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Design and Implementation of nRF Based Smart Home System Using IoT

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Abstract: **-- Presently, conventional wall switches are located in different parts of the house and one has to physically go near them and press them to turn the loads on/off. It becomes very difficult for the elderly or physically handicapped people to do so. We usually forget to switch off the electrical devices when they are not in use. This leads to wastage of lots of power resulting in wastage of money, and if more power is consuming more power is to be generated. To generate more power we need to use more energy resources and we know we are depending on conventional energy resources which are non-renewable which results in depleting enormous reserves of energy resources. So saving power techniques help us to save money, by preserving resources, it also useful for sustainable development, economical sustainability and enhances the quality of life by preserving energy resources. The home automation is one of the most emerging trends in modernization of home appliance control. With the advancement of Automation technology, life is getting simpler and easier in all aspects. In today's world Automatic systems are being preferred over manual system. With the rapid increase in the number of users of internet over the past decade has made Internet a part and parcel of life, and IoT is the latest and emerging internet technology. Internet of things is a growing network of everyday object-from industrial machine to consumer goods that can share information and complete tasks while you are busy with other activities. In the proposed paper we are designing a smart home system such that we can reduce the wastage of power and can use the power efficiently so that no switch is unnecessarily turn on and we can also know power consumed by each and every appliances in our home such that we can manage the usage of electrical appliances and devices.**

Index Terms **— Arduino atmega320p, raspberry pi, internet of things, webpage.**

I. INTRODUCTION

The main aim of the project is to develop a smart home system that can be controlled and monitored through internet of things. The home automation is one of the most emerging trends in modernization of home appliance control. Presently, conventional wall switches are located in different parts of the house and one has to physically go near them and press them to turn the loads on/off. It becomes very difficult for the elderly or physically handicapped people to do so. This paper proposes a smart home based system that employs the integration of wireless communication and last meter smart grid that to provide the user with remote control of various lights and appliances in their home from anywhere. With advancement of Automation technology, life is getting simpler and easier in all aspects. In today's world Automatic systems are being preferred over manual system. With the rapid increase in the number of users of internet over the past decade has made Internet a part and parcel of life, and IoT is the latest and emerging internet technology. Internet of things is a growing network of everyday object-from industrial machine to consumer goods that can share information and complete tasks while you are busy with other activities. Wireless Home Automation system(WHAS) using IoT is a system that uses computers or mobile devices to control basic home functions and features automatically through internet from anywhere around the world, an automated home is sometimes called a smart home. It is meant to save the electric power and human energy. . The home automation system differs from other system by allowing the user to operate the system from anywhere around the world through internet connection

We rely on electricity to power our lights, appliances, and electronics in our homes. Many of us also use electricity to provide our homes with hot water, heat, and air conditioning. As we use more electricity in our homes, electric bills rise. Every year, we use more energy than we did the year before. In fact, the amount of energy Americans use has doubled about every 20 years. All of that energy adds up, and much of it is wasted by using too much or not using it wisely. Energy isn't free. The grown-ups in your house pay for the all the electricity you use. So wasting energy is the same as wasting money - and we know that's not a good idea! Wasting energy isn't good for the environment either. Most of the energy sources we depend on, like coal and natural gas, can't be replaced - once we use them up, they're gone forever. Another problem is that most forms of energy can

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cause pollution. At a time when global climate is changing at alarming and extreme rates, governments and organizations are calling on everyone to do their share of preserving the planet. This is not only to prevent calamities brought about by the abuse we have done to Mother Nature, but also to make sure that future generations will still be able to enjoy the beauty and gifts that this world has to offer. And what better way to help than to start saving electricity at home. Saving energy saves our money, improves the economy, improves national security, enhances the quality of life and is also good for environment.

In the proposed paper we are designing a smart home system such that we can reduce the wastage of power and can use the power efficiently so that no switch is unnecessarily turn on and we can also know power consumed each and every appliances in our home such that we can manage the usage of electrical appliances and devices.

II. RELATED WORK

Design and implement a control and monitor system for smart house consists of many systems that are controlled by putty software as the main controlling system in this paper. The system is connected to the internet to monitor and control the house equipment's from anywhere in the world, the main objective of this project is to minimize the wastage of power due to our negligence or some other reason. And it is also helpful to handicapped. The proposed system makes our work easier and we can able to control any electrical appliances or devices just on our finger tips from anywhere.

