

# IOT Based Power Monitoring System and Control

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**Abstract:** IOT has become a part of the modern world; the significance and utilization are increasing with each passing day. This approach is to design an efficient and real-time wireless networks to monitor power consumption of electrical appliances. A sensor is set at the heap to ascertain current, a circuit is utilized to figure voltage and with these two, power can be computed. Control qualities are put away in cloud database. A web facilitating and space is made to get the orders from android application and send them to raspberry pi board at load, which triggers an electromagnetic transfer to change the condition of the heap. This project permit to get the power values and control gadgets from anyplace on the planet

**Keywords:** IOT, Microcontroller, Arduino, Raspberry pi, Android app.

## I. INTRODUCTION

Internet is an interconnection of computers all over the world. Internet links billion of devices worldwide, and is used to send, receive data all over the world. Internet has vast uses and applications in many fields and domain. One of the important applications of the internet is IoT[1]. IoT is interconnection of physical objects, vehicles etc. mixed with various other fields like embedded systems, sensors, software which helps to collect, transfer and exchange information. HP did a small survey in which they estimated the rise of connected devices over the years. In 1990 number of connected devices are 0.3 million, in 1999 number of connected devices are 90.0 million, in 2010 this number is 5.0 billion, in 2013 this number is 9.0 billion and in 2025 estimated number of connected devices is 1.0 trillion. IOT has many applications in many fields. This includes Wearables, Smart City, Smart grid, Industrial Internet, Connected car, Connected health, Smart retail, Smart supply chain, Smart farming. One of the main applications of IOT and the one this paper deals with is monitoring information from remote location[2].

The heart of the system is a Microcontroller. A microcontroller is a small computer on a single integrated circuit. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes[3]. There are different microcontrollers like Altera, Fujitsu, Holtek, Infineon etc., Atmel ATmega328P based Arduino is used in this paper because Arduino is made to help to use the microcontroller easily. Raspberry pi is also used in this paper. Raspberry Pi is neither a microprocessor or microcontroller, it is a single board computer which contains a SOC (System On Chip - Has multicore processor, GPU, ROM, I/O Peripherals inside it.), DDR RAM memory, Ethernet port, USB host, micro HDMI on it. Neither. The Pi is a small computer.

This paper presents a case study of a wireless sensor network (WSN) to support power management using Web services. The system is designed by the integration of WSNs with Ethernet/ Internet/ Web Service communications to acknowledge the power management and provide information services using IOT platform. It is based on the idea of collecting energy information using various wireless devices operating with different communication standards. The WSNs are increasingly being used in the home for energy controlling services [4]. Regular household appliances are monitored and controlled by WSNs installed in the home. New technologies include advancements in Information technology, sensors[5], metering, transmission, Distribution, and electricity storage technology, as well as providing new information and flexibility to both consumers and providers of electricity. Electrical vitality is extremely basic for everyday life and a spine for the business. Electricity is indiscipline to our daily life with vast need of electricity the thefting of power is also increasing. Now a day it is a very big problem that continues to plague power sector across the whole country. In this project, the main context revolve around energy conservation[6]. In order to maintain healthy flow of energy, load has to be taken into control. If the control of load is confined over a small area or a single network does not give the required efficiency. The solution for this opting cloud computing[7]. The system comprises of a brilliant detecting unit that identifies and controls the home electrical apparatuses utilized for day by day exercises by taking after various levy rates. It can decrease costs for the shoppers and along these lines enhance matrix strength. This increases the system efficiency in terms of range and compatibility.

## II. WIRELESS SENSOR NETWORK

WSN a modern information technology integrated with sensor technology, automatic control technology, data transmission network, storage, processing and analysis technology is a distributed system. WSN is low-cost, low power consuming, simple to deploy, without on-site maintenance, etc compared to traditional monitoring techniques.WSN in widely used in IOT to simplify and solve the complex problems of data transfer and storage[8].

## III. DESIGN AND IMPLEMENTATION

Sensor modules are interfaced to the load for measuring electrical parameters of the load. The details of the design and development of the sensing modules are provided in the following sections. Fig1 describes the functional description of developed system. USB Wifi dongle is connected to Raspberry pi[9] and is used to transmit the electrical parameters to the cloud via internet and to receive the instructions from the Android app through web server[10] to control the state of electromagnetic relays; so as the load. Wifi dongle uses 802.11b wireless standards as it has good signal range and low cost. Android app is developed regarding this project using Android Studio.

