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Energy Management in smart Grids using Embedded System & IOT

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***Abstract*—** Smart home consist of two words that are home controlling and energy monitoring network. In smart home to monitor the home it requires something physical quantity which can be monitor like temperature, moisture, gas leakage, humidity etc so for it requires sensor which can measure the physical quantity can convert it into electrical quantity. The web page can monitor the data .Web of things in which the network are interconnected on the web by adding IP address the data can be access which is called web page. To control the devices it also requires the web page by which it can be controlled as well as by an GSM module the system can be controlled. Here comes a energy sources which are of two type but one of it is getting depleted and that one is non renewable sources. It also pollutes the environment which affects the human beings. So sun is the best form of energy resources which is the example of renewable energy sources. This form of energy is unlimited and can be used in great amount. Smart grid is the electrical network in which self testing monitoring and analyzing is done and reported to the system because of this method the term automated is being introduced. The rapidly growing population over the past decades has resulted in increasing demands of electricity usage. The main objective of the system is to control the system as well as monitor the system by using web page and to save the electricity by using renewable energy sources.

Keywords- *GSM, smart grid, renewable energy sources, WOT, home automation, smart home.*

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I. INTRODUCTION

Web of things is in which the networks are interconnected on the web providing an IP address so as to access the data which is to be required. Now a day the use of web is increasing in great amount so as to get the information. In similar fashion we can even control the home appliances with the help of web as well as we can monitor the devices. The web is considered the helper in day today life. The web it provides the page which is to be access with the help of the IP address.

In earlier days the supply of power was one way communication so if there is any problem regarding to the electricity it was difficult. But now a day the word smart grid is playing an important role. Smart grid it provide us a two way communication and it is an electrical network in which self testing as well as monitoring is done and reported to the system. Because of this method the automated word is being introduced. The rapidly growing population over the past decades has resulted number of houses as well as the use of electricity is increase. Supply from the smart grid is unable to match the demand of electricity.

The electricity is generated from the non renewable energy source which is fossil fuel it is drastically getting depleted. It also pollutes the environment and human life. The fossil fuel leaves behind the carbon footprint which pollutes the society. Typically the energy sources are of two types i.e. renewable and non renewable. The renewable energy sources is eco-friendly and easily available for example sun. Sun this is readily available and can be used to great extend. The inverters can be used to convert the energy it can be stored in battery for the use.

In today's world the mobile plays an important role .Each and every one is having an android phone. By the use of android the system can control the on off of the devices. Hence the system becomes automated as well as even a non technical person can control as well as monitor its home devices. The main aim of this paper is to control as well as monitor the device. The sensor can also be used for controlling the on off of the devices by a threshold value. The solar energy is used which provides the energy with the help of the battery. The GSM module is used to control the device by an SMS. The authentication is done by GSM module. The controller is used to control all the commands and perform the required action. The web page has the device overall power consumption along with the device controlling. With the help of energy meter the system display the overall power consumption. The advantage of the system is the bill of the electricity is reduced automatically the use of non renewable energy resources is reduce hence the cost is reduced.

II. LITERAT URE REVIEW

H. Kumarage, et al. has explained secure data analytic for cloud-integrated internet of things applications. The article explores the unique problems and issues within this context of enabling secure cloud-based data analytic for the IoT. Three main applications based on the use of fully homomorphic encryption systems to achieve data security and privacy over cloud based analytical phases [1].

Z. Guo, et al. has derived home appliance load modeling from aggregated smart meter Data. The model, named Explicit-Duration Hidden Markov Model with differential observations (EDHMM-diff), for detecting and calculating individual home appliance devices from aggregated power signals collected by ordinary smart meters [2].

G. Oriti, A. L. et al. has derived power-electronics-based energy management system with storage. The EMS includes batteries and a controlled single-phase voltage source inverter digitally, which can be controlled as a current source or a voltage source the status of the ac grid depends on it and the user's preference. It also accomplishes peak power control by battery power supplied to the local loads while they are powered by the ac grid if the loads get large [3].

M. Collotta and G. Pau the paper explains a novel energy management approach for smart homes that combines a

wireless network, based on Bluetooth low energy, for communication among home appliances, with a home energy management (HEM) scheme. The approach addresses the impact of standby appliances and high-power rating loads in peak hours to the energy consumption charges of consumers [4].

