A

PROJECT REPORT

ON

"IoT Based Smart Energy Meter & Home Automation"

Submitted in partial fulfillment of the requirements for the award of degree of

BACHELOR OF TECHNOLOGY

in

Electrical and Electronics Engineering

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BANASTHALI VIDYAPITH RAJASTHAN

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CERTIFICATE

I hereby submit the project entitled **"IoT Smart Energy Meter & Home Automation"** in the **School of Automation** of the Banasthali Vidyapith, under the supervision of **"Dr. Pawan Kumar Pathak"**, School of Automation, Banasthali Vidyapith, Rajasthan, India.

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ABSTRACT

While traditional electricity meters measure the power consumption of a home or business, smart meters can record energy usage in real time. The primary objective of Smart Meters is to reduce energy consumption in households Most importantly, smart meters enable two-way communication between the utility and the home/business . While The Government of India's initiatives like 'Make in India' and 'Smart Cities' need an efficient, reliable, and continuous power supply. India's power sector in the present day is facing a lot of problems like AT & C losses, inefficient distribution, and transmission systems because of age-old infrastructure, and power theft. Advanced energy management and increased use of renewable energy resources are the foremost areas to concentrate on by governments for the development of the country. The government cannot take the initiative for a complete change of electrical equipment across the country but there is a need for changing the way of operation and control of the electrical equipment .This Report presents the IOT based smart energy meter and home automation to track the energy consumption automatically of the residential load and to control the home appliances. This meter is capable of sending the consumptions to the consumer as well as an electricity supplier. The readings are taken automatically by using the HLW8012 sensor. Then a predefined set of programs calculates the total bill of energy consumed over the selected interval using the ESP32 microcontroller. The bill is updated in the smartphone by employing a network of Internet of Things. This system eliminates the involvement of the operator for manual methods of taking the meter reading and updating the server for bills. The user can check the number of units consumed by the load at any time using the smartphone. In the future, this idea can be implemented for prepaid metering, which will eventually increase the revenue of the electricity distribution company. We are using ESP32 because of the inbuilt Wi-Fi and Bluetooth facility available in this microcontroller IoT is the combination of collect and exchange data from electronic hardware to the cloud platform and share with the software linked. The platform of the virtual android app is used. Which reflect all the value of Voltage, Current, Power, and unit consumed on the mobile screen. We are living in the fourth industrial revolution. Our life is becoming more comfortable and smarter with the help of rapid upgrade of technology. Internet of things (IoT) is playing a massive role in this. One of the major sides of IoT is a smart home. As we are in the era of never-ending growth of the internet and its application, smart home system or home automation system is highly increasing to provide comfort in life and improving the quality of life. In this paper, we present an IoT based low-cost smart home automation system. This system is based on a web portal which controlled by an ESP32 Wi-Fi module. Also, a custom-made private home web server is developed for maintaining the current states of home appliances.

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Chapter 1 INTRODUCTION

1.1 BACKGROUND :

Electricity was only available to the rich in the early years. Over time, technological advancements enabled common people in various regions of the world to have their needs met. Archaeologists have been involved in the genesis of the electric meter. In the early 1870s, telegraphs and arc lights were the most common uses of electricity. In 1879, Thomas Elva Edison invented the electric light, which opened up the electric power industry to the general public. In 1888, Oliver B. Shallenberger debuted his AC amp hour meter. Finally, ongoing advancements in measuring technology is bringing illumination to people's lives. Electric meters are electrical devices that can detect and show energy in a form of learning. Since the late 1800s, traditional meters have been in use. For both the generation and distribution of power, they communicate data amongst electronic equipment in a computerized environment. Alumina specimen are used to measure power use in various electric meters. Electric meters today are digital, but they still have significant restrictions. The following are among some of the shortcomings of a basic electric meter:

• Consumers will expect a monthly utility payment; therefore, meters aren't inherently dependable.

• The architecture of some devices supports the measuring process, which is why they are referred to as electromechanical meters.

• A significant number of testers are required for meter readings.

• Checkout process is time-consuming and costly.

• It is not possible to establish a new sort of hourly rate with the accompanying meter to urge the consumer.

• Metered software applications and supporting network infrastructure are difficult to develop.
Apart from the above-mentioned limitations, there are a few other factors that influence a huge gap between the consumer and the distributor due to the installation of traditional meters

1.2 MOTIVATION

The chance of lowering consumption, utilizing the latest Smart Meter will reduce energy prices. Traditional meters waste a lot of electricity on human energy. With household power usage measured monthly by conventional meters, electrical providers must examine new advances that will benefit both consumers and themselves. The research, however, chooses to make attempts to replace the electric meter in various households by lowering the obstacles erected by consumers. Electricity usage varies daily based on habits and is greatly influenced by customer behavior. Consumers are ignorant of how much consumption is created every hour and at anytime interval per day when using standard meters, since usage is not mentioned. Consumer apprehension might also be misled since most people know relatively little about Smart Meters and how they are installed. Finally, this research is recommended to include encouraging change and worrisome learning in the market.

1.3 WORK

The energy usage per hour collected from the energy source is the subject of this thesis function. These ad hoc values assist energy resources and users in determining their hourly reported energy usage. In reality, customer behaviour may be tracked and the information can be used to enhance customer experience, particularly when it is linked to a fluctuating price. This role bridges the gap between customers and electrical services, allowing them to interact successfully through cost-cutting techniques. To rectify misunderstandings, consumers must be informed about the measures. Standard data from groups of households were used in the sample research. The many alterations to usage have been clearly known and defined. Research can also assist consumers in thinking more critically about how they utilize their power. In addition, everyday patterns for an entire day are evaluated hour by hour. Future savings can be achieved by employing speculative models and mitigation approaches to choose when and what material to utilize. All of the following features are available through an IoT application on their mobile phone. From a distant location, a Blynk user may simply monitor the entire process of power consumption by diverse loads.

