IoT BASED POWER MONITORING SYSTEM FOR SMART GRID APPLICATIONS

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Abstract

Internet of things (IOT) is widely used in smart energy monitoring, industrial automation and variety of applications. Internet of Things comprise of a set of internet services provided on top of a number of Internet enabled embedded devices. At various stages of smart grid (SG), IOT devices are employed to monitor and control grid statistics for reliable and efficient delivery of power. Although IOT integration in the SG domain provides many benefits, the challenges in IOT-SG integration needs to be solved for the efficient operation of the grid. The IOT based power monitoring system is capable to measure and analyze the electrical parameters such as voltage, current, active power and energy consumption of loads. Blynk app is used to store the data, visualize the data and also control the loads in home. Blynk cloud is an open source IoT platform to store and show the real time data to the consumers or producers. Based on this data, the consumer and electrical power companies in the SG paradigm can better manage their consumption to reduce billing costs.

Keywords: : IoT aided SG, Power monitoring system, Blynk app.

Introduction

Today, technology has become an integrated part of people's lives. It continues to influence many aspects of daily life and has allowed better social interaction, ease of transportation, the ability to indulge in entertainment and media and has helped in the development in medicine. The creation of many devices such as mobile phones and computers have caused many people to rely on technology to communicate with their friends, store information such as pictures, movies, documents, and music. The internet has become a common interface that many devices use in order to simplify the daily life of many people. Internet helps us to bring in with immediate solution for many problems and also able to connect from any of the remote places which contributes to overall cost reduction and energy consumption.

Home automation or sensible home may be delineated as introduction of technology within the home atmosphere to provide ease and protection to its occupants [1]. By using the technology of the Internet of Things, the examination and execution of home automation have got additional average. Various wireless technologies which is able to support some sort of remote knowledge transfer, sensing and management like Bluetooth, Wi-Fi and cellular networks are used to enter abundant levels of acumen within the home [3]. Home automation for the older and disabled will offer raised quality of life for persons. It may provide an interface to home appliances or the automation system itself, via telephone line or the internet, to supply management and observance via a smart phone or personal computer.

The Internet might even be utilized in power monitoring system that offers several decisions from economical use of energy to additional console, protection and safety. Even over great distances the user can monitor and manage their home gate, various appliances and turn on/off the T.V without any human intervention. Despite these advantages, power monitoring system has however received extensive approval and an attention owing to its high significance and complexness [7]. This paper will describe an approach in which we implement a controlling and continuous monitoring system to control various home appliances with Android smart phone [5].

The integration of Information and Communication Technologies (ICTs) and IoT in SG ensure reliability, cost-effectiveness, and intelligent features with minimal human intervention. Two-way communication is the key requirement in the paradigm of IoT among smart devices and components [4]. Smart homes are developed by the integration of smart electric meters and IoT [6]. For deployment in smart cities, an IoT assisted real-time Zigbee mesh WSN based Automatic Meter Reading (AMR) system is implemented in [9]. The proposed system provides a reduction in peak loads with improved Demand Side Management (DSM) [5]. Sensors, communication, and control mechanisms will play a vital role in achieving reliable and secure power grids.

Statement of the Problem

The traditional energy meter only measures the measurement of power consumption in KWH or units by rotating disc in centre of meter. The disc is supported by a spindle which has a worm gear which drives the register. The register is a series of dials which record the amount of energy consumed. By using disc method, the accuracy of power consumption is less. So, this is a old process and there is a chance of power theft also by using conventional energy meters. The requirement of man power high compared to latest technologies.

Objectives of the study

The main objective of this IoT based power monitoring system is to monitoring and controlling of the home appliances, industrial loads, commercial usage appliances, etc. With the advanced technology presented in the market, not only monitoring and controlling of the appliances or loads is not sufficient. So, proposed power monitoring system is to detect the energy theft through the current sensor and give the accurate reading from the loads through the Mobile screen. In conventional energy monitoring system i.e., energy meter, only the readings were shown in the meter screen through the rotated disc. And also there is a chance of human error and human involvement. So, by keeping these drawbacks, we want to implement this IoT based Power monitoring system. By implementing this system, we can mitigate the energy theft, human error, inaccurate readings and more human intervention.

Review of Literature

Pavithra D & Balakrishnan R in [1] have concluded that the loads in the home can controlled individually by using Internet of Things with the advanced technology. Relay is used to control the loads individually.

