IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 6, May 2022
Impact Factor: 6.252

IoT Based Smart Energy Meter

Shubham Hadap[1], Deepti Ighe[2], Dhanashri Kadam[3], Rahul Niakm[4]
Faculty, Department of Electrical Engineering[1,2,3,4]
MET Institute of Engineering, Nashik, Maharashtra, India

Abstract: *Due to rapid increase in human population and the human's dependency towards electrical energy, the demand for electricity has increased many folds, causing deficit of electrical energy during peak hours. In order to cope up with the energy challenges, it is necessary to modernize the electrical system. Internet of Things (IoT) technology can be employed to energy consumption and distribution in different scenarios. This paper mainly focuses on automatic billing, power card facility, theft detection, power optimization and providing the relevant energy consumption information to user. IOT based smart energy meter system basically consists of three major components namely controller, Wi-Fi and Theft detection device. Whenever there is any theft or fault, the theft detector sensor detects the error and responds accordingly. The controller plays a vital role in keeping all the components in working state. In this system energy meters are connected to the internet i.e., using IoT concept, eliminates the human intervention in electricity maintenance. In the proposed work, IoT based meter reading system is designed to continuously monitor the meter reading and service provider can disconnect the power source whenever the consumer does not pay the monthly bill and also it eliminates the human intervention, delivers effective meter reading, prevent the billing mistakes..*

Keywords: Internet of Things(IoT), smart energy meter, automatic billing, Power theft detection

I. INTRODUCTION

At present, Electricity is the essential commodity in the world for human life today. Every home, offices, companies, industries requires electricity connection for their functioning. Due to rapid increase in human population and the human's dependency towards electrical energy, the demand for electricity has increased many folds, causing deficit of electrical energy during peak hours. In order to cope up with the energy challenges, it is necessary to modernize the electrical system. Internet of Things (IoT) technology can be employed to energy consumption and distribution in different scenarios. Latest development in IoT and digital technology, the concept of smart city is becoming smarter compared to earlier years. Therefore it is necessary to switch over to innovative and better alternatives such as smart grid, smart metering and zero energy building that will assist to minimize reliance on these assets by minimizing energy consumption and improving usage of renewable energies. This will in turn increase the efficiency of power and energy manages system. Accurate metering, detection of theft and implementation of proper tariff and billing system would manage the consumption of electrical energy. Collecting meter reading is one of the most difficult procedures in billing. The traditional electrical energy meter data collection is such that a person from the utility provider visits the consumer sites periodically to note the meter reading. This procedure has lot of drawbacks such as, it is time consuming, tiresome, requires more human resource, human error and even corruption is probable. The process may be interrupted due to bad weather conditions, also if the consumer is not available, the billing will be pending and human operator needs to revisit. India is facing energy deficit during peak hours. Low voltage during peak hours has been reported as a major power quality issue. Load shedding is a common power management practice followed by the utility providers. Energy conservation has great significance in this scenario of increasing electrical energy demand.

The present system of energy billing is error prone, time consuming and laborious. Errors get introduced at every stage of energy billing like errors with electro-mechanical meters, human errors while noting down the meter reading. These errors can be overcome by using the smart energy meter. The main objective of the proposed work is to develop a smart energy meter. The Arduino takes the pulse from the energy meter, calculate units and displays the reading on the LCD. The reading is stored in built in EEPROM so, in case of power failures it continues the computation. The reading of the energy meter is also sent to the cell phone of the user in the form of a message through Wi-Fi modem. The proto type system is powered by external power supply that takes the ac power and converts it into dc power and is fed to Arduino and Wi Fi.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 6, May 2022
Impact Factor: 6.252

This paper mainly focuses on automatic billing, power card facility, theft detection, power optimization and providing the relevant energy consumption information to user. Here the user can monitor the energy consumption units from a web page by providing device IP address. Theft detection unit connected to energy meter will notify company side when meter tampering and theft detection occurs in energy meter through PLC modem and theft detected will be displayed on the terminal window. In this system energy meters are connected to the internet i.e., IoT concept and it eliminates the human intervention in electricity maintenance. This paper is presented in six sections including introduction section. Section II presents the details of proposed prototype IoT based smart energy meter system. The hardware details of the proposed approach are given in section III. Software details are discussed in section IV. The experimental results observed are presented in section V and finally the conclusions are presented in section VI.