1.4 ORGANISATION OF THE REPORT

This Report on IOT based Smart Energy Meter is divided into four chapters after this introductory Chapter where we have discussed the background, motivation and work of our project, **Chapter 2** describes the keynote address where we elaborate about our purpose and give introduction of our project along with all the flowcharts, block diagram, circuit diagram that we have made during our research. We have also mentioned required code. It comprises of the hardware description of our project where we have given details about all the components that we have used along with suitable pictures.

Chapter 3 provides an account of result that we have acquired throughout this research and the discussions that we had which have formulated our ideology behind the motive of our work
Finally, **Chapter 4** compiles the conclusion that we have obtained and the future scope of IOT based meter.

Chapter 2 PROBLEM FORMULATION

2.1 PURPOSE

Electricity plays an important role in day- to- day life. Internet of Things (IoT) is an emerging field and IoT based devices have created a revolution in electronics.The main objective of this project is to create a awareness about energy consumption and efficient use of home appliances for energy savings.This system gives the information on meter reading, power cut and the alert systems for producing an alarm when energy consumption exceeds beyond the specified limit using IoT. This idea is being implemented to reduce the human dependency to collect the monthly reading and minimize the technical problems regarding billing process. This project extends the design and implementation of an energy monitoring system with the pre-intimation of power agenda using ESP32 micro controller and a . The advantage of this system is that a user can understand the power consumed by the electrical appliances on the daily basis and can take further steps to control them and thus help in energy conservation. The aim of this project is divided into two parts to design IOT based Smart Energy Meter and Home Automation which can be used to automatically measure energy consumption and automatically you can easily calculate the bill and to control the household appliances . This work deals with the energy consumption units measured from the user's location. For this, along with all the components (sensors, resistor, diode, etc.) required to make smart energy meter , we have used ESP32 Wifi module and Blynk application (purchased under 4000 INR)

Using current and voltage sensors required parameters is measured, and then we have interfaced the current and voltage sensors with wifi module and send the data to Blynk application . The Blynk application dashboard will display the voltage, current, power and total unit consumed in kWh. Monitoring and keeping track records of electricity consumption is a tedious task . therefore this meter serves in automating remote data collection.

The aim of second part of our project is to control all the devices of your smart home using ESP32 module and Blynk app the ESP32 module is connected with the WiFi, then you can control the home appliances from Blynk App and push-buttons. You can control, monitor the real-time status of the relays from anywhere in the world with the Blynk App. The method of regulating house appliances automatically utilizing various control system approaches is known as IoT home automation. Various control mechanisms may be used to regulate electrical and electronic equipment in the house, such as windows, refrigerators, fans, lights, fire alarms, kitchen timers, and so on

2.2 INTRODUCTION

IoT is an inter-network of physical devices like vehicles, buildings and other items embedded with electronics, sensors, actuators, software, and network connectivity which enable these objects to collect and exchange data . The Global Standards (2013) Internet of Things (IoT-GSI) define IoT as “a global infrastructure for the information society and it enabling advanced services by communicating (physical and virtual) things based on existing and evolving interoperable information and communication technologies .

IoT can offer advanced connectivity of devices, systems, and services which goes beyond machine-to-machine (M2M) communications and cover various protocols, domains, and applications . The interconnection of appliances (including smart objects), is expected to guide in automation in all fields, while also enabling advanced applications like a smart grid, and expanding to areas such as smart cities., agriculture, building management, healthcare, energy and transportation are the major applications of IoT technology which are used in real world.

The internet of things (loT) is a network of connected smart devices enabling to transfer data. The ‘thing’ in IoT could be a person with a heart monitor or an automobile with built-in-sensors, i.e. objects that have been assigned an IP address and have the ability to collect and transfer data over a network without manual assistance or intervention. The embedded technology in the objects helps them to interact with internal states or the external environment, which in turn affects the decisions taken. With rapid growth and development, energy crisis has become a very big issue. An applicable system has to be made in order to analyse and control power consumption. The existing system is error prone, labour and time consuming . The values that we get from the existing system are not precise and accurate though it may be digital type but it is always necessary that a concern person from the power department should visit the consumer house in order to note down the data and error can get introduced at each and every step. Therefore, the remedy for this solution is smart energy meter.

The smart grid plays a great role in our present society. Tens of millions of the people's daily life will be degraded dramatically because of the unstable and unreliable power grid . Smart meter is a reliable status real time monitoring, automatic collection of information, user interaction and power control device . It provides a two way flow of information between consumers and suppliers providing better controllability and efficiency . It provides real time consumption information providing energy consumption control. Whenever the maximum load demand of customers crosses its peak value, the supply of electricity for the customers will be disconnected with the help of smart energy meter . In ideal environment with normal work load condition, the life span of the smart meter is about 5 to 6 years . But in reality smart energy meter suffers environmental issues and decreases its life span with abnormal consumption of energy. The factors affecting lifespan of a smart meter consists of based energy meter system mainly consists of three major parts i.e., life expectancy (LE), genetics (GE), environment factors (EF), change over time (CT) and limited longevity (LL) .Controller, Wi-Fi and Theft detection part. Whenever there is any fault or theft, the theft detection sensor senses the error and circuit response according to the information it receives. The controller plays a major role in the system making sure all the components are working fine.