In this project we are using an nRF module for wireless communication which is based on pipelining concept. So it provides a high security and our data can't be hacked.

III. PLATFORM FOR IOT

We have developed a platform for the IoT as a scalable distributed system that can seamlessly support an in-home smart grid and different concurrent applications for remote

monitoring and control. The platform architecture is illustrated in Fig.1. It consists of three main parts: the sensor and actuator networks, the IoT server and the user interfaces for visualization and management. Sensor and actuator nodes communicate in a reliable bidirectional way with the IoT server. The communication between the nodes and the IoT server follows the TCP/IP client-server model.

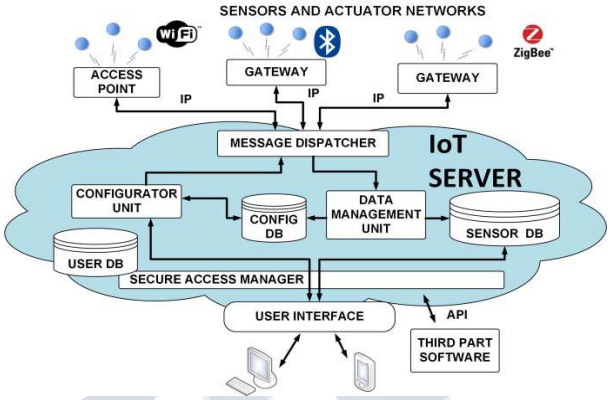

Fig. 1: Block diagram of the internet of things platform supporting the in-home smart grid.

Due to the possibility of using the system to collect sensitive and confidential data, the platform ensures an adequate security level both to end-to-end communications and to data access. For this reason, users need to be authenticated before they can access the platform and can only access specific sets of sensor data through HTTPS. The IoT server supports multiple encryption protocols At a finer level of detail, the IoT platform consists of several hardware and software components, each described by its functions and by its interfaces with other components. In this way, the architecture is easily scalable and robust. Each component can be modified, redesigned, and extended with minimum impact on the rest of the system.

IV. ARCHITECTURE

(a) Control module

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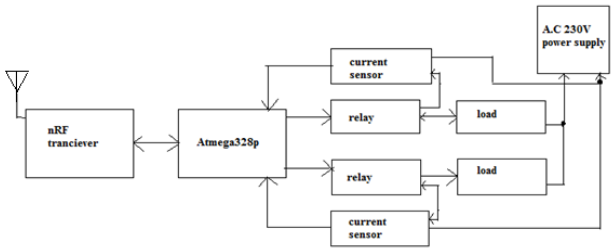

(b) Device module

Fig 2: Block diagram of the proposed system

In this system we are using nRF transceivers, raspberry pi, arduino atmega 328p,relays, current sensors, loads and A.C power supply.

1.Arduino board:

The Arduino is a family of microcontroller boards to simplify electronic design, prototyping and experimenting for artists, hackers, hobbyists, but also many professionals. People use it as brains for their robots, to build new digital music instruments, or to build a system that lets your house plants tweet you when they're dry. Arduinos (we use the standard Arduino Uno) are built around an ATmega microcontroller, essentially a complete computer with CPU, RAM, Flash memory, and input/output pins, all on a single chip. Unlike, say, a Raspberry Pi, it's designed to attach all kinds of sensors, LEDs, small motors and speakers, servos, etc. directly to these pins, which can read in or output digital or analog voltages between 0 and 5 volts. The Arduino connects to your computer via USB, where you program it in a simple language (C/C++, similar to Java) from inside the free Arduino IDE by uploading your compiled code to the board. Once programmed, the Arduino can run with the USB link back to your computer, or stand-alone without it — no keyboard or screen needed, just power supply is needed.

2. Raspberry pi:

The Raspberry Pi is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools. The Raspberry Pi is manufactured in two board configurations through licensed manufacturing deals with Newark element14 (Premier Farnell), RS Components and Egoman. These companies sell the Raspberry Pi online. Egoman produces a version for distribution solely in China and Taiwan, which can be distinguished from other Pis by their red coloring and lack of FCC/CE marks. The hardware is the same across all manufacturers. It has a Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded to 512 MB. It does not include a built-in hard disk or solid-state drive, but uses an SD card for booting and persistent storage. The Foundation provides Debian and Arch Linux ARM distributions for download. Tools are available for Python as the main programming language, with support for BBC BASIC (via the RISC OS image or the Brandy Basic clone for Linux), C, Java and Perl.