Android studio is the official IDE for the android application development[11]. It works based on IntelliJ IDEA. Electrical parameters stored in cloud are retrieved into the android app using WebView function. By clicking the ON and OFF buttons in android app, the corresponding state of the load will be updated in the webserver. MYSQL is used as a database at the webserver and PHP is used to fetch data from the database. Android application will communicate with the PHP page and PHP will contact MYSQL database and will fetch the result and return the results to Raspberry pi. Raspberry pi will change the corresponding state of the load.

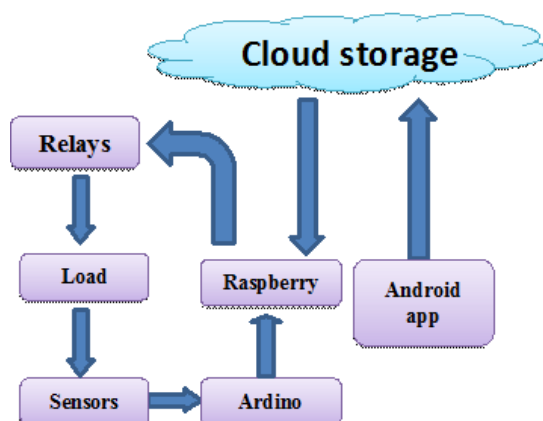


Fig.1.Functional description of system

## IV. HARDWARE

### A. RASPBERRY PI

Raspberry Pi is a credit card sized small CPU or a complete computing platform[12] developed by Raspberry Pi foundation in UK and released in February, 2012 and it is shown in Fig.2. It supports different distributions of linux but recommended is **Raspbian**. Raspbian is a new operating system with the use of Debian by Raspberry Pi foundation i.e., Raspberry + Debian = Raspbian. The raspberry Pi foundation provides OS like Raspbian, Noobs, Snappy, Ubuntu Core, Openlec, osmc, pidora, RISC OS etc. on their official website [www.raspberrypi.org](http://www.raspberrypi.org). The most important feature of Raspberry Pi is its processor's speed and its small size. It is very much small according to its powerful features. Raspberry Pi supports various programming languages such as Python, C, Perl and Ruby. Python is the main programming Language. Raspberry Pi model A+ was released followed by B, B+, Raspberry Pi 2 and recently released Pi 3. There are some basic changes in hardware with the changes in the board version.

The Broadcom BCM2835 SOC utilized as a part of the original Raspberry Pi is to some degree comparable to the chip utilized as a part of original cell phones (its CPU is a more established ARMv6 design), which incorporates a 700 MHz ARM1176JZF-S processor, Video Core IV representation handling unit (GPU), and RAM. It has a level 1 (L1) store of 16 KB and a level 2 (L2) reserve of 128 KB. The level 2 cache is used primarily by the GPU. The SOC is stacked underneath the RAM chip, so simply its edge is self-evident. The Broadcom BCM2836 SOC is used by Raspberry Pi 2 with a 900 MHz 32-bit quad-focus ARM Cortex-A7 processor (as do various current phones), with 256 KB shared L2 store. The Broadcom BCM2837 SOC is used by Raspberry Pi 3 with a 1.2 GHz 64-bit quad-core ARM Cortex-A53 processor, with 512 KB shared L2 cache.

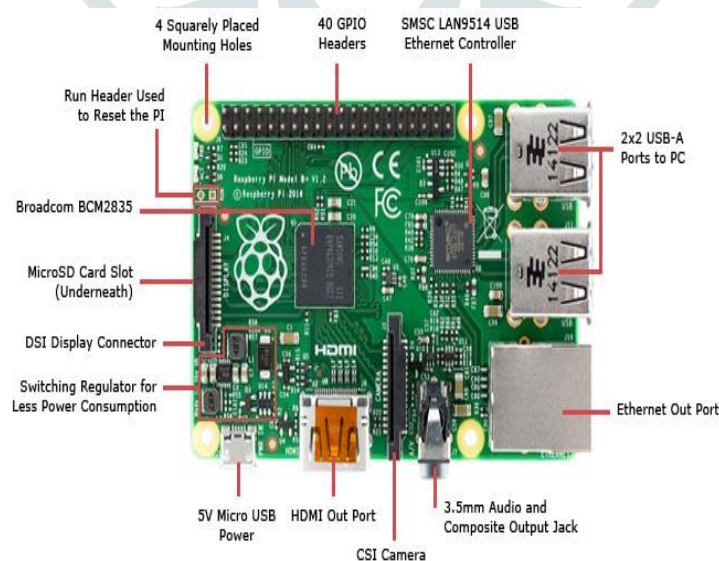


Fig.2.Raspberry pi 3B+ Microcontroller Board

### B. ARUDINO UNO

Arduino Uno is a microcontroller board based on the ATmega328[13]. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, a reset button and it is shown in Fig.3. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an

AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDIUSB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial convertor.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

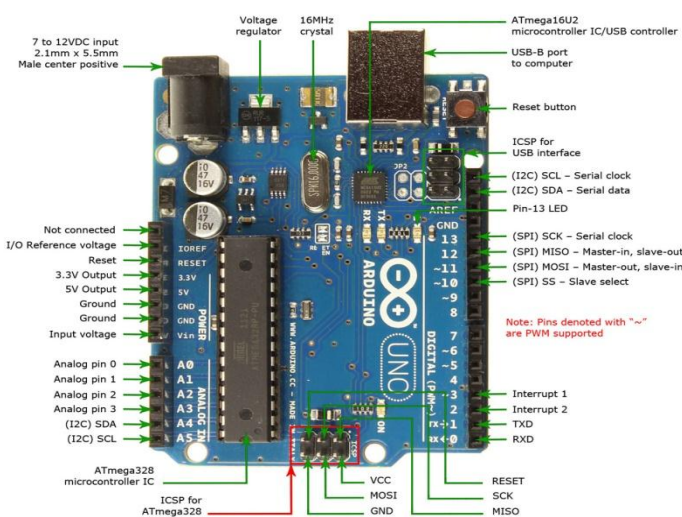


Fig.3.Arduino Uno Board

### C. Current Sensor

In this project current sensor ACS712[14] is used to measure the current, voltage and it is shown in Fig.4. It gives accurate current measurement for both AC and DC signals. These are good sensors for metering and measuring overall power consumption of systems. This sensor produces an output voltage which is directly proportional to sensed current. It works on the principle of Hall Effect. 5V should be supplied to Vcc of ACS712 breakout board and the GND should be the negative of 0v of supply. Once it is powered, the Vout should produce output voltage which represent current going through the sensing pads. When the load is in OFF state then the sensor produces Vcc/2 voltage (no load voltage). ACS712 is able to measure current in two directions. Output voltage more than 2.5V (VCC/2) indicates current in one direction and voltage less than 2.5V indicates current in another direction.

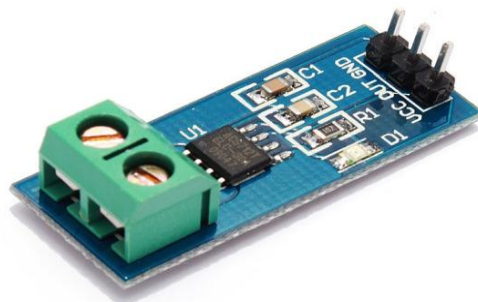


Fig.4.ACS712 Hall Effect Current sensor

### D. VOLTAGE SENSING CIRCUIT

AC voltage measurement can be carried out by converting AC voltage into proportional DC Voltage using rectifier and filter circuits. For low AC voltage (mili volts) measurement precision rectifier is used as diode knee voltage is 0.7 Volt. Similar to DC voltage measurement Voltage divider is constructed using 47K Ohm variable resistor R1. 5v zener diode is used to protect Arduino from accidental excess voltages. Adjust the resistor R1 (47K) to calibrate the voltage. Here the AC voltage that we can give to transformer is from 50V to 230V depending on its ratings. Rectified DC is fed to the voltage divider circuit.

Connect Arduino as per circuit shown in Fig.5[15], make ground common for Arduino and circuit shown in figure. Adjust the resistor R1 to get proper reading. When AC Voltage is 250V we get 5V output.

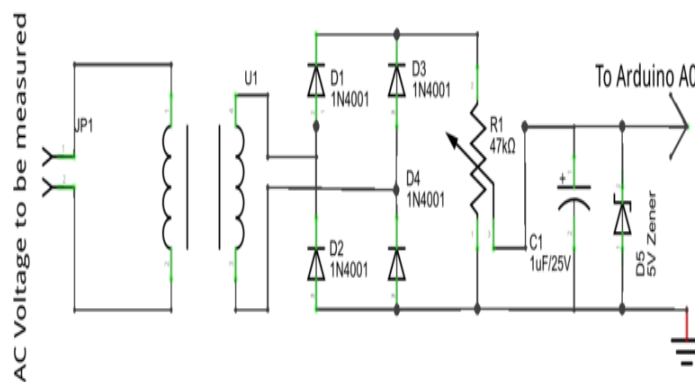


Fig.5.Voltage sensing circuit

## V. SOFTWARE

### A. ANDROID STUDIO

Android studio is the official IDE (Integrated Development Environment) or tool (layman terms) for developing application exclusively for Android platform. It has a strong editor tool for developing creative UI and emulators for different versions to test and simulate sensors without having actual Android devices. It also has a very useful Gradle plugin using which you can create application files (apks) with different configurations. Moreover it makes exporting and uploading apk on playstore easy with a single click. In the recent updates Android studio has brought instant run which makes testing even faster and easier.