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Therefore, IoT can improve the performance and efficiency of the smart grid mostly in the three phases. Firstly, it increases the reliability and durability. Secondly, it focuses on enablement i.e. collection and analyzation of data to manage active devices within the smart grid. Lastly, controlling can be done by analyzing the result obtained from the second phase which helps the grid department to make fine decision for future upliftment.

The energy meter available till now can only control and monitor the energy consumption of customers. Smart energy meter developed using power line communication (PLC) helps in power loss . Several system using Arduino as well as microcontroller have been developed though the efficiency to measure power consumption drastically increased but due to cost effective it may not be considered as the suitable one. The consumer cannot have a good and accurate track of the energy consumption on a more interval basis 'The conventional meter has some of the common errors like

- Time consuming.
- Chance of theft.
- Error while taking the information and extra human involvement.
- Consumer cannot have daily update of his/her usage.

Thus, we proposed a smart system which enables the consumer as well as producer to monitor and control the energy consumption on more immediate basis.

Home automation (HA) is designing an automation system for the home. It involves the control and automation of anything and everything that runs on electricity and can be connected and controlled by a third party system .

Home automation has greatly increased in popularity over the past several years . The major important advantages of automated home is the ease of functionality and home can be managed by using a vast array of devices like desktop, laptop, tablet or Smartphone which is based entirely on the user's discretion. Home automation is automated system that composed of hardware , communication and electronic interfaces and integrate the electrical devices with one another. Domestic activities can be synchronized by pressing the button even from a remote location which means users can controls the system from remote locations like change the room temperatures, control the TV/Audio/Video entertainment systems and can limit the amount of sunlight. Since the 20th Century Home automation become practical with advancement of information technology. It is basically an application of computer and information technology to automate the home, household activity, Offices, classrooms and housework etc. It's provides centralized control to the user on Appliances, control of Temperature, Light, and appliances with other systems and to provide Comfort, better convenience, security and energy efficiency also for Physically disabled & elderly users it might provide a quality of life for persons who might otherwise require caregivers or institutional care . IOT is in huge demand because of higher affordability and simplicity through Smartphone and other portable device connectivity . IOT is widely used for implementing the automation system like Home & Offices.

The Wifi Module ESP32 will Receive commands from the smartphone wirelessly through the internet. To encode the ON/OFF signal and send it to Server and to ESP32 Board we need the best IoT Platform. So we chose Blynk as no other application can be better than this one. This project requires internet connectivity & can't work without Internet connection. In our project we have used four channel relay module to connect four bulbs through ESP32 wifi module to Blynk app and control their ON/OFF functions directly from our phone.

2.3 Hardware Description

1. CURRENT SENSOR

This is SCT-013-030 Non-invasive AC Current Sensor Clamp sensor 30A. SCT-013-000 is a Non-Invasive AC current sensor i.e., it is a current transformer that can be used to measure AC current up to 100 amperes.

This non-invasive current sensor clamped around the supply line can measure a load up to 30 Amps, and allow you to calculate how much current pass through it. It can be useful for building your own energy monitor or for building an over-current protection device for an AC load. This current clamp can be used to detect a current of up to 30A. Simply clip it around the current source that you wish to measure and it will produce a (very) small AC voltage proportional to the current. The cable is terminated on one end with a standard 3.5mm jack (like a headphone jack).

Use this to build your own energy monitor and keep your power usage down, or use it to build an over-current protection device for an AC load. See the link below for an example project. Check out the datasheet for the pinout of the 3.5mm jack.

Fig 1. Current Sensor

2. VOLTAGE SENSOR :

A voltage sensor is a gadget available that can help to detect or sense or measure the present voltage in the system. The sensor can detect the kind of voltage present (may it be AC or DC voltage).The input for the sensor is the voltage present and the possible outputs are analogue voltage signal, current signal, or audible signal are the sensor's output. The ZMPT101B AC Voltage Sensor is true to be employed. The sensor present is the best gadget for measuring the voltage (may it be AC or DC voltage) with the help on an open- source platform like Arduino. Engineers deal directly with measurements in many electrical projects, which have some basic needs like high galvanic isolation, wide range, high precision, and good consistency. Within a 250V AC voltage range, modules is also monitored and so the analogue output modified. It's fresh new, high-quality, and efficient.

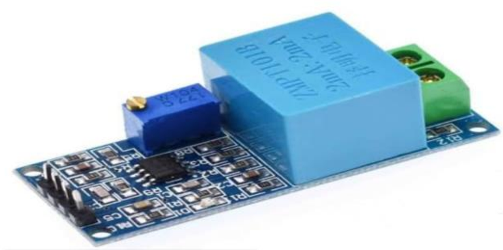


Fig 2. Voltage Sensor

3. LCD DISDAY (16*2) :

LCD is a display that operates in the first mode. The appliance connected is continuously monitored by ESR32 WIFI module and is displayed upon the LCD present. The load increases, a message about power usage is delivered to the system and necessary data is seen on the LCD. LCD- Liquid Crystal Display is a straight 2-D display which takes support, help of the light-modulating features of liquid crystals bought together with polarizers. Liquid crystals don’t have their own light instead a backlight is needed for them to enlighten and glow.