3. nRF transceiver:

The nRF24L01 is a single chip 2.4GHz transceiver with an embedded baseband protocol engine (Enhanced ShockBurst™), designed for ultra low power wireless applications. The nRF24L01 is designed for operation in the world wide ISM frequency band at 2.400 - 2.4835GHz. An MCU (microcontroller) and very few external passive components are needed to design a radio system with the nRF24L01. The air data rate supported by the nRF24L01 is configurable to 2Mbps. The high air data rate combined with two powers saving modes makes the nRF24L01 very suitable for ultra low power designs. The nRF24L01 is configured and operated through a Serial Peripheral Interface (SPI.) Through this inter-face the register map is available. The register map contains all configuration registers in the nRF24L01 and is accessible in all operation modes of the chip

4. ACS712 current sensor:

The ACS712 device is provided in a small, surface mount SOIC8 package. It consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. When current is applied through the copper conductor, a magnetic field is generated which is sensed by the built-in Hall element. The strength of the magnetic field is proportional to the magnitude of the current through the conduction path, providing a linear relationship between the output Hall voltage and input conduction current. The on-chip signal conditioner and filter circuit stabilizes and enhances the induced Hall voltage to an

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appropriate level so that it could be measured through an ADC channel of a microcontroller

5. Relay

A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote-control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability. Relays are used in a wide variety of applications throughout industry, such as in telephone exchanges, digital computers and automation systems. Highly sophisticated relays are utilized to protect electric power systems against trouble and power blackouts as well as to regulate and control the generation and distribution of power. In the home, relays are used in refrigerators, washing machines and dishwashers, and heating and air-conditioning controls. Although relays are generally associated with electrical circuitry, there are many other types, such as pneumatic and hydraulic. Input may be electrical and output directly mechanical, or vice versa.

V. IMPLEMENTATION

We create a webpage to maintain all the electrical loads in our home. And it contains the options for each device to on and off. When an input is given, then from raspberry pi the given input is given to nRF transceiver and from it, it transmits another nrf transceiver through a serial wireless communication. Then from nRF it is received by arduino and it drives the particular relay to on or off the given load. Current sensor that is connected to load calculates the current consumed by that load and sends that information to arduino. We know a.c voltage for house hold purpose is 230 volts. By multiplying it with current that is consumed we can calculates the power consumed by that load. So the current in m.amp, power in watts, and the no.of units consumed by loads are sent to nRF transceiver from arduino and from it, that information is sends to another nRF through a wireless communication. From nrf it is received by raspberry pi and uploads it on putty window and updates them on webpage.

In web page we have the options like light1 on, light1 off, light2 on, light2 off, all on and all off. We can select required option from them. if light1 on option is selected then another webpage is loaded showing the current, power and number of units consumed by loads, “the device1 has been turned on “ displayed on webpage. The same is repeated for all other options.

VI. RESULTS

Depending on the input given by the user in webpage display, the hardware of the system turns loads on or off. Instead of just turn on or off the loads, it also displays the current, power, and number of units of the power consumed by each load. Current, power, number of units consumed by the loads database is stored in separate notepads. Those values are initially displayed on putty window. Then they are uploaded on webpage in few micro seconds. And webpage gets refreshed for the given time and takes new values.