J. Kim,et al has demonstrates a home appliance control framework based on a smart TV set-top box. As a core component, is installed on the smart TV set-top box as a home gateway software module. And the home gateway module architecture is designed so that a home appliance control driver is installed only when necessary. From any place using a Web-based application or browser the user can control the device. Both IP-based and serial communication based home appliances can be included in the demonstration system [5].

P. Visconti,et al. demonstrated monitoring system of thermo-solar plant based on touch screen interface locally by PC and remotely by Android devices. The paper describes a programmable electronic unit for the environmental parameters controlling and the electrical functions is managed of a civil/industrial thermo-solar plant. The unit which to be control acquires data from analog sensors, processes these information and external actuation devices with dedicated relay outputs by sending the command, allowing the optimization of plant performances in order to maximize efficiency and energy saving [6].

S. Xu, Y. Qian and R. Q. Hu explained a reliability of smart grid neighborhood area networks. In the paper, they present a comprehensive survey of reliability issues posted by the smart grid with a focus on communications in support of neighborhood area networks (NAN). Specifically, they focus on network architecture, reliability requirements and challenges of communication networks and systems, secure countermeasures, and case studies in smart grid NAN [7].

T. Strasser et al. a review of architectures and concepts for intelligence in electric energy systems in future. The paper recent developments enabling higher intelligence in future smart grids with an overview. The combination of renewable sources and storage systems into the power grids is analyzed [8].

Y. E. Wu and K. C. Huang presents the design of a smart household illumination dimming-control. The control can be operated using either an Android application or a computer using either Zigbee or through Wi-fi to connect to a Database Management System (DBMS). In the paper, a linear dimming scheme was used to reduce the light gleaming. In order to achieve variations in the illumination environment, a LED with highly efficient three color was used as the light source. The paper covers the designs of six environment illumination for users control who can deliver the control states to the central controller and mobile phone [9].

Mohanty, S.; Panda, B.N.; Pattnaik B.S. derived the implementation of a WOT based smart grid to monitor and control renewable energy sources. The integration of Web of Things with existing power grid architecture will provide us various opportunities for improvements in our energy saving techniques [10].

M. Mentesoglu, A. Kavak, M. Yakut, A. Tangel, S. Sahin and H. Ozcan proposed mobile device controlled smart home management system to design and implement using communication protocol. A handshaking mechanism between a mobile device and control unit and for messaging packet structure is used between control unit and sensors/actuators are explained. With the system, the controlling of smart home system can be done over a wireless LAN by authorized users using an Android based device on which the implemented GUI software is running [11].

N. Datta, T et.al. describes a project in which an electrical circuit is developed by which an user can turn on or off any electrical devices i.e. fans, lights and can lock or unlock windows, doors etc. of the house or office through sending message using a custom built android application to a specific phone number connected to the microcontroller. In the system an android application is used to send instruction through message. At the receiving end, a GSM module receives the message and sends the particular hexadecimal codes to a microcontroller. Then the code is read by microcontroller and sends the signals to relays for performing action according to the specified logic [12].

Xin Liu et al. explained , a real-time household load priority scheduling based on prediction of renewable source availability is explained to maximize the benefits of renewable sources and the total cost of consumption of grid energy for given consumers is minimized comfort constraints [13].

Zipperer et al. presents a discussion of the state of the art in managing the electricity in smart homes, the various enabling technologies that can accelerate this concept, and topics around consumer behavior with respect to energy usage [14].

Saha, M. Kuzlu et al. explained demonstration of a home energy management system with thermostat control. The paper presents a hardware architecture that allows control of an air conditioning unit by varying the thermostat set point [15].

