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Wireless Sensor Network System Design using Raspberry Pi and Arduino for Power Monitoring Applications

Bharati Taktode [1],Dr. V.A.More [2]

[1] Student M.E. (EC), [2]Associate Professor,

Department of ECE, Jawaharlal Nehru Engineering College, Aurangabad, (India)

ABSTRACT

With over a decade of intensive research and development, wireless sensor network technology has been emerging as a viable solution to many innovative applications. In this paper, we describe a wireless sensor network system that we have developed using open-source hardware platforms, Arduino and Raspberry Pi. The design and development of a smart monitoring and controlling system for household electrical appliances in real time has been implemented. The novelty of this system is the implementation of the controlling mechanism of appliances in different ways. The system has been design and developed to monitor the electric parameters including voltage, current and subsequently calculates the power consumption of the home appliances that are need to be monitored. Also the proposed system is a user authentication, economical and easily operable. Smart power conservation is a method of controlling home appliances manually or through the pc or mobile for the convenience of users. Controlling of electrical devices in the home that can be programmed using Arduino controller.

Keywords: current measurement, power Consumption, raspberry pi. voltage measurement ,wireless sensor network, ,

I.INTRODUCTION

The WSNs are increasingly being used in the home for energy controlling services. Regular household appliances are monitored and controlled by WSNs installed in the home. With over a decade of intensive research and development, wireless sensor network technology has been emerging as a viable solution to many innovative applications. Wireless sensor network (WSN), which integrates sensor technology, wireless communication technology, embedded computing technology and distributed information management technology, has been under rapid development during recent years. A wireless sensor network is a collection of nodes organized into an interactive network. Each node consists of processing capability (one or more microcontroller's chips) and contains types of memory, with a Wi-Fi module. The nodes communicate wirelessly to raspberry pi.Regular household appliances are monitored and controlled by WSNs installed in the home. The measurement of electrical parameters of home appliances is done by interfacing with fabricated sensing modules. The paper focuses on human-friendly technical solutions for monitoring and easy control of household appliances. The inhabitant's comfort will be increased and better assistance can be provided. Sensor

network systems, like most embedded systems, needs to be tightly coupled to their applications. However, the aforementioned recent advances have helped to reduce the complexity of implementing wireless sensing and actuation systems and have made it fairly easy to implement a prototype system for proof-of-concept and demonstration purposes. In this paper, we present a wireless sensor network system developed using open-source hardware platforms, Arduino and Raspberry Pi, and the Wi-Fi module. Such a design has the advantages of low cost, easy to build, and easy to maintain, as compared to some earlier designs such as the TEO system. The major obstacles for sensor network technology to become a transformational force in engineering, scientific, and commercial application domains lie in its lack of reliability, flexibility, scalability, interoperability, and in its extreme difficulties in long-term deployment, operation, and maintenance especially by non-engineering application domain practitioners. The system presented in this paper represents a step forward towards addressing these challenging issues. The rest of the paper is organized as follows. In Section 2, the system related work is described, in section 3, overall system architecture is described. Then, in Section 4, the hardware and software components are presented, and results are in Section 5 to demonstrate the usefulness of the design. Finally, the paper is concluded with a summary in Section 5.

II.RELATED WORK

Here, will discuss the related works done about smart home systems based on the wireless communication technology. Energy Management using the Wi-Fi technology to reduce the power wastage and system control. The suggested system consists of an power cutoff outlet, a Wi-Fi hub and a raspberry pi. The power outlet with a Wi-Fi module cuts off the ac power when the energy consumption of the device connected to the power outlet is not needed. The central hub collects information from the power channels and controls these power channels through the wifi module. The router sends the state information to a server i.e raspberry pi and then a user can monitor or control the present energy usage using the user interface. This facility may create some easiness for the users. The system has been designed for measurement of electrical parameters of household appliances. Important functions to the system are the ease of modeling, setup, and use.

III.SYSTEM OVERVIEW

In this paper, the system describe here consist of two node, router, and raspberry pi. The voltage, current and power measured in the node. Then node is send this measured electrical parameters through the Wi-Fi module to raspberry pi, we use Router here for communication, which recognizes the IP address of raspberry pi & then raspberry pi sends all the measurement of electrical parameters of the equipment to the mobile or Desktop which is used by the consumer. We can give the command to ON and OFF the electric home appliance through the phone or pc. The raspberry pi here work to subscribe and publish the parameters data.

