International Journal of Research in Advent Technology, Vol.5, No.3, March 2017
E-ISSN: 2321-9637
Available online at www.ijrat.org

Smart Electricity Meter using Wi-Fi

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Abstract: This paper describes the digitization of energy meter readings over the internet. The proposed system design eliminates the human involvement in electricity maintenance. The buyer will be able to pay for the usage of electricity on schedule. The user can monitor energy consumption in watts from a webpage by providing a channel id for the meter. The Webpage utilizes the MATLAB analytics to analyze the energy usage to give more detailed description and visualization of the energy usage statistics. Wi-Fi unit performs IOT operation by sending energy meter data to a webpage which can be accessed through the channel id of the device.

In the proposed system, consumer can do power management by knowing energy usage time to time. The proposed system utilizes an Arduino microcontroller. The bill generated can be displayed on the webpage through the Wi-Fi module. The customer will be able to pay the bill on schedule. Revenue losses to the government can be reduced and one can utilize power more efficiently.

Index terms- Arduino controller, ATmega 328p, ESP 8266, 16*2 display.

1. INTRODUCTION:

The Internet of things concept enables us to connect the normal day to day devices with each other over the internet. The devices connected through IOT concept can be controlled and analysed remotely. The IOT concept provides the basic infrastructure and opportunities to form a connection between the physical world and computer based systems [8]. The concept has been gaining importance with more and more wireless devices that are increasing rapidly in the market. It connects the hardware devices with each other over the internet. The ESP 8266 Wi-Fi module used in the system provides the connectivity with the internet in the system.

Now-a-days the demand for electricity is increasing at a constant rate throughout the population and is being utilized for various purposes wiz, agriculture, industries, household purposes, hospitals etc.,. So, it is becoming more and more complicated to handle the electricity maintenance and requirements. Therefore there is an immediate requisite to save as much electricity as possible. As the demand from the newer generations of population for electricity is increasing so in accordance with it the technology improvement is needed. The proposed system provides a technical twist to the normal energy meters using the IOT technology. Also there are other issues that we have to address such as power theft and meter tampering which in turn generate economic loss to the nation. Monitoring, Optimized power usage and reduction of power wastage are the major objectives that lie ahead for a better system.

The present system vastly depends on human involvement for billing. Billing requires a human individual to visit each and every customer's energy meter and generate the bill by taking the unit readings from the energy meter. This is a time consuming process. To address all the mentioned constraints we developed a system on the basis of IOT technology.

Smart energy meter using Wi-Fi system is designed based on three major objectives. They are 1.to provide automated meter reading over an immediate basis. 2. To use the electricity in an optimized manner 3.in order to reduce the power wastage. Similarly the system should also be useful to the service end. So the system basically can be classified on the basis of service ends in two ways. 1. Consumer end 2.Service end. The data from the system is displayed on a webpage which can be accessed by both the consumer and service provider.

The system is designed on an Arduino micro controller [2]. It can be structurally differentiated into three parts controller, theft detection circuit and a Wi-Fi unit. The controller performs the basic calculations and processes the information. Theft detection circuit provides information about any meter tampering and the most important role is played by the Wi-Fi unit to send the information from the controller over the Internet. The service end can remind the consumer about the bill generated for the usage over a common messaging platform. The Arduino controller is programmed on the Arduino software IDE which is a pre-requisite to operate on the Arduino board. Its code is derivative of the c language [1].

