IoT Based Power Monitoring System

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Abstract— **Today in many smart systems, IOT plays important role. It is mostly used in power monitoring, Household applications and also in industrial applications. In that power is the most important thing which is to be monitored, control and should properly utilized. In this paper, system is designed for monitor and control street light of particular area. With the help of LDR power consumption is possible. This system is useful to measure the electrical quantities like voltage, current, power, frequency, power factor. By using WI-FI module all this quantity will be send to the things peak. Things peak is the server or software based application which is used to store all this data and will be updated automatically.**

Keywords— Arduino, IOT, PZEM004T meter, WI-FI module, LDR

I. INTRODUCTION

Electricity theft is the main problem, so large amount of power and money wasted in every year that's why power consumption is necessity of time. Renewable energy sources and non -renewable energy sources both used for generation of electricity, But some of the sources from non-renewable are consumed highly and day by day it is available in less quantity.

A system which connects smart devices providing accurate data, embedded with sensors, software, and other technologies to other devices is nothing but Internet of Things(IoT). Energy monitoring is the smartest thing by using internet of things, By using Internet of Things, system can be controlled remotely or by using sensors from anywhere. ESP8266 WI-FI module is used in this project to send the data to Things Peak server. In this system LDR is used to automatically ON and OFF street lights and PZEM004T meter is used to measure electrical quantities also this system displays all this quantities on 16*2 display board and IOT using internet. Regular household devices are also controlled and monitored by using this system. Power monitoring and control using IOT is nothing but wireless system which is widely used nowadays and convenient. Energy consumption will be less by using this system compared to other old technologies. Arduino Uno is used in this project to connect LDR, Wi-Fi module and other sensors which turns complex system to easy one. By using LDR, bulb glows only at night, no need any kind of switches for On and off purpose so energy consumption reduces. Electrical parameters which are available at Things Peak server by using ESP8266 Wi-Fi module are very useful for analysis as well as future study purpose and most important it avoids pen paper work. We can access this data from anywhere.

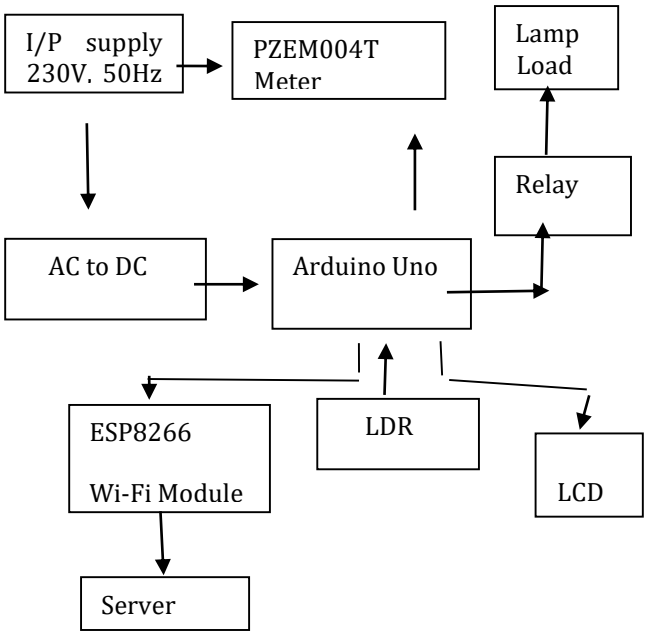
II. LITERATURE SURVEY

In this paper they described low cost power monitoring system and control which reduces power consumption which in turns to savage of power. It measures electrical parameters smartly and then manage whole system. A web server is allow to store the data which is accessed by operator from anywhere by the use of Things Peak server. From literature survey, this system is also useful for household devices by remotely or by using internet of things.

This paper focus on monitor, control and switching of street lights. The system is designed in the way that it controls the street light without help of the operating person. By using LDR, the intensity of lights is determined then operation on street light is done. LDR is also called as photoresistor and it works on the principle of photoconductivity. It operates lamps by identifying darkness and dimness. Lamps are Off during the day while lamps are On during night. IoT prefers real time monitoring and energy quality control, detects abnormal conditions. According to literature survey, Things Peak server shows the data in various formats like graph format, Numerical format, Time format suitable to various conditions.