R. Morello, C. De Capua, G. Fulco and S. C. Mukhopadhyay in [2] have concluded that By using IoT in the electrical grid in future how to monitor the smart grid appliances will be measured or monitored in future.

H.G.Rodney, Tan IEEE, C.H.Lee and V.H.Mok in [3] have concluded that A microcontroller based automatic electricity meter reading system which provides cost effective, reliable and interference free data transfer between remote meter reading units and the electric utility control center.

Patel Darshit & Patel H.B in [4] have concluded that GSM based energy meter monitoring and load control talks about different peculiarities and advances that can be incorporated in a smart meter. The microcontroller takes the reading from the energy meter via an opto coupler and display the reading. It is also sent to user through GSM modem being fed from the microcontroller via level shifter IC and RS232 link.

Khan, Fahad & Siddique in [5] have concluded that Smart energy meter that the users will be able to monitor their current power consumption anytime from anywhere by using their mobile phone. It provides a cost efficient manner of electricity billing.

Atzori, Luigi, Antonio Iera, and Giacomo Morabito in [6] have concluded that Fog/edge computing is an architecture organized by the networking edge devices or clients to provide computing services for customers or applications in the space between networking central servers and end-users.

Y. Saleem, N. Crespi, M. H. Rehmani and R. Copeland in [7] have concluded that SGs employ various devices for the monitoring, analysis, and control of the grid, deployed at power plants, distribution centers, and in consumers' premises in a very large number. Hence, an SG requires connectivity, automation, and the tracking of such devices. This is achieved with the help of the Internet of Things (IoT).

S. Uludag, K. S. Lui, W. Ren and K. Nahrstedt in [8] have concluded that Deployment of data generation devices such as sensors and smart meters have been accelerating toward the vision of smart grid. The volume of data to be collected increases tremendously. Secure, efficient, and scalable data collection becomes a challenging task.

Govindak in [9] has conclude that Design of Smart Meter using Atmel 89S52Microcontroller consists of a power meter reader system with GSM interface. The GSM modem also has SMS receiving capability. On receiving particular user request it sends required signal to the microcontroller in order to do counting for required operation. It can switch loads ON/OFF as desired.

Research Methodology

Every user who is experienced in the existing system may think of a system that may add more flexibility and run with some common applications such as android. This work is designed in such a way to avoid the disadvantages of the existing system. The main objective of the Proposed system is to design and to execute an cost effective and open source IoT based Power Monitoring System that's capable of leading most of the homes and sustain the power monitoring system. The predictable system contains a great elasticity by using wireless reliable technology to interconnecting various modules to the server of Power Monitoring system. This in turn reduces the deployment cost; will add to the flexibility of advancement, and system reconfiguration. The projected system can make use of wireless LAN(Local space Network) connections between various sensor, hardware modules and server, and various communication protocols between users and server [5].

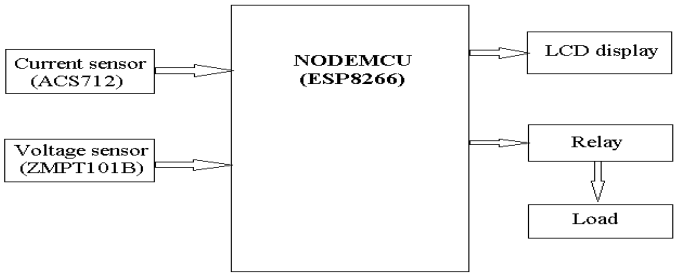

Figure-1: Block diagram of IoT Based Power Monitoring System

The block diagram of IoT based Power Monitoring System is shown in Fig. 2. In this proposed system, Current sensor is used to calculate the current and it is connected to the Nodemcu through analog pin. Voltage sensor is used to calculate the voltage. After calculating the readings of current and voltage, Nodemcu will gather load data in terms of current and voltage through analog pins and saves it in internal memory. Wi-Fi module fetches load data from Nodemcu through a UART interface and communicates the load data with the cloud server [8]. Wi-Fi modulates acts as a gateway between the monitoring side and the web server side. The voltage and current values will be continuously uploaded to the Cloud Server. At the same time, Current and power values will be shown in the LCD screen and at every second values will be refreshed. In the block diagram, single channel relay module is used to control the load. By using this relay, we can turn on or off the load. Based on the requirement of loads, we can choose different types of relay module. For 2 loads, two channel relay module is required and for 4 loads, four channel relay module is required.

