller. Program can be loaded to the board from easy to use Arduino program. It can be powered with a power jack or ac to dc adaptor or with battery.

B. NodeMCU

Node MCU is a Lua based firmware especially used for ESP8266Wi-fi module. The nodeMCU is the firmware which comes with esp8266 development kit. ESP8266 is the low cost most important part of any IOT based product. ESP8266 Wi-fi module is system on chip (SOC) with frequency of 2.4GHZ. It uses TCP/IP protocol for transmission of data over the internet. It has 96KB RAM and 64KB ROM. The Wi-fi module is used to transfer the reading of meter to the webpage which can be accessed globally [3].

C. Current Sensor

Current sensor is a sensor so as to provide the measurement of current. ACS712 current sensor is the main component of this project. The principle of hall effect is the basis of this sensor. If a conductor having current is present in a magnetostatic field in the perpendicular direction, then a potential difference is generated across its edges orthogonal to both the magnetostatic field as well as current. This potential difference refers to hall voltage and the corresponding current is called hall current .The potential difference linearly varies with the current flowing through the current carrying element. The main purpose of using ACS712 current sensor is that it is able to provide the measurement of dc current as well as ac current. Moreover, it also provides seclusion between arduino and load. The current sensor is a 3 terminal device and pins are Ground, Vout and Vcc.

D. MQTT Dashboard

MQTT stand for Message Queuing Telemetry Transport. It is a broker which is used to monitor the data sent by Wi-fi module over the internet. It works on the top of the TCP/IP Protocol. Adafruit is one of the types of MQTT Broker. Adafruit generates a unique Input Output Key (called AIO Key) for every user and by putting the AIO key in the program of nodeMCU, the hardware parts of the project may be connected to the internet that allows to transfer and display the data over the internet.

E. IFTTT (If-this-then-that)

IFTTT is a type of trigger generator that is used to generate the succession of conditional statements called applets. The applet runs whenever the conditional statements are fulfilled and whenever applet runs, it sends SMS, notification or mail to the client. Before creating the applet, the client has to make sure that the IFTTT is connected to the Adafruit from where it gets the readings and when that reading reaches the threshold value, user gets an SMS or mail notification.

III. OPERATION

The complete connection is shown in figure 1. The current sensor retrieves the data from the load and this data is then transferred to Arduino via Universal Asynchronous Receiver Transmitter (UART)

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communication [6]. The microcontroller then performs arithmetic and logical operation to calculate power and bill. This data is then transferred on MQTT server as Adafruit IO platform by using NodeMCU for real time monitoring. For receiving mail, whenever the bill becomes greater than or equal to the threshold value (shown as 'Th'), IFTTT (if this then that) trigger generator is connected to the Adafruit Dashboard. The complete process flow is shown with the help of flowchart shown in figure 2.