III. METHODOLOGY

A. Block Diagram



B. Arduino Uno

Arduino Uno is microcontroller board based on ATmega328P microcontroller and it is developed by Arduino.cc. Burning and uploading of program in Arduino is easier than microcontroller. Arduino uses IDE software that is Integrated Development Environment. Program can be done on Arduino by using c and c++ language.

It has 6 analog input pins, USB interface, 16MHz frequency crystal oscillator, 14 digital I/O pins. These pins are used to connect various external sensors and electronic devices. In 14 I/O pins, 6 pins are PWM output.

The board has in built good features can be directly connected to computer, laptop through USB cable. By using USB cable we can transfer or upload code from our computer to the Arduino through IDE software. If USB cable is not available then we can use Ac to DC adapter. When board does not work properly or hang then Reset pin is provided to reset the board then program starts from initial point.

Arduino requires 5V supply which can be obtained by AC to DC adapter or through USB cable. It has also other pins like 1.PWM – It provides 8 bit output and it is available on the board at no. 3, 5, 6, 9, 10, 11.

2.Rx and Tx – It is at no 0 and 1 serially. Rx pin is used for receiving the data while Tx pin is used to transmit the data. Both are called serial communication pins.

3.GND – This pin is provided to connect the ground. More than one ground pin is available on Arduino for connection.

4.Vin – It is input voltage pin available on Arduino, supply is provided through power jack.

5.LED – It is available on Arduino Board At pin no.13. It works on High and Low value and according to situation it turns ON and OFF.

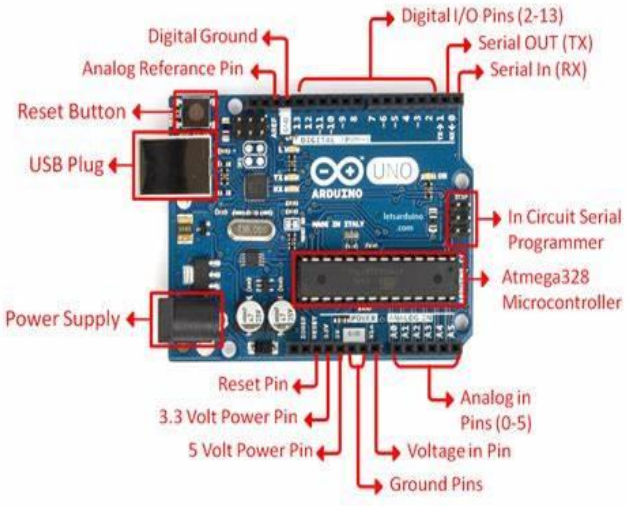


Fig.1 Arduino Uno Image

C. PZEM004T Meter

PZEM004T Meter is the best solution to measure the electrical ac quantities like voltage, current, power, energy, frequency, power factor and by using IoT platform the measurement values can be send to the server online by using internet and can be access from anywhere.

Now PZEM004T meter is upgraded to version 3.0 from its old version 1.0. This updated version is suitable to measure all electrical parameters mentioned above. It is available with current transformer coil which senses the current so does not require any measurement circuit.