### B. RASPBIAN OPERATING SYSTEM

Debian Wheezy is a form of Debian which was produced for gadgets with the ARM processor, for example, the Raspberry Pi. As Wheezy is a general ARM discharge it didn't exploit the Raspberry Pi's equipment where huge speed increments could be made. A little gathering of engineers kicked together and off improving the product that is accessible for Debian Wheezy particularly for the Raspberry Pi and discharged another conveyance as Raspbian.

Raspbian has a straightforward desktop condition with the commonplace format of a menu bar at the base of the screen and a projects menu in the base left corner. It is a decent decision for individuals who are not use to a Linux working frameworks, it additionally requires less specialized information to use than some other working frameworks. There is additionally a wide bolster group with heaps of aides and instructional exercises accessible on the web. As Raspbian is a Linux working framework it has great security highlights, has brilliant systems administration and abilities and access to 1000's of free projects and utilities called bundles that can be introduced basically from the terminal.

## VI. RESULTS

The Hardware part of the project is shown in Fig.6. On and off switches to control load are provided in the android app shown in fig.7. Electrical parameter Voltage is shown in Fig.8. Electrical parameter Current is shown in Fig.9. Electrical parameter Power is shown in Fig.10.

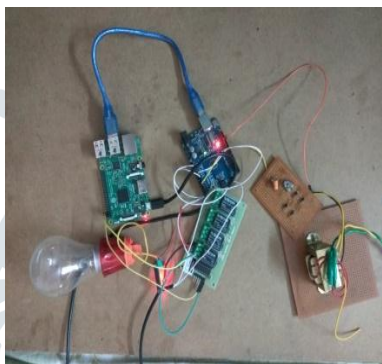


Fig.6. Hardware part of project

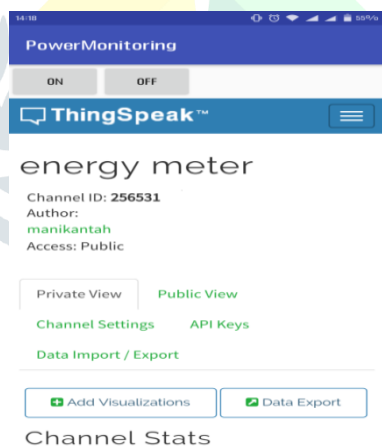


Fig.7. on and off switches for load control

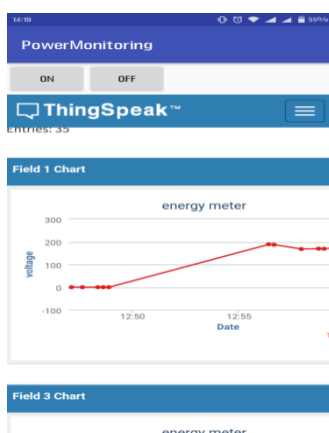


Fig.8. Electrical parameter Voltage



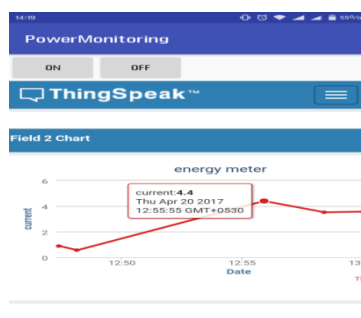


Fig.9. Electrical parameter current.



Fig.10. Electrical parameter power

## VII. CONCLUSION

A smart power monitoring and control system has been designed and developed towards the implementation of an intelligent building. This system monitors and controls the power consumption of home appliances remotely by using wireless network. And also protect the load from High voltages. The entire system is designed on an embedded platform which is easy to design and consume less power, and provides at low cost with portable size. Thus, the continuous monitoring of the electrical appliances can be observed through a website as well as android app.

Further, this work can be extended for power consumption of whole building and electricity bill can be determined. This project can be installed at the transformer to determine the illegal connections for households and by verifying the power in each transmission line, the load at the end of line from transformer can be regulated.

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