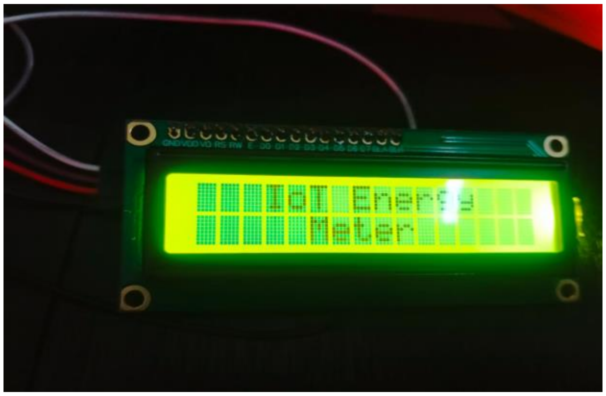


Fig 3. LCD display

4. I2C MODULE :

I2C Module has a factory present PCF8574 I2C chip which changes I2C serial data to parallel data to display. This gadget is present with a factory enabled I2C address which is 0*27 / 0*3F to figure out which configuration we have got we can check it through the black I2C adaptor which is on the downside of the gadget. If A0, A1, A2 named pads present then the default gadget configuration we've is 0*3F and if there aren't any named pads then the configuration received is 0*27. This helps in adjusting the contrast and brightness of the LCD that is used.

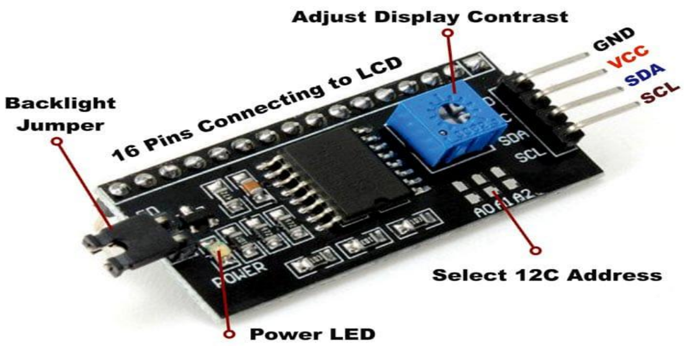


Fig 4. I2C Module

5. ESP32 WIFI module:

It is a sequence of less cost, less power arrangement with bluetooth and and Wi-Fi combined together. This gadget gives scope of use in both of the technology namely Bluetooth and Wi-Fi that helps in better connectivity and transmission of data within a small arrangement of components.

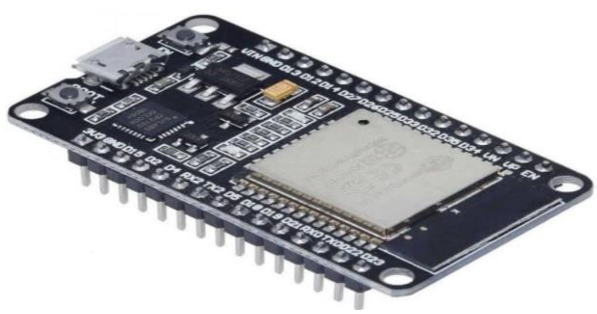


Fig 5. ESP32 wifi Module

6. CAPACITANCE :

Keltron High Quality 10uF 100 Volts DC Radial Aluminium Electrolytic Capacitor.
Capacitance: 10uF, **Voltage Rating:** 100V, **Diameter:** 6.3mm ± 0.5mm, **Height:** 11mm ± 1.0mm, **Pitch (Lead Spacing):** 2.5mm ± 0.5mm, **Lead Diameter:** 0.5mm ± 0.05,

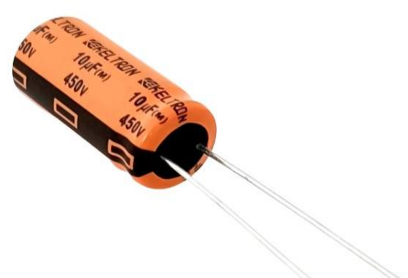


Fig 6. Capacitance

7. 4 Channel Relay Module:

A current carrying coil of an insulated wire wrapped around a piece of iron is an electromagnet. A power relay module is an electrical switch which is operated with the help of an electromagnet , which is activated by a low power signal generated by a microcontroller..When the current passes, the electromagnet completes or breaks the electrical circuit. It is a flame sensor Relay module that can detect the flame of wavelength at 760nm to 1100nm range of the light source.

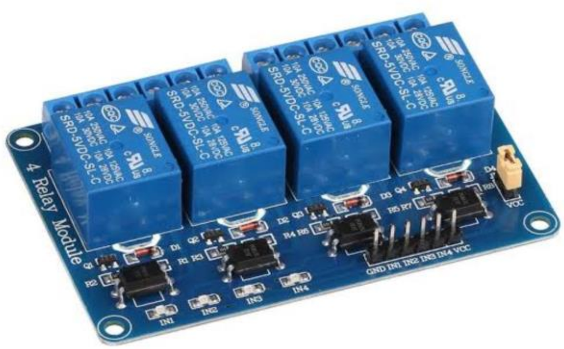


Fig 7. 4 Relay Module

8. RESISTANCE

The 10K Ohm resistor is often used as a pull-up resistor for an input pin. For example on Arduinos we can use a 10K Ohm resistor to pull-up an input pin, so that when the button is pressed, it pulls the input pin high with 5V, triggering an action in our code.

Fig 8. Resistance

9. BREADBOARD

A breadboard, solderless breadboard, or protoboard is a construction base used to build semi-permanent prototypes of electronic circuits. Unlike a perfboard or stripboard, breadboards do not require soldering or destruction of tracks and are hence reusable.