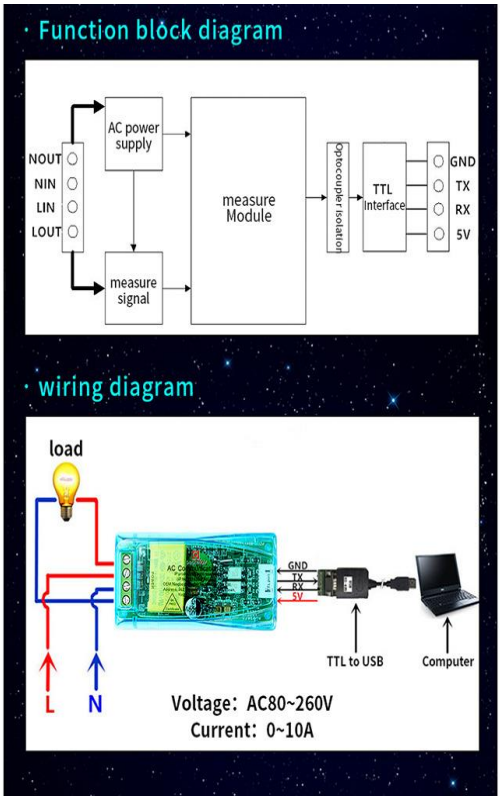


Fig.2 Block diagram and Wiring diagram of PZEM004T Meter

Measuring parameters and their range is as follows

1.Voltage

- Measuring range is from 80-260V
- Accuracy is 0.5%

2.Current

- There are different Measurement range of current is available in PZEM004T meter like 0-10A, 0-100A Etc suitable to our requirement
- Measurement of current is starting from 0.01, 0.02 respectively
- Accuracy is 0.5%

3.Frequency

- Frequency measurement is available from 45Hz-65Hz
- Accuracy is 0.5%

4.Active Power

- Measurement range is 0-2.3KW for 10A Kit and for 100A kit, range is 0-23KW
- Accuracy is 0.5%

5.Energy

- Measurement of energy is available from 0-9999KWH
- Accuracy is 0.5%

6.Power Factor

- Measurement range is 0.00-1.00
- Accuracy is 1%

Some precautions should be taken while using this meter is, this meter should be used only in indoor applications, connections should made accurate don't make faulty connections for wiring, load should not be exceed rated value.

PZEM004T Meter is also known as Multifunction Meter or AC digital Multifunction smart meter.

It is easily interface with Arduino and microcontroller and also have serial communication. This meter have Automatic measurement and overload warning alarm. Measured quantities are transmitted to 16*2 LCD display by using Arduino functions.

It has the dimensions 3.1*7.4 cm and have 33m bundled current transformer coil

Fig.3 Current Coil of PZEM004T Meter

D. LDR

A Light Dependent Resistor (LDR) is also known as Photoresistor, Photoconductor and Cadmium Sulphide (CdS) cell. It works on the function of resistivity, hence they are light sensitive device. LDR is made up of semiconductor material . LDR works on the principle of photoconductivity.

When light falls on the device their resistance is decreased and increased in night means at dark time. At night when it is dark resistance of LDR is very high and also called dark resistance. Its high value is 1012 ohm. LDR is a non-linear device. LDR's are less sensitive than Photodiodes and Phototransistors.

Working Principle of LDR

LDR works on the principle of photoconductivity. When light falls on its surface then material conductivity reduces and electrons in valence band are excited to the conduction band of the device. These photons in the incident light must have energy greater than the band gap of the semiconductor material then electrons from valence band jumps to the conduction band.

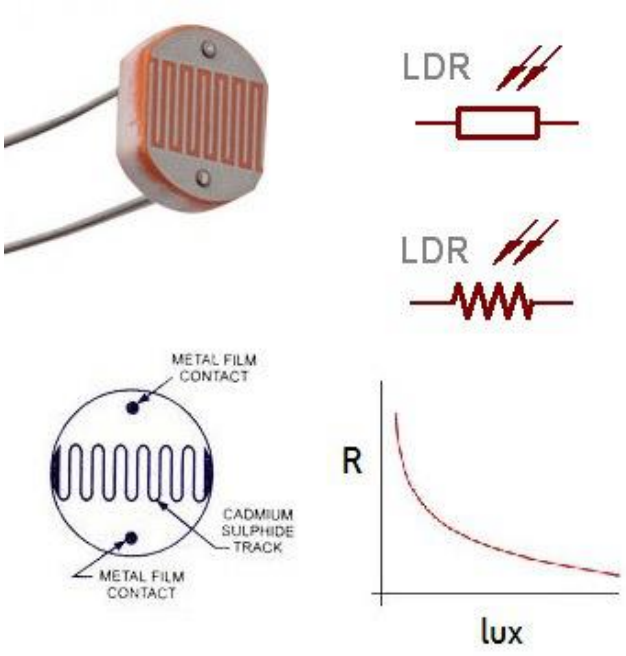


Fig.4 LDR Symbol and basic structure

LDR's are classified as Intrinsic Photoresistors and Intrinsic Photoresistors. It have simple construction and mostly used in street lightening and garden lightening. It is used in electrical as well as electronic projects. Some of its applications are Street lights, Garden Light, Smoke alarms, light sensor.