III. METHODOLOGY

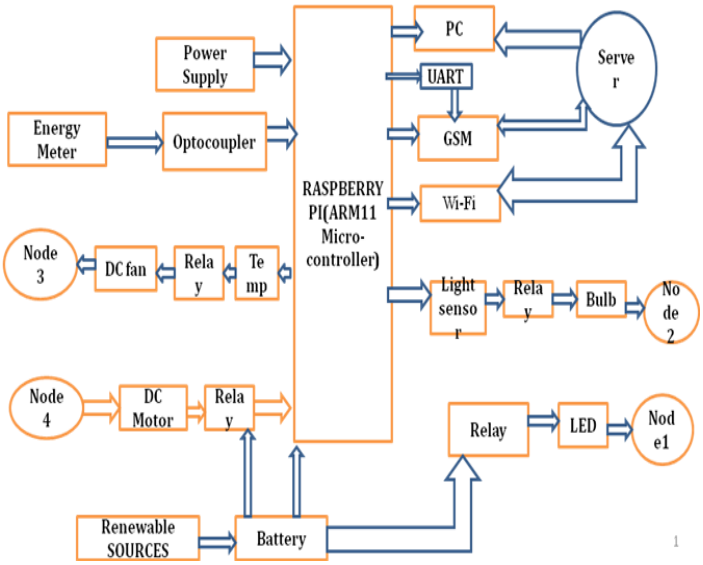

Figure 1.Block Diagram of Energy Management in smart Grids using Embedded System & IOT

The block diagram as shown above explains the overall system. In which the power supply is being used which include filter, transformer, IC7805 as well as diodes. The step up transformer step down the voltage i.e. 230V to 9V.Then next rectification is done by an diode. The filter removes the unwanted noise and IC 7805 converts 9V into 5V.the power supply provides the supply to the microcontroller i.e. Raspberry pi. The raspberry pi it acts as a mini computer in which ARM 11 controller is being used. The ADC circuit is being used so as to convert the analog value into digital value.

The two sensors is being used temperature sensor as well as LDR. .The threshold value is being set the role of temperature sensor is when the temperature exceed the fan should turn on.LDR the role of these sensor depends on light intensity higher the light intensity the bulb will remain off. The output of this signal is given to the ADC circuit and then to the controller. The bulb is on when the light intensity is less.

The GSM module is used along with RS 232 for TTL compatibility.GSM and GPRS uses sim900n module for communicating. The use of GSM module is to control the on off of the motor with the help of single message. The command is being sent to the microcontroller and then the required action is being performed. In this led on/off as well as motor on off can be done through a message. Relay is provided so as to perform the action.

Energy meter is used along with the optocoupler .It is provided so as to provide the isolation to the system. As the energy meter has very high voltage and current and there are the chances that system might get damage so to provide isolation the optocoupler IC is used .The role of web of things is to create an web page with a IP address by which controlling as well as monitoring can be done. The web page will include the number of devices along with the controlling action whether to turn on/off the devices. The web page will also have the values of sensor as well as the total power consumption i.e. in voltage and in current format. The web page is very useful to know how much power is drawn by the loads. The whole system uses solar energy as power supply.

The solar power can store the charge up to 1.2KW. The solar power is provided with the battery the whole energy is stored in battery. Due to the use of this energy source the system requires very less electricity which is generated from non renewable energy sources .Smart home mainly consist of two parts controlling of the system as well as monitoring of the system. The monitoring is done through web page which provide us the total power consumption (voltage and current) as well as the web page can monitor the sensor value. The microcontroller used is ARM11 which is present in raspberry Pi. The advantage of the raspberry pi is it act as a minicomputer as well as it is provided with an memory card in which the various program folders can be saved. The raspberry pi supports python language as well cpp.

The overall system cost is very less as well as o non technician can also use this system. The system also saves lots of energy ultimately the electricity bills get reduces. The microcontroller requires very less voltage to operate i.e. 5V.The voltage transformer as well as current transformer is used. The system is eco-friendly. The data can also be saved in PC. The IP address can also be access by an mobile device. There is two way communication due to which if any problem persist the system is able to display. It can be used in various field like as security purpose as well as in hospital near patient just according to application the system can be changed. This system is energy efficient.

IV. ALGORITHM

(1)Start

(2)Connect the main supply to the system

(3)Connect the 12v dc supply to arm board from battery

(4)The system will initialize &message will be send to monitor

(5)Temperature, light, total power rating will be displayed on monitor.

(6)Connect GSM module to the UART of controller.

(7)The values displayed on monitor will be given through GSM module.

(8)GSM/GPRS module will transferred this value on server system.

(9)If temperature value exceeds 50 degree then turn on the fan and go to the step 4 and step 13.

(10)If temperature value is below 50 fan will be off .