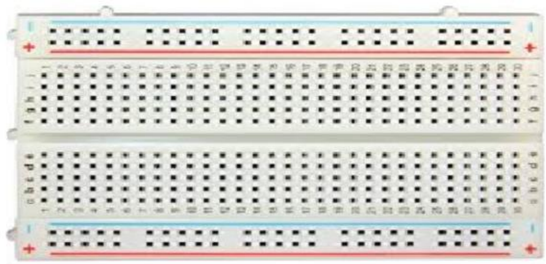


Fig 9.BreadBoard

10. BULB HOLDER

A **lightbulb socket**, **lightbulb holder, light socket**, **lamp socket** or **lamp holder** is a device which mechanically supports and provides electrical connections for a compatible electric lamp base.

Fig 10. Bulb Holder

2.4 Software Discription

1. Blynk App

Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It’s a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets. It’s really simple to set everything up and you'll start tinkering in less than 5 mints. Blynk is not tied to some specific board or shield. Instead, it's supporting hardware of your choice. Whether your Arduino or Raspberry Pi is linked to the Internet over Wi-Fi, Ethernet or this new ESP8266 chip, Blynk will get you online and ready for the Internet of Your Things**.**

I. Blynk Server

Blynk Server is an Open-Source Netty based Java server, responsible for forwarding messages between Blynk mobile application and various microcontroller boards (i.e. Arduino, Raspberry Pi. Etc).Blynk Cloud is software written on Java using plain TCP/IP sockets and running on our server. Blynk iOS and Android apps connect to Blynk Cloud by default. Access is free for every Blynk user. To run Blynk Server, all we need is Java Runtime Environment.

II. DESIGN’S

The design consists of two main part hardware and software. The hardware contains microprocessor , microcontroller, different sensors, actuator’s etc.
Software consists of different programming concept which are used in our project. With the help of IoT this hardware and software can link to each other.

III IOT ARCHITECTURE

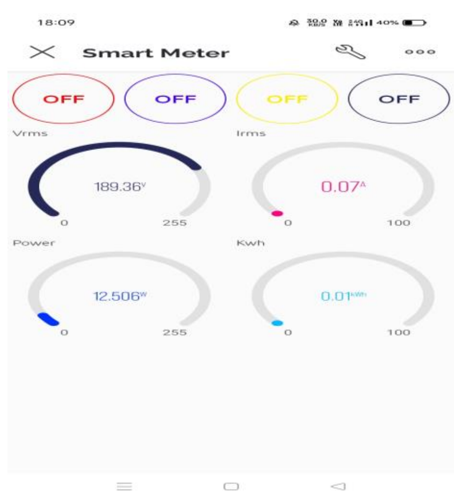
The Internet of thinks (IOT) is a rapid explained technology that is shaping up to bring the next revolution in computing and information technology. IOT system has application across industries through their unique flexible and ability to be suitable in any environment.

Setting Up Blynk 2.0 Web and Mobile Dashboard

Blynk is an application that runs over Android and IOS devices to control any IoT based application using Smartphones. It allows you to create your Graphical user interface for IoT application. Here we will display the IoT Energy Meter Data on Blynk Web Dashboard and also in mobile Application.Visit blynk.io and sign up using the email ID.

- First create two template on your computer and after creating template authentication code is sent to your mail Id.

- Assign the name and hardware Type and from the web dashboard , create 4 widget gauge Irms,Vrms, Power,KWh and ON & OFF Button.



Required Library Installation

1. EmonLib Library

The EmonLib Library is used for Electricity Energy Meter. EmonLib is a Continuous Monitoring of Electricity Energy repeats, every 5 or 10s, a sequence of voltage and current measurements. EmonLib continuously measures in the background the voltage and all the current input channels, calculates a true average quantity for each, and then informs the sketch that the measurements are available and should be read and processed.

2. Blynk Library

Blynk is the most popular Internet of Things platform for connecting any hardware to the cloud, designing apps to control them, and managing your deployed products at scale. With Blynk Library you can connect over 400 hardware models including Arduino, ESP8266 & ESP32 to the Blynk Cloud.