IV. TECHNOLOGIES USED

A. ESP8266 WI-FI Module

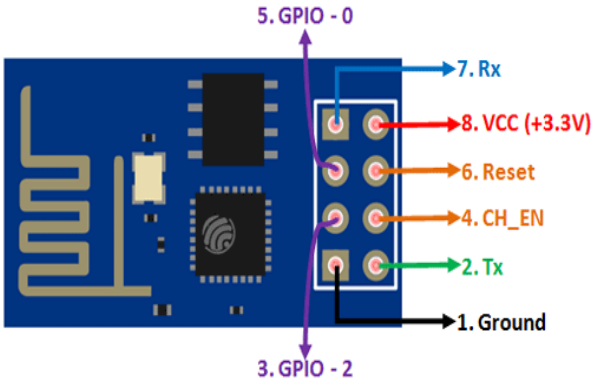


Fig.5 Basic Structure of ESP8266 WI-FI Module

ESP8266 Wi-Fi Module is a technology based device. It is developed by Espressif system. It is mostly used in IoT based Applications. It is used to send the data to a web server. It is low cost device which available easily and also easy to use.

ESP8266 consists of 8 pins as follows:

1.Tx
2.Rx
3.GPIO 0
4.CH_PD
5.GPIO 2
6.VCC
7.RESET
8.GND

Where Tx and Rx are used for communication, GPIO pins are general purpose I/O Interface pins, GND and VCC are used as power pins.

It is a microchip with full stack TCP/IP and having microcontroller capability. ESP8266-01 communicates to the Arduino with the help of AT commands. It have baud rate 115200. operating voltage range of this wi-fi module is 3.0V-3.6V, average value of operating current is 80mA. Specific program is used to interface wi-fi

module to Arduino. It uses serial communication or UART interface for connectivity to the Arduino UNO. It hosting wi-fi networking functions from another application. The ESP8266 works on 3.3V only, its maximum voltage range is 3.6V, any voltage range beyond the 3.7V can damage the device. It is mostly used in IoT based projects.

There many wi-fi modules available in market, so we have to choose the device according to our requirements. It can upload data offline so no need of internet. Internet requires only to view the data which is posted on things peak server. For that purpose the specific SSID and password should written in program.

B. Things Peak Server

Things Peak server is an IoT based platform in which we can Visualize, Analyze, live data in the cloud. By the use of Things Peak we can send data privately and analyze, visualize anytime anywhere. It collects data Of different fields by making different channels and these channels we can see privately as well as publically, both options are available there. Things peak works with MATLAB, Arduino, ESP8266 wi-fi module, Beckhoff, Raspberry pi, etc. In Things peak data will be updated automatically when any operation will perform regarding its application. We can record any data values with the help of sensors by interfacing wi-fi module also we can download data sheet of that values so pen paper work is avoided. Real-time data collection, data updating, data processing these are some features of Things Peak. In Things Peak, channel is the most important thing where you can see your data. Each channel has 8 fields for storing the data and latitude, longitude elevation, status, etc options are available. Things Peak has IoT platform with MATLAB analytics.

Things peak also consists of time zone management, read/write API keys, JavaScript based charts where read/write API keys are used to read and write data. We can see stored data in Things Peak server in different formats like graphical, Numerical, Time zone also it indicates location.