Results and Discussion

Figure-2 shows the IoT based power monitoring system with no load. The current and voltage values displayed in LCD display and also displayed in the mobile screen through the Blynk app.

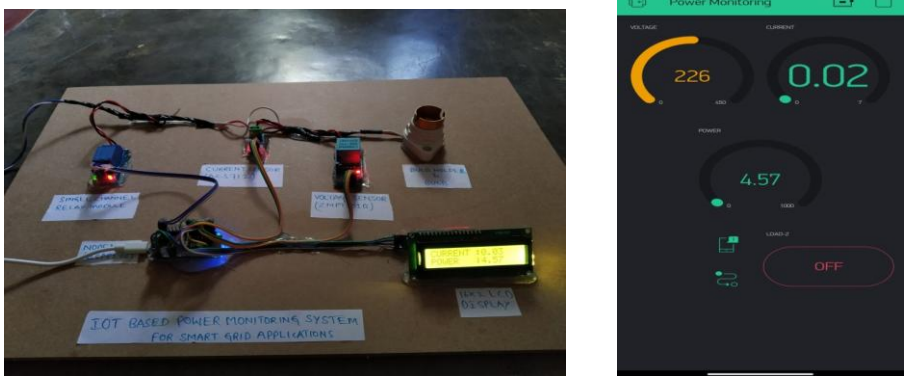

Figure-2: IoT based Power Monitoring System and Expected result with No Load

Figure-3 shows the IoT based power monitoring system with 100 watts load. The current and power values displayed in LCD screen and also displayed in the mobile screen through the Blynk app.

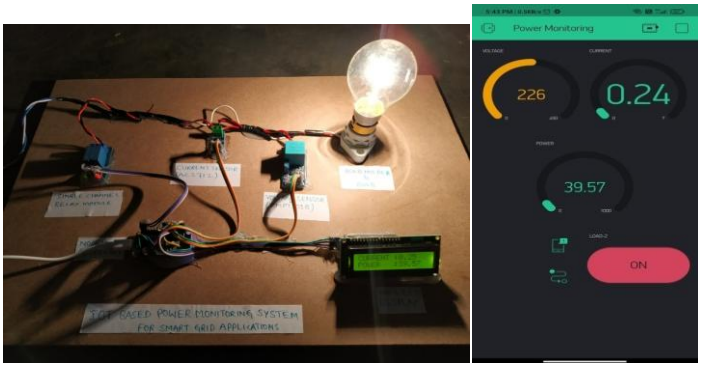

Figure-3: IoT based Power Monitoring System and Expected result with 100W Load

Figure-3 shows the IoT based power monitoring system with 200 watts load. The current and power values displayed in LCD screen and also displayed in the mobile screen through the Blynk app. Mobile screen shows some warning because there is a limit set through the Blynk app to limit the power consumption.

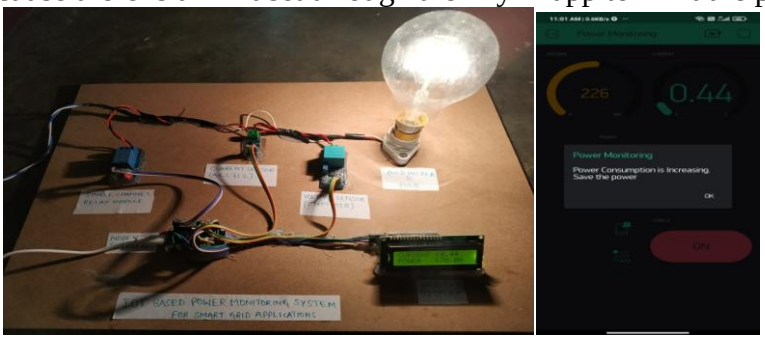

Figure-4: IoT based Power Monitoring System and Expected result with 200W Load

Conclusion

In this paper, IoT based power monitoring system is implemented to monitor and controlling the loads in home using Nodemcu and Internet of Things technology. It can overcome the problem of energy theft, incorrect billing and human errors. The system is suitable for real-time power monitoring and for remotely controlling the home appliances. This system can be employed in many places like homes, commercial buildings, industries, power system like generation, transmission and distribution etc. The various future applications may be used by controlling various household devices of house with internet, Industrial automation and management through internet. By using this method, electricity bills will be decreased due to the less power consumption. The large scale installation of proposed design requires to develop cost-effective power sensing and monitoring devices that can be easily integrated into the consumer premises. In the future, authors are interested to develop a cloud-based smart metering system for the deployment in smart cities.

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