ZMPT101B Voltage Sensor Calibration

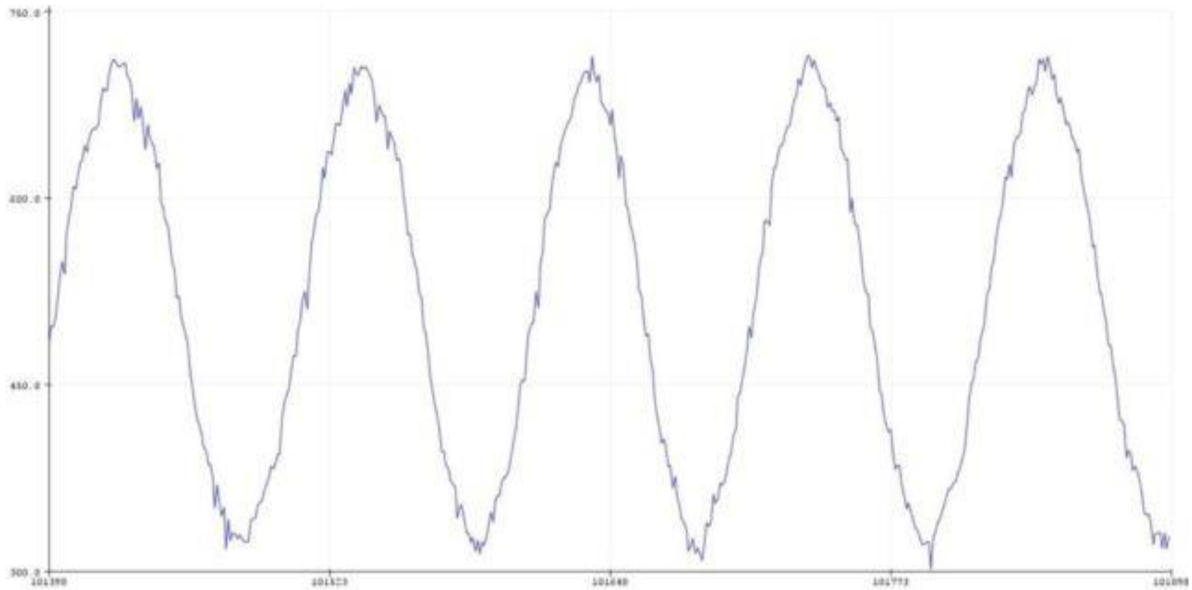
Initially the ZMPT101B Voltage Sensor requires calibration as it doesn't come pre-calibrated. To calibrate the sensor, we can use an Arduino UNO/Nano Board. Since Arduino UNO/Nano has a perfect linear ADC pin, it can be a good choice for calibration. You can use analog pin A0 of Arduino to calibrate the sensor.
Now upload the following code to the Arduino Board.

```
void setup()
{
Serial.begin(9600);
}

void loop()
{
Serial.println(analogRead(A0));
delay(100);
```

```
}
```

After uploading the code, open the Serial Plotter. If the Serial Plotter doesn’t show the sine wave, then rotate the potentiometer to calibrate the sensor. Once it shows a proper sine wave, you can assume it is a proper calibration.



Source Code/Program for IoT Smart Energy Meter

This code is an Arduino sketch that implements an IoT energy meter using an ESP32 board. The code uses several libraries such as LiquidCrystal_I2C, EmonLib, EEPROM, WiFi, WiFiClient, and BlynkSimpleEsp32.
Copy this code and upload it to the ESP32 Board.

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 20, 4);
#include "EmonLib.h"
#include <EEPROM.h>
#define BLYNK_PRINT Serial
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
```

```
EnergyMonitor emon;
#define vCalibration 83.3
#define currCalibration 0.50

BlynkTimer timer;
char auth[] = "**********************";
char ssid[] = "**********************";
char pass[] = "**********************";
float kWh = 0;
unsigned long lastmillis = millis();
void myTimerEvent()
{
  emon.calcVI(20, 2000);
  kWh = kWh + emon.apparentPower * (millis() - lastmillis) / 3600000000.0;
  yield();
  Serial.print("Vrms: ");
  Serial.print(emon.Vrms, 2);
  Serial.print("V");
  EEPROM.put(0, emon.Vrms);
  delay(100);
  Serial.print("\tIrms: ");
  Serial.print(emon.Irms, 4);
  Serial.print("A");
  EEPROM.put(4, emon.Irms);
```

```
delay(100);
Serial.print("\tPower: ");
Serial.print(emon.apparentPower, 4);
Serial.print("W");
EEPROM.put(8, emon.apparentPower);
delay(100);
Serial.print("\tkWh: ");
Serial.print(kWh, 5);
Serial.println("kWh");
EEPROM.put(12, kWh);
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Vrms:");
lcd.print(emon.Vrms, 2);
lcd.print("V");
lcd.setCursor(0, 1);
lcd.print("Irms:");
lcd.print(emon.Irms, 4);
lcd.print("A");
lcd.setCursor(0, 2);
lcd.print("Power:");
lcd.print(emon.apparentPower, 4);
lcd.print("W");
lcd.setCursor(0, 3);
```

```
  lcd.print("kWh:");
  lcd.print(kWh, 4);
  lcd.print("W");
  lastmillis = millis();
  Blynk.virtualWrite(V0, emon.Vrms);
  Blynk.virtualWrite(V1, emon.Irms);
  Blynk.virtualWrite(V2, emon.apparentPower);
  Blynk.virtualWrite(V3, kWh);
}
void setup()
{
  Serial.begin(115200);
  Blynk.begin(auth, ssid, pass);
  lcd.init();
  lcd.backlight();
  emon.voltage(35, vCalibration, 1.7);  // Voltage: input pin, calibration, phase_shift
  emon.current(34, currCalibration);    // Current: input pin, calibration.
  timer.setInterval(5000L, myTimerEvent);
  lcd.setCursor(3, 0);
  lcd.print("IoT Energy");
  lcd.setCursor(5, 1);
  lcd.print("Meter");
  delay(3000);
  lcd.clear();
```

```
}
void loop()
{
  Blynk.run();
  timer.run();
}
```

Code Explanation

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 20, 4);
```

This includes the LiquidCrystal_I2C library, which is a library for controlling an I2C-based LCD display. The lcd object is created with the address 0x27, 20 columns, and 4 rows.

```
#include "EmonLib.h"
#include <EEPROM.h>
```

This includes the EmonLib library, which is a library for energy monitoring, and the EEPROM library, which is a library for reading and writing data to the ESP32's non-volatile memory.

```
#define BLYNK_PRINT Serial
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
```