V. RESULTS

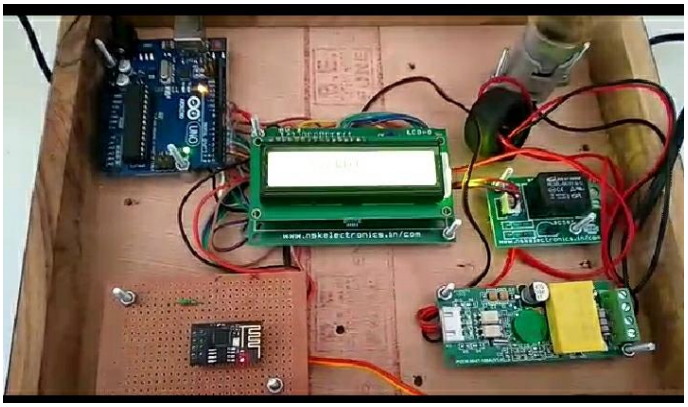
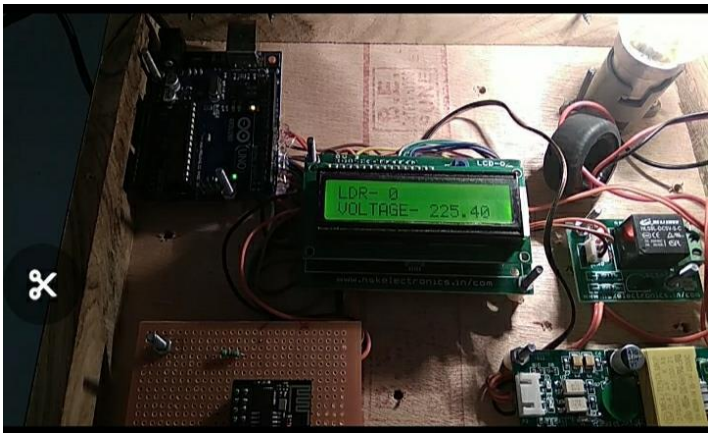
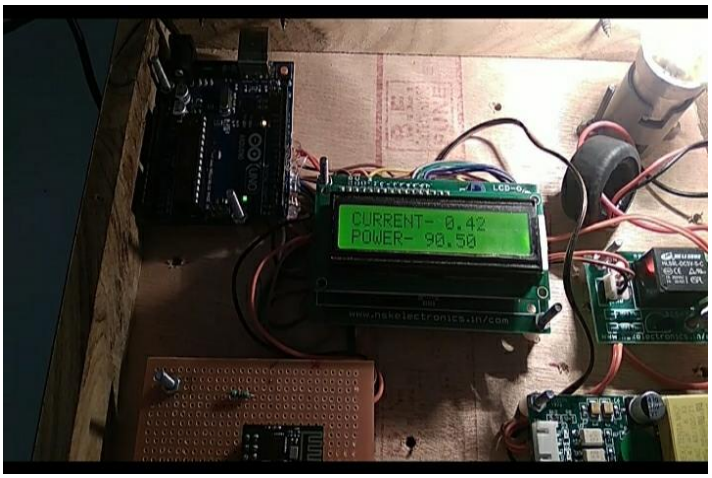
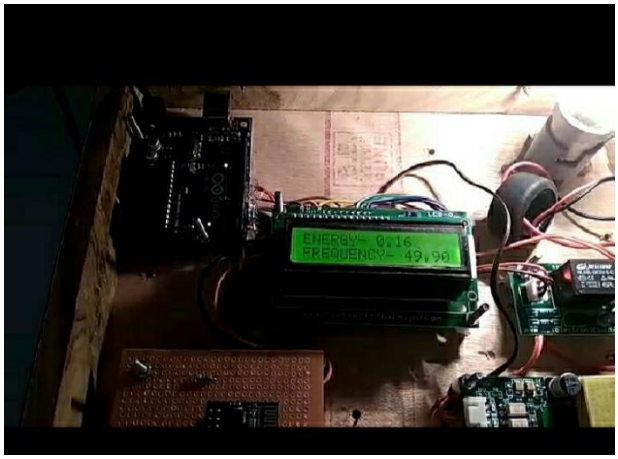


Fig.6 System Kit

Results were obtained when bulb is ON







I. CONCLUSIONS

The system monitors and control the power consumption of appliances automatically by using IoT platform through wireless network. It protects the load from high voltages. The system is designed such a way that it consumes less power and have low cost with a portable size. This system makes entire process smart one because it automatically displays all function values on display board through Arduino and on Things Peak server. This project is also installed for domestic level to find out electricity theft. This project avoid calculations of electrical parameters, saves time and pen paper work.

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