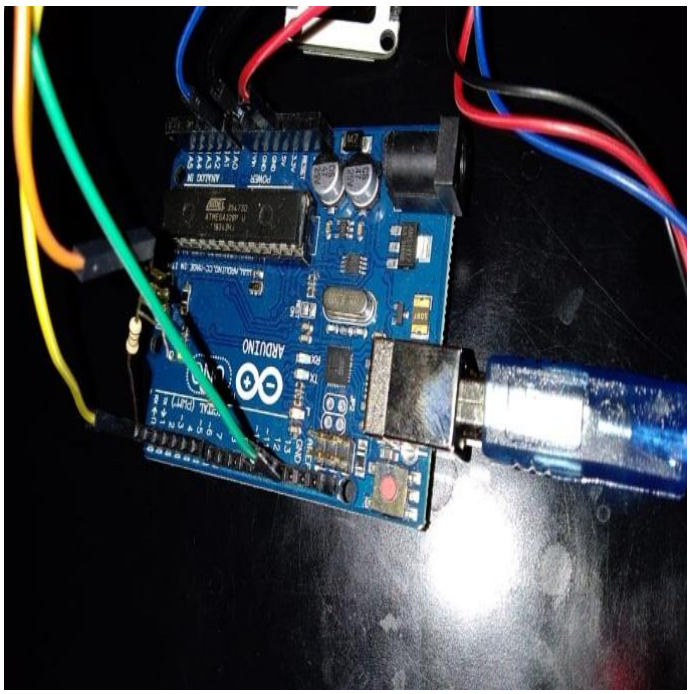

Figure 1.Arduino board with connection

IV. RESULTS

All of the results obtained are shown in this section. The first result is the result obtained from the Adafruit Dashboard shown in figure 3. As shown in the screenshot, the power in Watt (shown as 3.37) reading is displayed according to which the total bill amount (i.e.10.11) is obtained.

This is the second result that has been obtained from MQTT Dashboard. It can also show the live power consumption and bill amount (as shown in the screenshot in figure 4).

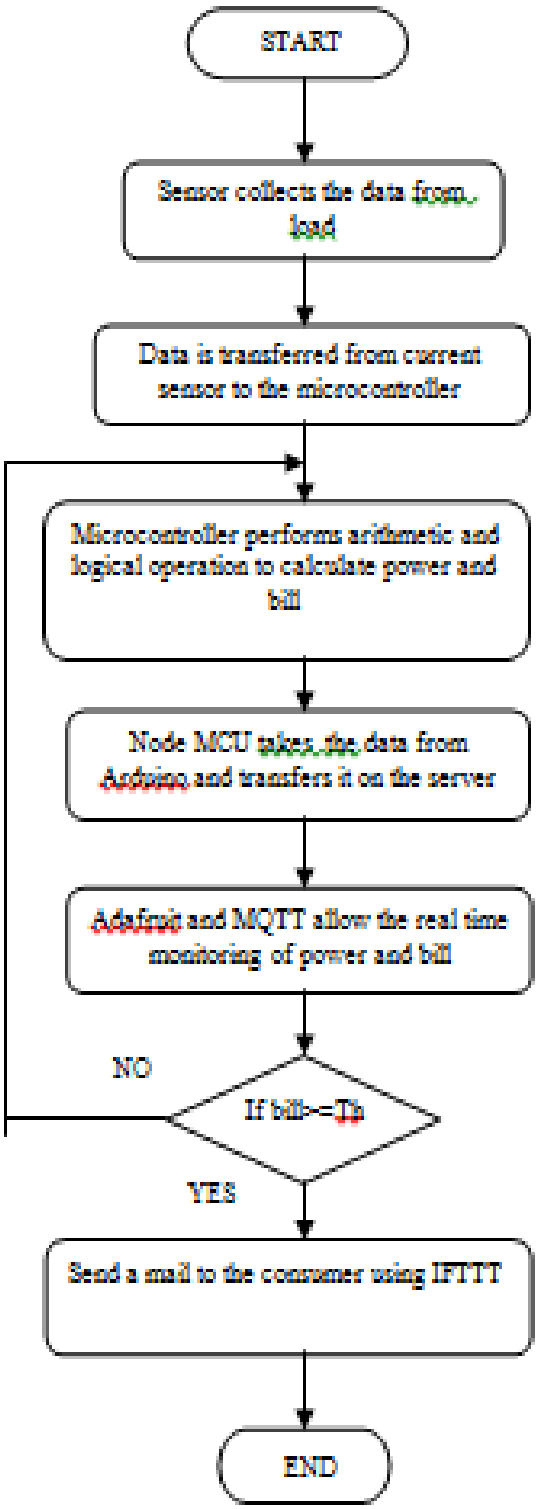

Figure 2. Flow of Operation

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Figure 3.Adafruit dashboard reading