The measurement of electrical parameters of home appliances is done by interfacing with fabricated sensing modules. The system operates/controls in two modes. Normal mode (controlling)and economic mode. In normal mode or manual controlling, device status changed by manually. In economic mode, device status is

changed by the Android phone. The overview of the system is given in the figure no.1 system consist of node 1, node 2, router for finding the IP address for the wireless communication between user and the node. so we can see the parameters reading and ON and OFF the home appliance.

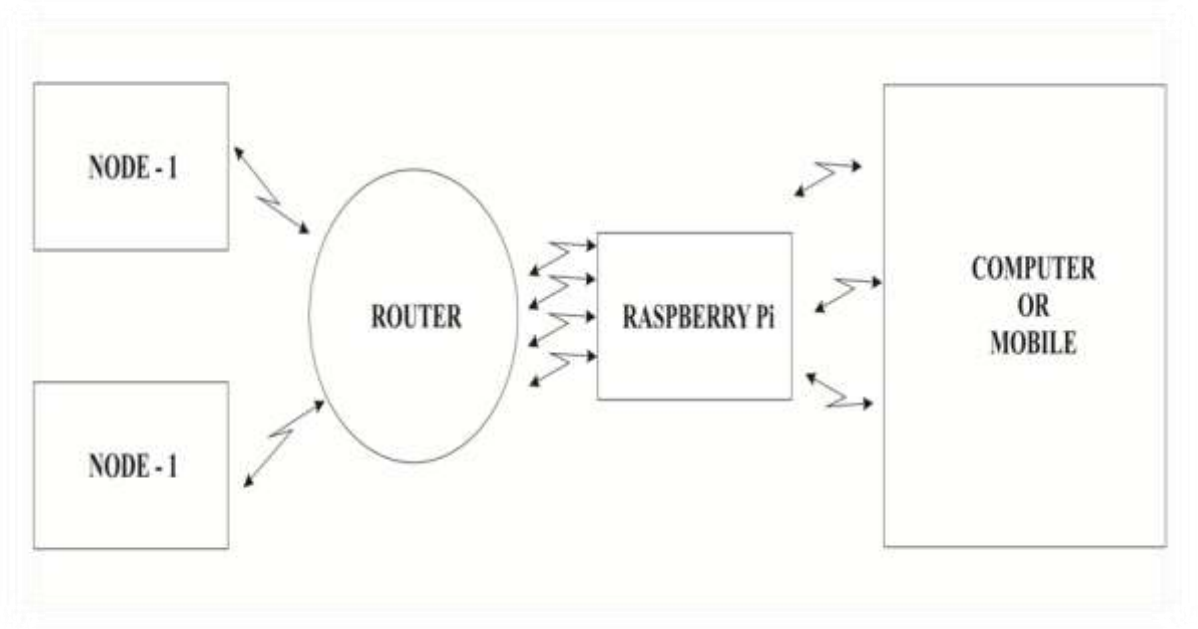

Fig.1.system overview

IV.SYSTEM DESCRIPTION

Fig.2 shows the functional block diagram of the system node. here in this system we give the ac supply to both the load and the microcontroller. Microcontroller need 5v ac supply to work so here we use mini power supply circuit which consist of step down transformer, bridge rectifier and filter to produce 5v dc supply and then it give to the microcontroller. Load current is sensed by the current sensor ACS712 For sensing current, we use ACS712 current measurement sensor. The main features of this sensor include fully encapsulated PCB mounting and compact size. The circuit design layout for current measurement is shown in. In this current sensor, the voltage is measured across the burden resistor of 50 Ω. The necessary filtering and amplification is required to bring the voltage with the necessary measurement level of arduino. The measurement of electrical parameters of home appliances is done by interfacing with fabricated sensing modules. The system operates/controls in two modes. Normal mode (controlling)and economic mode. In normal mode or manual controlling, device status changed by manually. In economic mode, device status is changed by the Android phone or PC.