(11)If light intensity is less than 40 then turn on the led and go to the step 4 and step 13.

(12)If light intensity is exceed value 40 then led will be off.

(13)WEB page will be created & it can be monitor.

(14)Switch to solar panel.

(15)Stop.

V. RESULTS

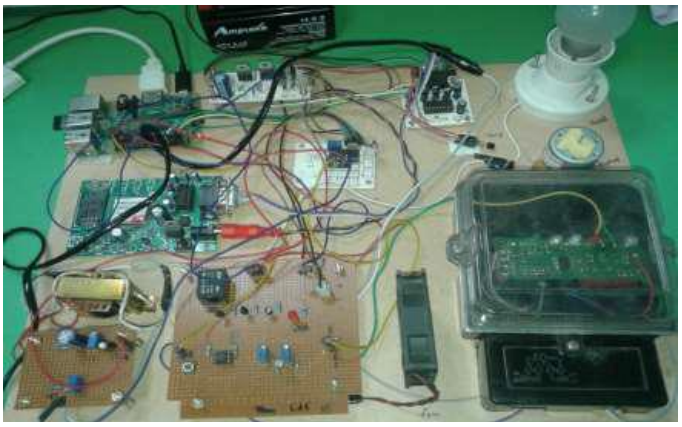

Figure 2..Node section of Energy Management in smart Grids using Embedded System & IOT

In above circuit diagram used LDR for light measurement. Here 10K resistor is used as base resistor for transistor it limits the current & allows 2ma Current to flow through LDR. It also used 10K variable resistor using this resistor the value is varied LDR using this.BC547 is used for amplification. The analog output from sensor is given to the ADC MCP 3008 pin no3 i.e. ch3 which converts i.e. analog signal to digital .Output of ADC is then given to the raspberry Pi GPIO9.Power supply required is 5v Dc supply voltage.

Thermistor is used along with the 10k resistor to limit the current along with the BC547 transistor to amplify the signal. The analog output from sensor is given to the ADC MCP 3008 pin no3 i.e. ch3 which converts the analog signal to digital .Output of ADC is then given to the raspberry Pi GPIO17.Power supply required is 5v.

AC Bulb is made on by using the relay circuit which is connected to mains supply .freewheeling diode is used 1N4007 for reducing the back emf current. To avoid surge current we used the relay circuit. The input B to the transistor is coming from the raspberry Pi. Current sensing circuit uses half wave rectifier circuit. Voltage divider is used as voltage sensing circuit.

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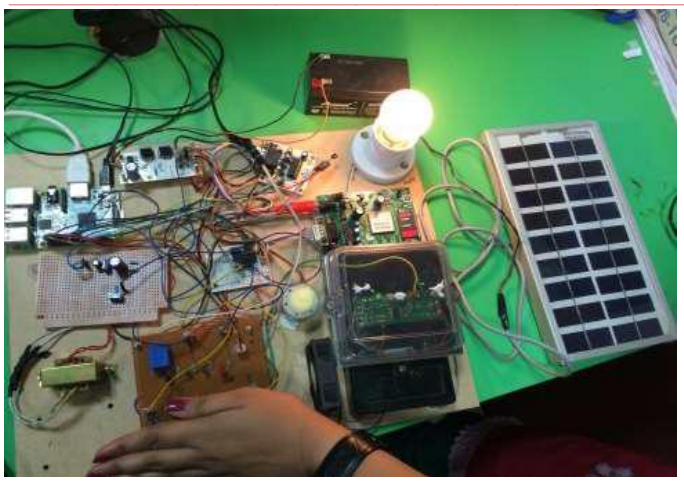

Figure 3 Bulb on by an LDR sensor

When the value of the LDR goes below the threshold value the bulb is on. The above figure 3 represents the output of the LDR

The figure 4 it shows the output window which is present in Linux window. It is the main window by which the whole system is initialized and the system executes the required command by performing the action.