2. PROPOSED METHOD:

Block diagram

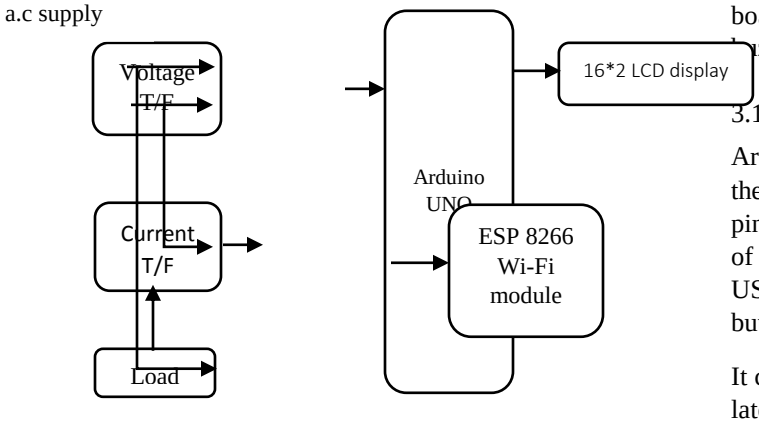

Figure 1: Block diagram

The block diagram consists of an Arduino UNO board, an ESP 8266 Wi-Fi module and a 16*2 LCD display. The Wi-Fi module is the main component used in the IOT operation. The centre piece being the Arduino board provides the connection between the different components of the proposed system [3]. The Arduino UNO board is based on the ATmega 328p processor [4]. It is the core of the system which is necessary for the principle operations that are necessary to be carried out such as the automatic electricity billing and tampering detection inputs from the tampering circuit. The load represents the devices that require the electricity to operate. The ac supply is connected to the system through the transformers to power the system. The Meter is also connected to the system to automate the power usage of the household. The readings from the energy meter are then processed and are updated over the Wi-Fi through the ESP 8266 Wi-Fi Module [5]. If any tampering is detected the system updates the situation on the webpage used to display the energy readings. After updating the energy readings on the webpage, the system then displays the energy readings on the LCD display. In case of any tampering the buzzer will go off making a loud noise. All the information from the system is readily available on a webpage called Thingspeak.com.

3. IMPLEMENTATION:

The smart electricity meter using Wi-Fi module can be easily deciphered in to two parts. The first part being the physical part and the second one being the Webpage.

3.1. ***The physical part:*** It consists of the Arduino board, ESP 8266 Wi-Fi module, 16*2 LCD display, buzzer and power supply.

3.1.1. *Arduino Uno board*

Arduino is a microcontroller board and it is based on the AT mega 328P [4]. It consists of 14 digital I/O pins and 6 analog input pins and a crystal oscillator of 16 MHz frequency, a power supply jack and a USB port to dump the code, ICSP header and a reset button.

It can be powered with the power jack at the start and later can be powered with AC to DC adapter or with a battery.

3.1.2. *ESP 8266 Wi-Fi module*

The ESP 8266 Wi-Fi module is a low cost component with which manufacturers are making wirelessly networkable microcontroller module. ESP 8266 Wi-Fi module is a system-on-a-chip with capabilities for 2.4GHz range. It employs a 32 bit RISC CPU running at 80 MHz. It is based on the TCP/IP (Transfer control protocol) [3]. It is the most important component in the system as it performs the IOT operation. It has 64 kb boot ROM, 64 kb instruction RAM, 96 kb data RAM.

Wi-Fi unit performs IOT operation by sending energy meter data to webpage which can be accessed

through IP address. The TX, RX pins are connected to the 7 and 8 pins of the Arduino microcontroller.

3.1.3. *16*2 LCD display*

LCD (Liquid crystal display) screen is an electronic display module and finds a wide range of applications. 16*2 display means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5*7 pixel matrix. The 11, 12, 13 and 14 pins of the display are used as data pins for Arduino interfacing. It is used to display the wattage.

3.2. *Web page*

Our system can be used to display the energy meter information in terms of Watts and the corresponding bill generated for the amount of energy consumed. Every user would be able to access the information from anywhere on the earth. Thingspeak.com is one such webpage which takes the help of the MathWorks MATLAB analytics to present the device information in a more detailed analysis in both description and visualization.

Thingspeak.com provides the user the ability to add any number of channels to one account and in each account information can be fed into 8 fields [7]. An account can be assigned to one division of an area and n channels can be created to a suite of n meters in the locality. The analytics can be viewed by both the consumer and service provider. MATLAB visualizations can be added to the analytics to provide a comprehensive analysis of the energy usage.

4. RESULTS:

The following are the results obtained.