This defines BLYNK_PRINT as Serial, includes the WiFi and WiFiClient libraries for connecting to a WiFi network, and includes the BlynkSimpleEsp32 library for connecting to the Blynk cloud platform.

```
EnergyMonitor emon;
#define vCalibration 83.3
```

```
#define currCalibration 0.50
BlynkTimer timer;
char auth[] = "nrexz-lNuB963age87Dlm7GvtmGure2y";
char ssid[] = "realme 6";
char pass[] = "12345678";
float kWh = 0;
unsigned long lastmillis = millis();
```

This declares an EnergyMonitor object emon, defines two calibration constants for the voltage and current measurements, declares a BlynkTimer object timer, and sets up arrays for the Blynk authentication code, WiFi SSID, and password. The variable kWh is used to store the cumulative energy consumption, and lastmillis is used to store the time of the last energy calculation.

```
void myTimerEvent()
{
  emon.calcVI(20, 2000);
  kWh = kWh + emon.apparentPower * (millis() - lastmillis) / 3600000000.0;
  yield();
  Serial.print("Vrms: ");
  Serial.print(emon.Vrms, 2);
  Serial.print("V");
  Serial.print("\tIrms: ");
  Serial.print(emon.Irms, 4);
  Serial.print("A");

  Serial.print("\tPower: ");
  Serial.print(emon.apparentPower, 4);
```

```
Serial.print("W");
Serial.print("\tkWh: ");
Serial.print(kWh, 5);
Serial.println("kWh");

lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Vrms:");
lcd.print(emon.Vrms, 2);
lcd.print("V");
lcd.setCursor(0, 1);
lcd.print("Irms:");
lcd.print(emon.Irms, 4);
lcd.print("A");
lcd.setCursor(0, 2);
lcd.print("Power:");
lcd.print(emon.apparentPower, 4);
lcd.print("W");
lcd.setCursor(0, 3);
lcd.print("kWh:");
lcd.print(kWh, 4);
lcd.print("W");

lastmillis = millis();
```

```
    Blynk.virtualWrite(V0, emon.Vrms);
    Blynk.virtualWrite(V1, emon.Irms);
    Blynk.virtualWrite(V2, emon.apparentPower);
    Blynk.virtualWrite(V3, kWh);
  }
```

This is the myTimerEvent function, which is called periodically by the BlynkTimer object timer. It calculates the RMS voltage, current, and apparent power using the calcVI function from the EnergyMonitor object emon, updates the cumulative energy consumption kWh, and displays the results on the LCD display and on the Blynk app. It also writes the results to the ESP32’s EEPROM.

```
void setup()
{
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass,  "blynk.cloud", 80);
 lcd.init();
  lcd.backlight();
  lcd.clear();
  emon.voltage(35, vCalibration, 1.7); // Voltage: input pin, calibration, phase_shift
  emon.current(34, currCalibration); // Current: input pin, calibration.
  timer.setInterval(5000L, myTimerEvent);
  lcd.setCursor(3, 0);
  lcd.print("IoT Energy");
  lcd.setCursor(5, 1);
  lcd.print("Meter");
```

```
    delay(3000);
    lcd.clear();
  }
```

This is the setup function, which is called once when the ESP32 starts. It sets up the serial communication with a baud rate of 115200, connects to the Blynk cloud platform using the authentication code, SSID, and password, initializes the LCD display and turns on the backlight, calls the eepromState function sets up the voltage and current measurement using the voltage and current functions from the EnergyMonitor object emon, sets the interval of the BlynkTimer object timer to 5000ms and sets the timer event function to myTimerEvent, displays a message on the LCD display, and then clears the display.

```
void loop()
{
  Blynk.run();
  timer.run();
}
```

This is the loop function, which runs continuously after the setup function has finished. It runs the Blynk and timer functions to process any incoming data and to trigger the myTimerEvent function at the specified interval.

Code for IOT Based Home Automation

```
#include <BlynkSimpleEsp32.h>

BlynkTimer timer;

// define the GPIO connected with Relays and switches
#define RelayPin1 23 //D23
#define RelayPin2 19//D22
#define RelayPin3 18  //D21
#define RelayPin4 5  //D19
```

8. #define SwitchPin1 15 //D13
9. #define SwitchPin2 14 //D12
10. #define SwitchPin3 22 //D14
11. #define SwitchPin4 13 //D27

12. #define wifiLed   2   //D2

13. #define VPIN_BUTTON_1   V1
14. #define VPIN_BUTTON_2   V2
15. #define VPIN_BUTTON_3   V3
16. #define VPIN_BUTTON_4   V4

17. int toggleState_1 = 1; //Define integer to remember the toggle state for relay 1
18. int toggleState_2 = 1; //Define integer to remember the toggle state for relay 2
19. int toggleState_3 = 1; //Define integer to remember the toggle state for relay 3
20. int toggleState_4 = 1; //Define integer to remember the toggle state for relay 4

21. int wifiFlag = 0;

22. #define AUTH "ruPLgAKJOa5SpwC48kT-TZsoR8nRNWq8"   // You should get Auth Token in the Blynk App.
23. #define WIFI_SSID "realme 6"   //Enter Wifi Name
24. #define WIFI_PASS "12345678"   //Enter wifi Password