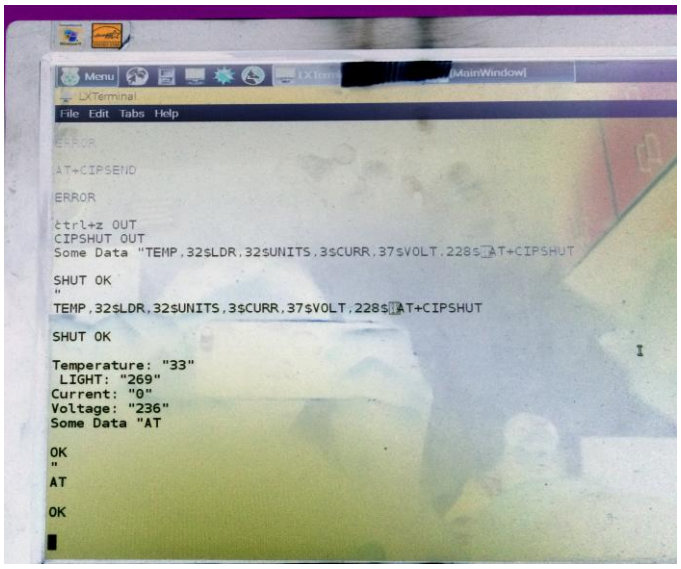

Figure 4.Output main window

The figure 5 displays the output on the web page which shows the temperature sensor value as well as LDR value. The overall power consumption in terms of voltage and current along with how much units the power is consumed is displayed so as to compare the previous data with the present data. By entering the IP address the web page will be opened which will display the values as well the device can be controlled through web page as shown in figure 7.

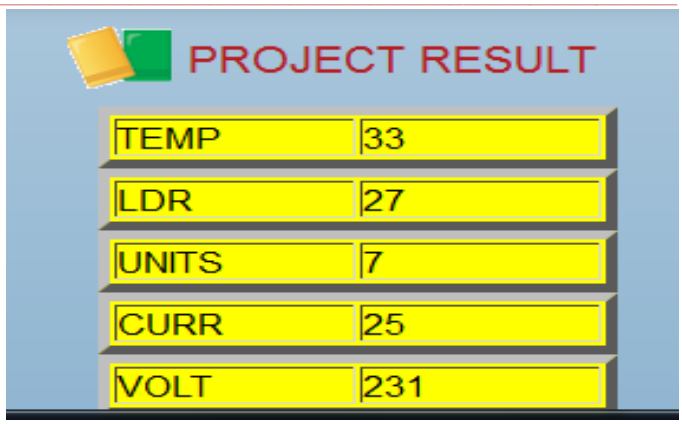

Figure 5.Web page displaying sensor values with total power consumption

Figure 6.Controlling the device by an SMS

The figure 6 in which the command is sent to the microcontroller in this format once the command is send the microcontroller will perform the required action depending on the command. The GSM module is used in which an SMS is send to particular number which is present in the GSM module this command is send to the microcontroller to do the specific task.

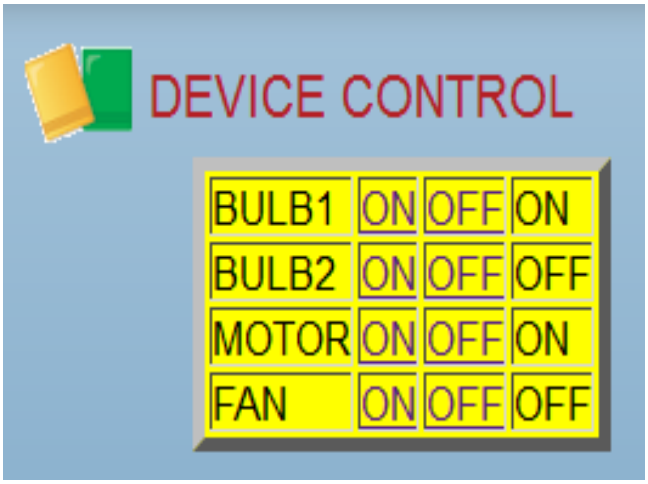

Figure 7.Device control on web page

VI. CONCLUSION

In this system the raspberry pi is used as a controller which requires very less power to operate i.e. 5V.Thus the main aim was to use the energy efficiently so by the use of raspberry pi along with the solar energy which uses the battery as to store the energy because of this energy required is very less as well as it is cost effective. The use of LCD which also requires the supply is reduce as no LCD is being used. So the system is cost effective and also the non renewable energy sources are used very less which ultimately reduces the electricity bills.

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