Manual control: An on/off switch is provided to directly intervene with the device. This feature enables the user to have more flexibility by having manual control on the appliance usage without following automatic control.

Also, with the help of the software developed for monitoring and controlling user interface, user can control the device for its appropriate use. This feature has the higher priority to bypass the automatic control. Remote control: The smart power monitoring and controlling software system has the feature of interacting with the appliances remotely through internet (webpage). This enables user to have flexible control mechanism remotely through a secured internet web connection. This sometimes is a huge help to the user who has the habit of keeping the appliances ON while away from house. The user can monitor the condition of all appliances and do the needful.

4.1 Voltage measurement

The measurement of the voltage is performed by using a step down transformer to reduce 230V to 9V RMS. The output signal was then fed into voltage divider to further step down the signal voltage below 3.3V. The signal is shifted up above the reference setting, before the signal is sent to microcontroller. The reason for this is because the Analog to Digital Convertor (ADC) of microcontroller only can take the positive values of signal and the signal has to be less than 3.3V which is safe for microcontroller.

4.2 Current Measurement

The measurement of the current is done with the help of a current transformer. The output signal of the current transformer is very small; hence the signal is amplified after it is level shifted. The signal is then fed into ADC of microcontroller to calculate its Irms value.

4.3Power measurement

The power measurement is calculated from the obtained power factor angle and RMS values of current and voltage signals as discussed in the above sections. In order get the real power values of the household appliances; the power factor angle is multiplied with the current RMS (Irms) and voltage RMS (Vrms) as shown in eq (1). The computation of the power measurement is done in the arduino which is programmed by using C.

$$\textbf{Power = Vrms * Irms}$$

Eq no.1

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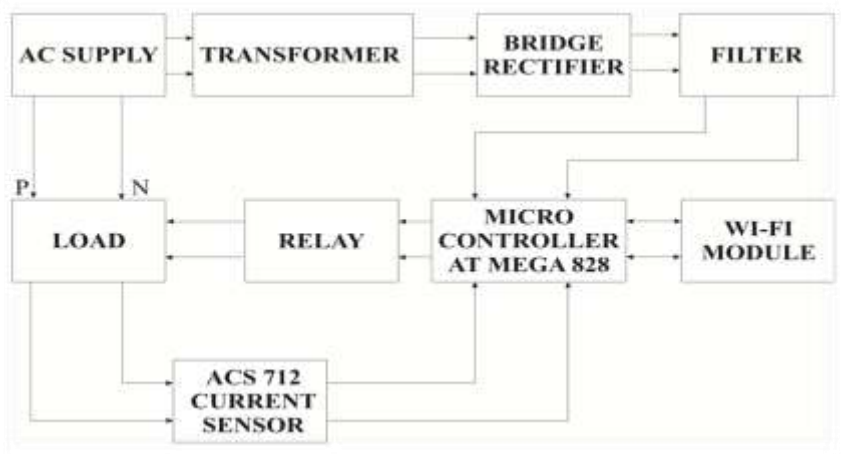