II. LITERATURE SURVEY

Title 1: Smart sensory energy metering.

Introduction:

SSEM (Smart Sensory Energy Metering) is an electronic device that records consumption of electric energy and allows customers to program how and when their home uses energy.

Title 2: IOT Based Smart Energy Meter for Efficient Energy Utilization in Smart Grid.

Introduction:

Smart grid plays an important role in our current society and in our networks. Smart meters play a vital role. Smart meter provides immediate monitoring of reliable status, automatic information collection, user interaction and energy control. It also provides a double flow of information between consumers and suppliers, provides better control and efficiency. It also provides real-time consumption information and provides power control. As long as the customer's maximum load demand exceeds the maximum value, the electricity supply to customers will be separated with the help of an intelligent power meter. In an ideal environment with normal workload conditions, the smart meter has a service life of 5 to 6 years. In project, the use age of the smart meter with IOT technology is introduced. The IOT-based power meter system consists mainly of three main parts, which are remote control, Wi-Fi and theft detection part. When there is an error or theft, the theft detection sensor detects the error response and the circuit according to the information it receives. The console plays a key role in the system to ensure that all components work well. Therefore, Internet of things can improve the performance and efficiency of the smart grid mainly in the three phases.

Title 3: Implementation of Smart Meter Working as IEEE1888-6LoWPAN Gateway for the Building Energy Management Systems.

Introduction:

When building the power management system, Smart Meter (SM) plays an important role in helping users feel active and determine energy consumption. As a result, multiple efforts have been made to improve the function of this device in order to contribute to the reduction of energy consumption towards a green economy and sustainable development. In addition to SM, other protocols have been developed to achieve intelligent, convenient and safe management and control between buildings or building blocks. With the growing growth of devices connected to the Internet, the Internet of things, the integration of millions of devices into the Internet IPv4 is not the best option. Therefore, IPv6 is designed to solve this problem. IPv6 allows more Internet based devices. IPv6 is more complex than IPv4; therefore, devices usually consume more energy. Based on previous concerns, the low power IPv6 protocol was developed for the wireless personal area network to reduce consumption.

III. PROPOSED METHODOLOGY

Our proposed system uses the Arduino UNO board, Wi-Fi module and a LCD display. The Wi-Fi module is the main component in the IOT operation. The Arduino UNO board is connected to a sensor which will sense the meter readings and the readings are then processed and are updated over the Wi-Fi through the Wi-Fi module. The readings are updated over the webpage which can be easily accessed by the users. This allows the user to easily check the energy usage by

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 6, May 2022
Impact Factor: 6.252

using a simple web application. Thus this system allows the users to effectively monitor the electric meter readings and check the billing online with ease.

IV. HARDWARE DETAILS

In this section hardware details are described, first design module is explained then brief description about each hardware components are given one after the other in the following section.

Design Model

In the prototype system the power utility maintains a server and each consumer are provided an energy meter. The server, power sim meters and Wi-Fi module are used to communicate with each other using Wi-Fi network. Fig 2 shows prototype power sim energy management system. The energy meter consists of a microcontroller (ATmega328), energy measuring chip (AAE7751), Current transformer, potential transformer, LCD display and a relay.

The energy consumption by counting the output pulses of the EM chip on an interrupt basis. The Microcontroller uses AT command set to communicate with the Wi-Fi module. The Embedded C programming language has been used to program the microcontroller and to connect the server respectively.

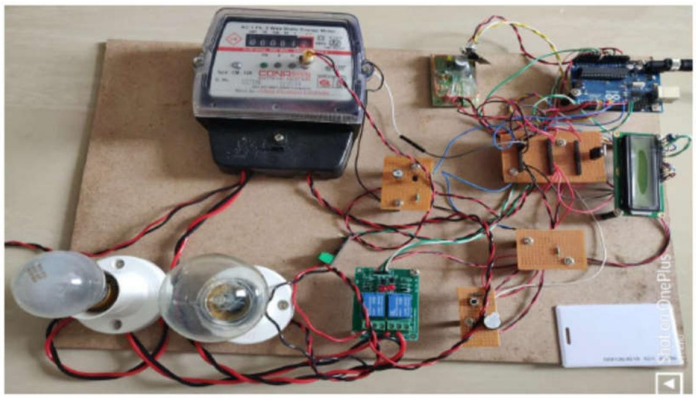

Figure 2: Designed proto type smart energy meter model.