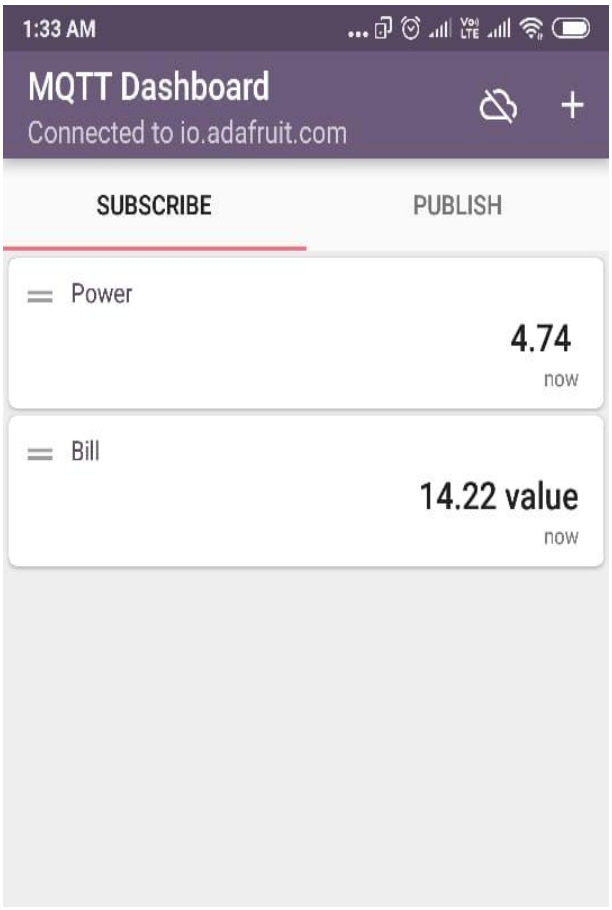

Figure 4. MQTT dashboard reading

The last result that is obtained from IFTTT trigger generator is shown in figure 5. As shown, a mail from IFTTT is received whenever the bill amount reaches the threshold value.

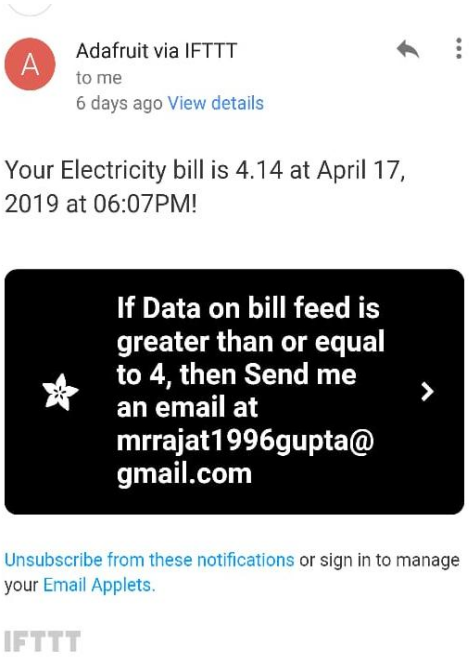

Figure 5. G-mail notification

V. CONCLUSION & FURURE SCOPE

Smart energy meter is mainly intended for cities which have public hotspot or where internet is available. The smart energy meter is based on concept of IoT that requires internet. The aim of the smart energy meter is to replace the conventional energy meter or billing system used in India [7]. The smart energy meter will enable the users to access the meter reading globally at any time. It can be used to reduce the power wastage by optimizing the power usage. A mobile app can be used to notify the user whenever limit is crossed. This meter will remove the requirement of a person to take readings and by doing that it can save a lot of time and cost. The smart energy meter will increase the reliability and flexibility too.

This paper aims to provide the overall infrastructure of smart billing system that is currently being used for the concepts related to smart city. The project provides the entire power readings by single click. The major improvement that can be done in this proposal is that it can be used to save energy by using another Arduino and human sensor that will detect if someone is present in the room or not. If no

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one is present, then it will trigger ansms or mail to notify the user.

This system can be used to replace the prepaid meters (used in smart cities) that don't allow us to monitor or recharge without entering the token no to the meter

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