Fig.2.functional block diagram of system node

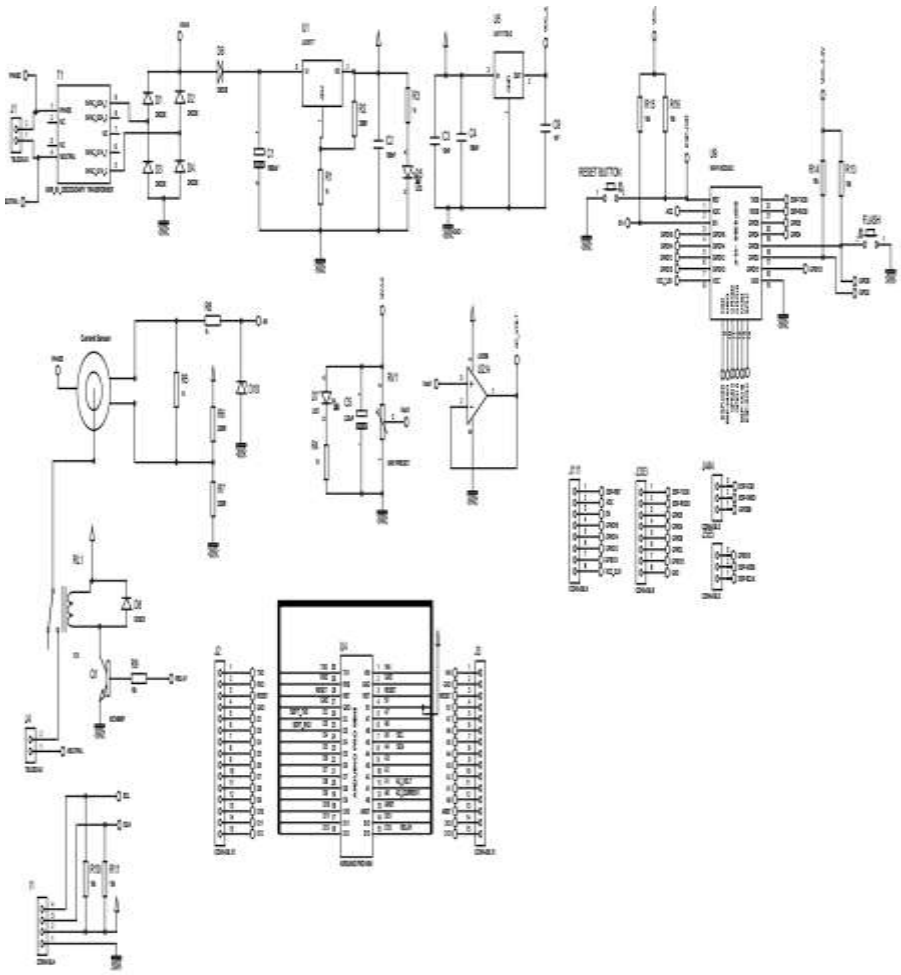

Fig.3.circuit diagram of system

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We have already discussed the functioning of the components which can be seen in the circuit diagram. this is all about the hardware component of the system

V. HARDWARE

5.1 Raspberry Pi

The Raspberry Pi is a credit-card sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that your desktop PC does, like spreadsheets, word-processing and games. It also plays high definition video. We want to see it being used by kids all over the world to learn how computers work, how to manipulate the electronic world around them, and how to program. The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high definition video, to making spreadsheets, word-processing, and playing games.