Digital Electronic Energy Meters: Digital signal processor or high performance microcontrollers are used in digital electric meters. Similar to the Analog meters, voltage and current transducers are connected to a high resolution ADC. Once it converts Analog signals to digital samples, voltage and current samples are multiplied and integrated by digital circuits to measure the energy consumed.

Microcontroller also calculates phase angle between voltage and current, so that it also measures and indicates reactive power. It is programmed in such a way that it calculates energy according to the tariff and other parameters like power factor, maximum demand, etc. and stores all these values in a non-volatile memory EEPROM.It contains real time clock (RTC) for calculating time for power integration, maximum demand calculations and also date and time stamps for particular parameters. Further it interacts with liquid crystal display (LCD), communication devices and other meter outputs. Battery is provided for RTC and other significant peripherals for backup power.

Arduino

Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232 is shown in figure 3. Some boards, such as later-model Uno boards, substitute the FTDI chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own ICSP header. Other variants, such as the Arduino Mini and the unofficial Boarding, use a detachable USB-to-serial adapter board or cable, Bluetooth or other methods, when used with traditional microcontroller tools instead of the Arduino IDE, standard AVR in-system programming (ISP) programming issued.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 6, May 2022
Impact Factor: 6.252

Figure 3.Aurdinu

LCD display

A liquid-crystal display (LCD) shown in figure 4, is a flat-panel display or other optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour or monochrome. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as pre-set words, digits, and 7-segment displays, as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

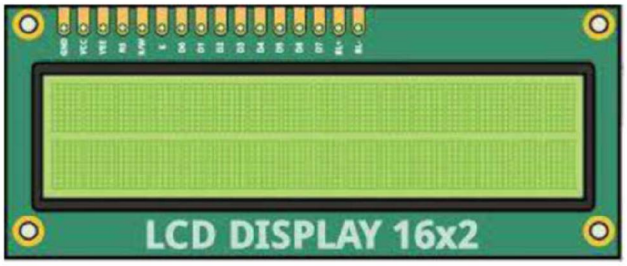

Figure 4. LCD Display

Regulated Power Supply

Today almost every electronic device needs a dc supply for its smooth operation and they need to be operated within certain power supply limits. This required dc voltage or dc supply is derived from single phase ac mains. A regulated power supply can convert unregulated an ac (alternating electric current or voltage) to a constant dc (direct electric current or voltage). A regulated power supply is used to ensure that the output remains constant even if the input changes. A regulated DC power supply is also called as a linear power supply; it is an embedded circuit and consists of various blocks. The regulated power supply will accept an ac input and give a constant dc output. Figure 5 shows a typical regulated dc power supply.

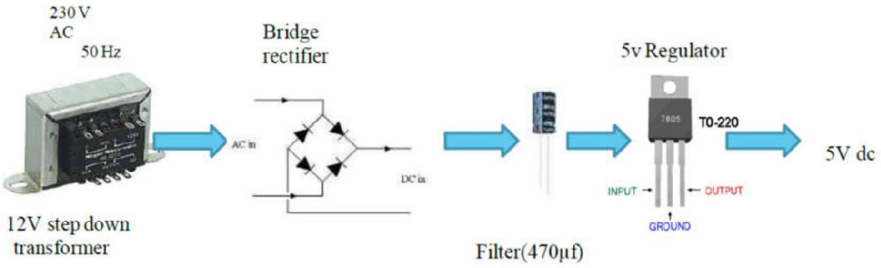

Figure 5 Regulated power supply

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 6, May 2022
Impact Factor: 6.252

Wi-Fi Module (ESP8266)

ESP8266 is Wi-Fi enabled system on chip (SoC) module developed by Espressif system is shown in figure 7. It is mostly used for development of IoT (Internet of Things) embedded applications. It employs a 32-bit RISC CPU based on the Tensilica Xtensa L106 running at 80 MHz (or over clocked to 160 MHz). It has a 64 KB boot ROM, 64 KB instruction RAM and 96 KB data RAM. External flash memory can be accessed through SPI.ESP8266 module is low cost standalone wireless transceiver that can be used for end- point IOT developments.To communicate with the ESP8266 module, microcontroller needs to use set of AT commands. Microcontroller communicates with ESP8266-01 module using UART having specified Baud rate.