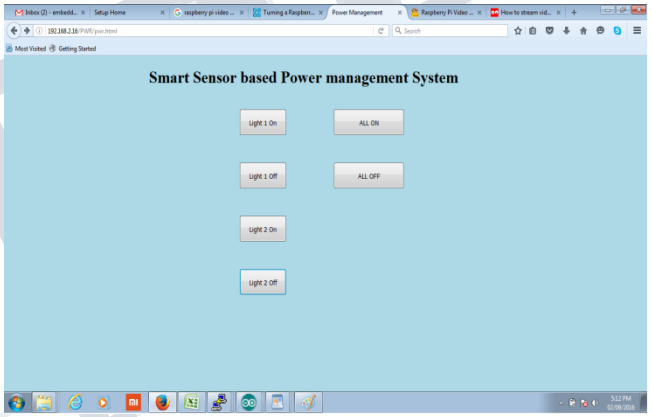

Fig 3: Webpage display

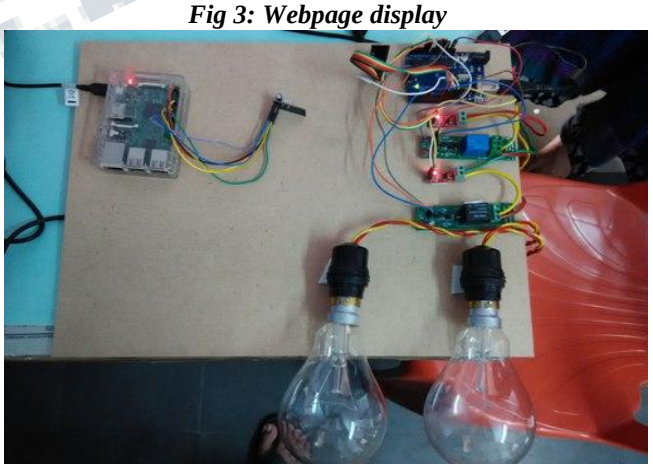

Fig 4: Both lights are off

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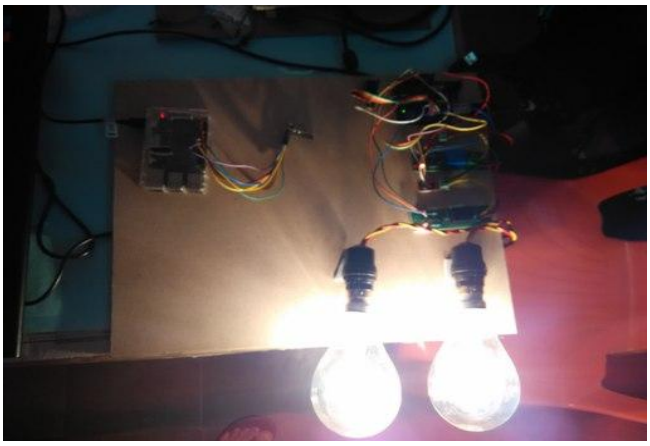

Fig 5: Both lights are on

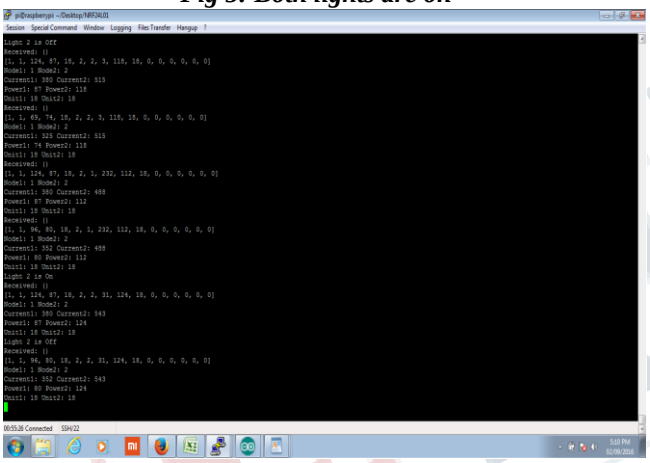

Fig 6: putty window

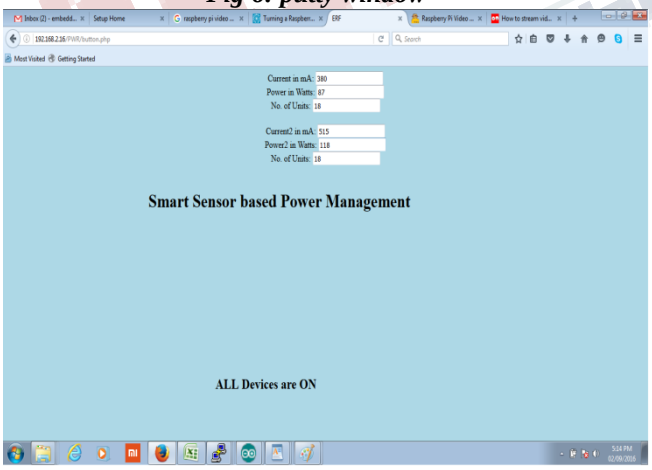

Fig 7: Power consumption by loads display on webpage

VII. CONCLUSION

In this nRF based smart home system using internet of things we can able to control and monitor any home appliances from anywhere. As the technology grows new equipments, new modules arrive in market. But this system is an all time useful as it is integrated with an emerging technology IOT. The components used in the system have unique capabilities which enhance the reliability of the system. One more advantage of the system is that as it is associated with power saving techniques it is also helpful to environment

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