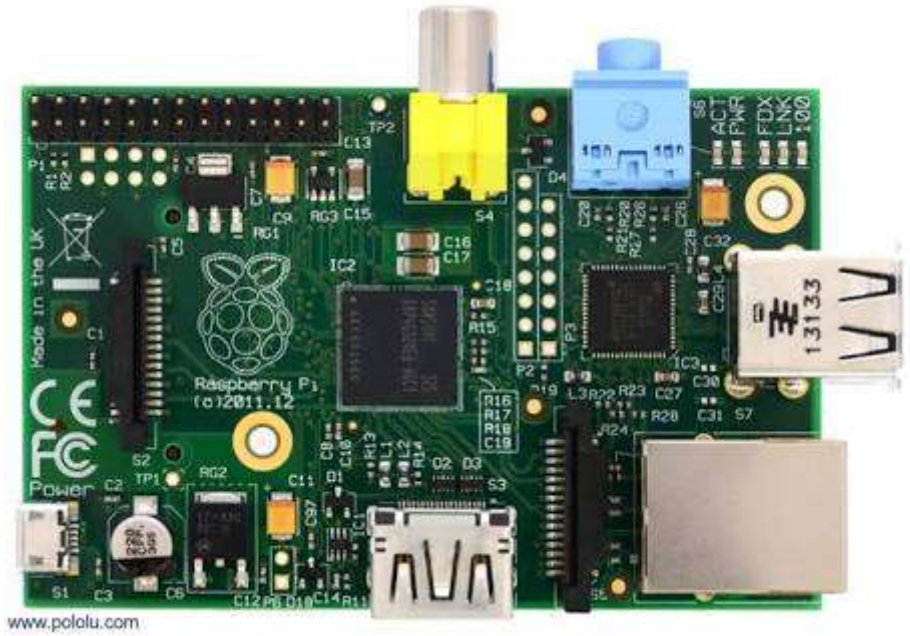

Fig.3.raspberry pi model B

5.2 Arduino

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

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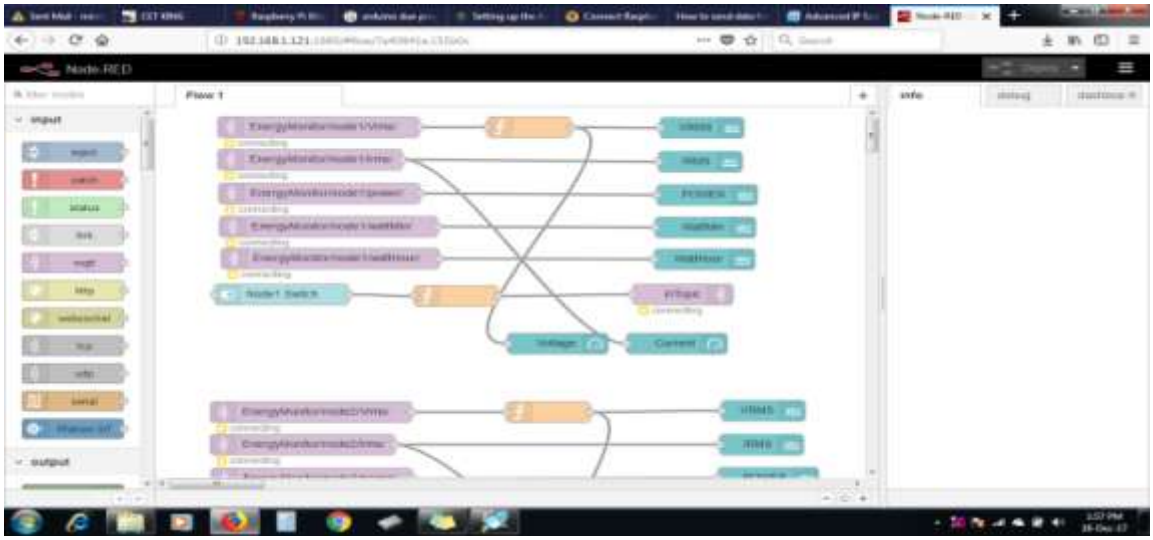
The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

Fig.4.hardware for node to connect load

Software used to implement this system is node red software and Coding for system to work properly is done in c language and python. There are some screen shot for the software program of project.