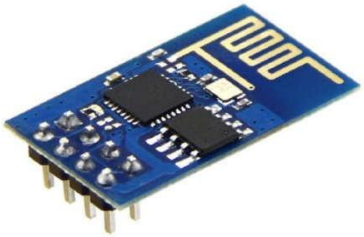

Figure 6 WiFi Module

The Project has achieved following objectives:-

1. Easy of accessing information for consumer from energy meter through IoT.
2. Theft detection at consumer end in real time.
3. LCD displays energy consumption units and temperature.
4. Disconnection of service from remote server.

VI. ADVANTAGES

1. From this system consumer can set the monthly electricity billing budget. Hence less wastage of energy.
2. Every month the person from electricity department has not to visit the consumer house for the note down the consumed energy hence labour work get reduced.
3. The cost of this device is not more because the system uses the low cost equipment and also the installed energy meter will not be replaced or tampered. From the installed energy meter authorized this system takes the input.

VII. CONCLUSION

In the aera of smart city, smart grid advancement, prototype smart energy meter is a step forward and it mainly focusses on the connectivity & networking factor of the IoT. In this system, an energy consumption calculation based on the counting of calibration pulses is designed and implemented using Arduino Uno MCU in embedded system domain. In the proposed work, IoT based meter reading system is used to continuously monitor the meter reading, current energy consumption, theft detection and service provider can disconnect the power source whenever the consumer does not pay the monthly bill.All these information are sent in the form of message alerts to the consumer mobile phone.Also it eliminates the human intervention, delivers effective meter reading, prevent the billing mistakes.

VIII. ACKNOWLEDGMENT

We would like to thanks Dr. Deepak Kadam, (HOD) of Electrical department, MET IOE Nashik, and Mr. Rahul Nikam, Sr. Associate Professor of Electrical department MET IOE Nashik, and Mr.AbhilashNetake, Sr. Associate Professor of Electrical department MET IOE Nashik, for their inspiration, guidance and valuable suggestions.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 6, May 2022
Impact Factor: 6.252

REFERENCES

[1]. Nabil Mohammad, AnomadarshiBarua and Muhammad Abdullah Arafat† Department of Electrical and Electronic Engineering, ―A Smart Prepaid Energy Metering System to Control Electricity Theft‖, International Conference on Power, Energy and Control (ICPEC) 2013.

[2]. Visalatchi S and Kamal Sandeep K, ―Smart Energy Metering and Power Theft Control using Arduino& GSM‖, 2nd International Conference for Convergence in Technology 2017.

[3]. Mohammed HosseinandHosseinHejazi Design and Implimentation of an Internet of Things Based Smart Energy Metering 6th IEEE International Conference on Smart Energy Grid Engineering in 2018.

[4]. BibekKanti Barman, Shiv NathYadav, Shivam Kumar and SadhanGope, ―IOT Based Smart Energy Meter for Efficient Energy Utilization in Smart Grid‖, IEEE conference 2018.

[5]. Garrab, A.; Bouallegue, A.; Ben Abdallah, ―A new AMR approach for energy saving in Smart Grids using Smart Meter and partial Power Line Communication‖, IEEE First International Conference on Renewable Energies and Vehicular Technology (REVET), pp. 263 – 269, march 2012.

[6]. SomashekharSwamy and P K Kulkarni Realization of Energy Management System, Impendents on its path in India. International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering Volume 9, Issue 5,May 2020.

[7]. Smart Power Meter for the IoT, M. Carratu; M. Ferro; A. Pietrosanto; V. Paciello, 2018.

[8]. Energy theft and defective meters detection in AMI using linear regression, SookChin Yip; Chia-Kwang Tan; Wooi-Nee Tan; Ming-Tao Gan;Ab-Halim Abu Bakar, IEEE 2017.

[9]. Apoorva ,Ashwini and Nisarga B.E project report on IoT based smart energy meter with power theft information and automatic billing Global Academy of Technology Bangaluru for the year 2019-20.

[10]. Eyad I. Abbas, Mohammed E. Safi and Mustafa Abd-alreesJaber Department of Electrical Engineering, ―Design and Implementation Prepaid Energy Meter Supported by RFID and GSM Technologies‖, International Conference on Advanced Science and Engineering (ICOASE), Kurdistan Region, Iraq 2018.