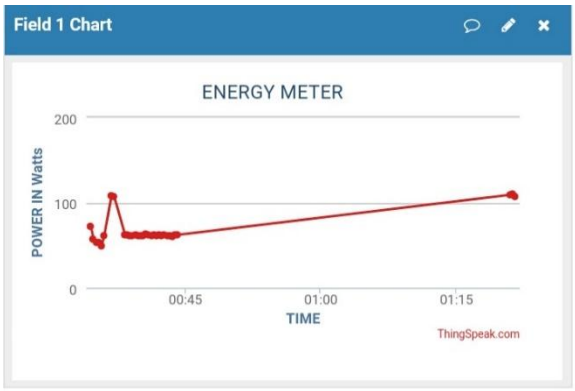

Figure 2: Energy usage profile on Thingspeak.com

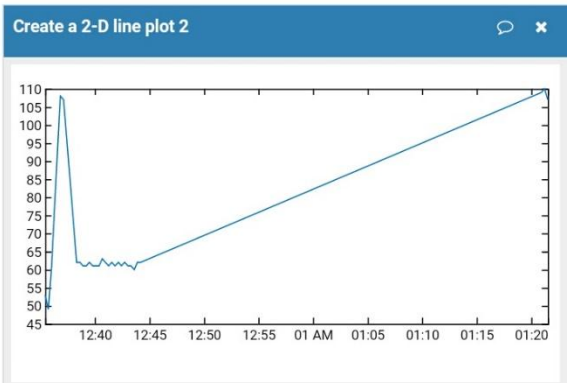

Figure 3: 2D plot of the energy usage profile

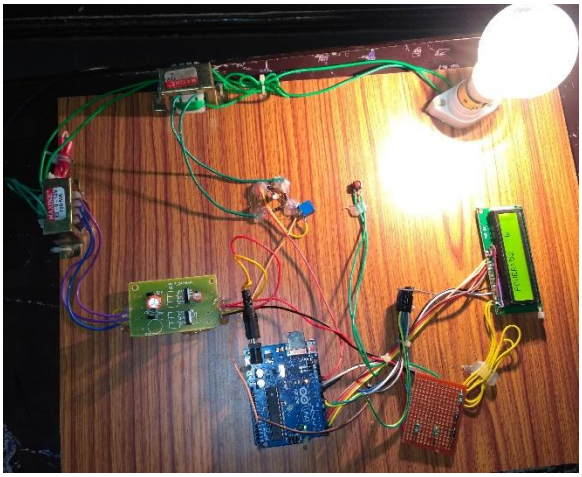

Figure 4: System implementation

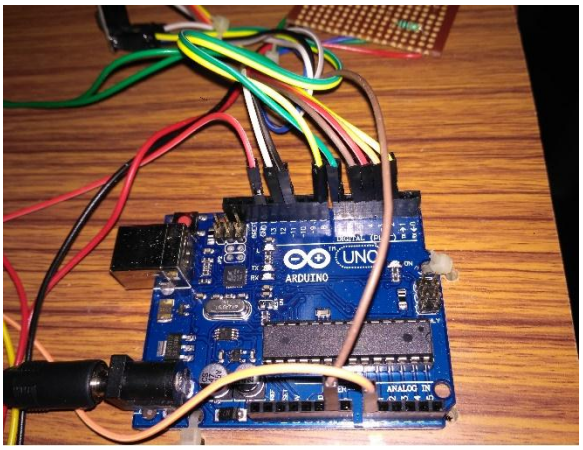

Figure 5: Arduino board with connections

Figure 6: LCD display showing energy usage

5. CONCLUSION:

The system is mainly intended for smart cities with public Wi-Fi hotspots. The project is based on the internet of things concept. This is aimed at replacing the old energy meters with an advanced implementation. It can be used for automatic power reading by which one can optimize their power usage thereby reducing the power wastage. The readings from the meter are uploaded to Thingspeak.com where a channel with the energy usage for a particular energy meter can be viewed by both the service end and the customer. MATLAB visualizations can be further added to provide detailed power usage and billing as per the government rules. A smart app can be used to alert the user when a threshold is crossed.

6. FUTURE SCOPE:

The project is focused on the government's plan to turn the major cities of the country into smart cities. The project provides the entire energy readings at one's finger tips. The project can be further extended to detect the energy meter tampering. A smart app can be designed to provide various alerts based on the readings from the device. A unified can be provided to the customers for both viewing the energy usage and a platform to pay the bill online following the digital India initiative. In one case the service provider can evaluate the bills which are not paid and can disconnect the energy connection remotely.

Acknowledgement

I thank the management, Principle, HOD, our guide Ch.Karuna pravaha, M.Tech,. Assistant professor, Dept. of ECE,Tirumala Engineering college and staff of the ECE department, Tirumala Engineering College, Guntur, India in encouraging us for this work.

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