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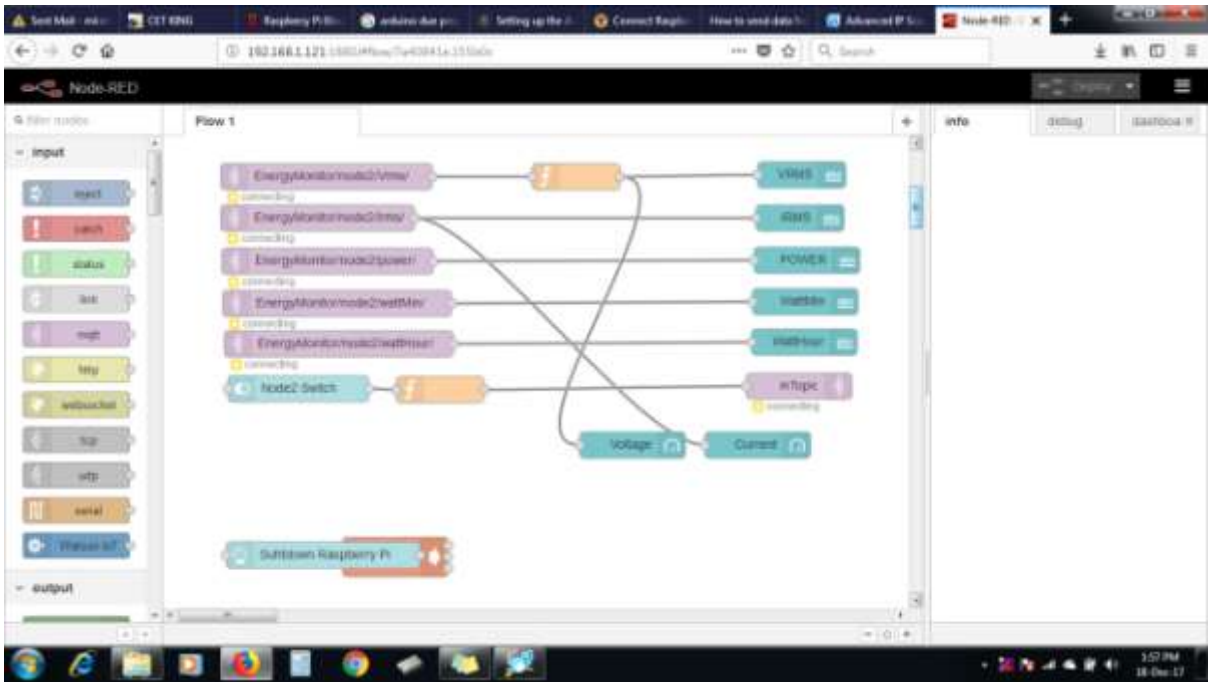
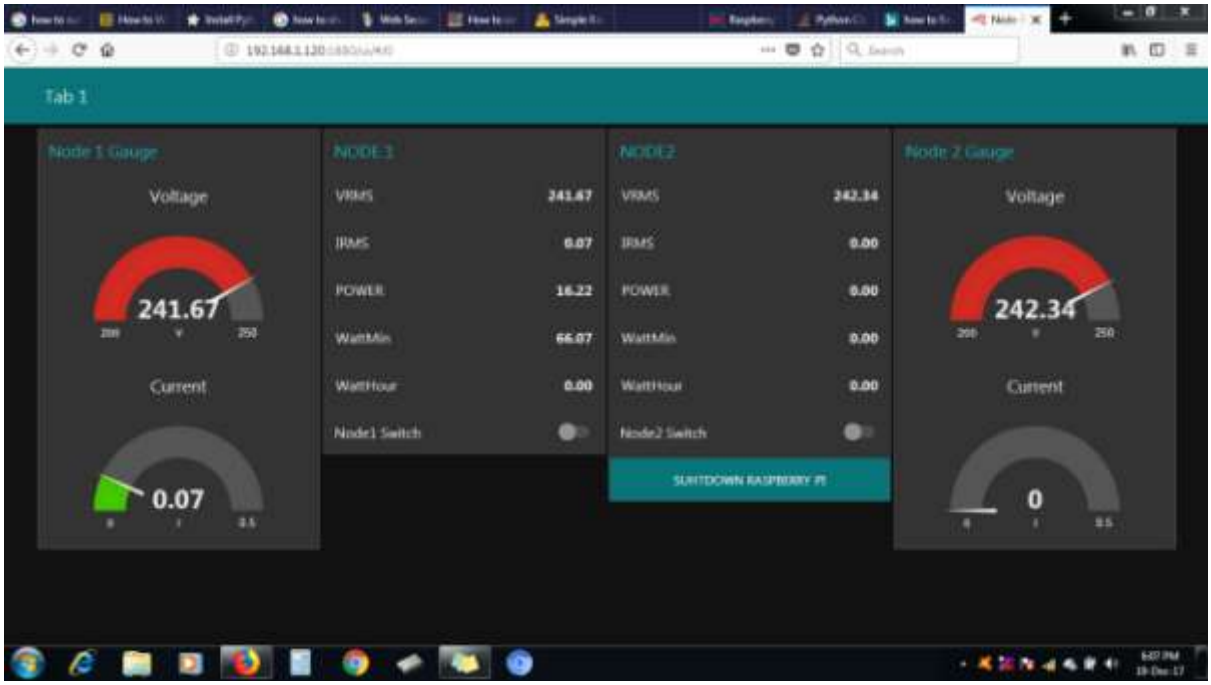


VI.RESULT

In this study we consider some activities that are majoring current, voltage, watt per minute etc. When we switch on the power supply we can calculate voltage per minute or watt per minute as per this data we can understand which node or which electronic device consume large amount of power and what should we do to reduce our electric consumption from the statistics.



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VII.CONCLUSION

An intelligent power monitoring and control system will be design and develop towards the implementation of smart building. The proposed system will monitor and control the electrical appliance usages at home. The real-time monitoring of the electrical appliances can be viewed through website. The sensor networks will be programmed with various user interfaces suitable for users such that the system can be maintained and interacted easily.

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