25. void relayOnOff(int relay){

26. switch(relay){

27. case 1:
    a. if(toggleState_1 == 1){
    b. digitalWrite(RelayPin1, LOW); // turn on relay 1
    c. toggleState_1 = 0;
    d. Serial.println("Device1 ON");
    e. }
    f. else{
    g. digitalWrite(RelayPin1, HIGH); // turn off relay 1
    h. toggleState_1 = 1;
    i. Serial.println("Device1 OFF");
    j. }
    k. delay(100);
28. break;
29. case 2:
    a. if(toggleState_2 == 1){
    b. digitalWrite(RelayPin2, LOW); // turn on relay 2
    c. toggleState_2 = 0;
    d. Serial.println("Device2 ON");
    e. }
    f. else{
    g. digitalWrite(RelayPin2, HIGH); // turn off relay 2
    h. toggleState_2 = 1;
    i. Serial.println("Device2 OFF");
    j. }
    k. delay(100);
30. break;
31. case 3:
    a. if(toggleState_3 == 1){
    b. digitalWrite(RelayPin3, LOW); // turn on relay 3
    c. toggleState_3 = 0;
    d. Serial.println("Device3 ON");

e. }

f. else{

g. digitalWrite(RelayPin3, HIGH); // turn off relay 3

h. toggleState_3 = 1;

i. Serial.println("Device3 OFF");

j. }

k. delay(100);

32. break;
33. case 4:

a. if(toggleState_4 == 1){

b. digitalWrite(RelayPin4, LOW); // turn on relay 4

c. toggleState_4 = 0;

d. Serial.println("Device4 ON");

e. }

f. else{

g. digitalWrite(RelayPin4, HIGH); // turn off relay 4

h. toggleState_4 = 1;

i. Serial.println("Device4 OFF");

j. }

k. delay(100);

34. break;
35. break;
36. default : break;
37. }
38. }

39. void with_internet(){
40. //Manual Switch Control
41. if (digitalRead(SwitchPin1) == LOW){
42. delay(200);

```
relayOnOff(1);
Blynk.virtualWrite(VPIN_BUTTON_1, toggleState_1);   // Update Button Widget
}
else if (digitalRead(SwitchPin2) == LOW){
delay(200);
relayOnOff(2);
Blynk.virtualWrite(VPIN_BUTTON_2, toggleState_2);   // Update Button Widget
}
else if (digitalRead(SwitchPin3) == LOW){
delay(200);
relayOnOff(3);
Blynk.virtualWrite(VPIN_BUTTON_3, toggleState_3);   // Update Button Widget
}
else if (digitalRead(SwitchPin4) == LOW){
delay(200);
relayOnOff(4);
Blynk.virtualWrite(VPIN_BUTTON_4, toggleState_4);


}
}
void without_internet(){
//Manual Switch Control
if (digitalRead(SwitchPin1) == LOW){
delay(200);
relayOnOff(1);
}
else if (digitalRead(SwitchPin2) == LOW){
delay(200);
relayOnOff(2);
}
```

```
else if (digitalRead(SwitchPin3) == LOW){
delay(200);
relayOnOff(3);
}
else if (digitalRead(SwitchPin4) == LOW){
delay(200);
relayOnOff(4);
}
}
BLYNK_CONNECTED() {
// Request the latest state from the server
Blynk.syncVirtual(VPIN_BUTTON_1);
Blynk.syncVirtual(VPIN_BUTTON_2);
Blynk.syncVirtual(VPIN_BUTTON_3);
Blynk.syncVirtual(VPIN_BUTTON_4)
}
// When App button is pushed - switch the state
BLYNK_WRITE(VPIN_BUTTON_1) {
toggleState_1 = param.asInt();
digitalWrite(RelayPin1, toggleState_1);
}

BLYNK_WRITE(VPIN_BUTTON_2) {
toggleState_2 = param.asInt();
digitalWrite(RelayPin2, toggleState_2);
}

BLYNK_WRITE(VPIN_BUTTON_3) {
toggleState_3 = param.asInt();
digitalWrite(RelayPin3, toggleState_3);
}
```

```
BLYNK_WRITE(VPIN_BUTTON_4) {
toggleState_4 = param.asInt();
digitalWrite(RelayPin4, toggleState_4);
}
void checkBlynkStatus() { // called every 3 seconds by SimpleTimer
bool isconnected = Blynk.connected();
if (isconnected == false) {
wifiFlag = 1;
digitalWrite(wifiLed, LOW); //Turn off WiFi LED
}
if (isconnected == true) {
wifiFlag = 0;
digitalWrite(wifiLed, HIGH); //Turn on WiFi LED
}
}
void setup()
{
Serial.begin(9600);
pinMode(RelayPin1, OUTPUT);
pinMode(RelayPin2, OUTPUT);
pinMode(RelayPin3, OUTPUT);
pinMode(RelayPin4, OUTPUT);
pinMode(wifiLed, OUTPUT);
pinMode(SwitchPin1, INPUT_PULLUP);
pinMode(SwitchPin2, INPUT_PULLUP);
pinMode(SwitchPin3, INPUT_PULLUP);
pinMode(SwitchPin4, INPUT_PULLUP);

//During Starting all Relays should TURN OFF
digitalWrite(RelayPin1, toggleState_1);
```

```
digitalWrite(RelayPin2, toggleState_2);
digitalWrite(RelayPin3, toggleState_3);
digitalWrite(RelayPin4, toggleState_4);

WiFi.begin(WIFI_SSID, WIFI_PASS);
timer.setInterval(3000L, checkBlynkStatus); // check if Blynk server is connected every 3 seconds
Blynk.config(AUTH);
}

void loop()
{
if (WiFi.status() != WL_CONNECTED)
{
Serial.println("WiFi Not Connected");
}
else
{
Serial.println("WiFi Connected");
Blynk.run();
}

timer.run(); // Initiates SimpleTimer
if (wifiFlag == 0)
with_internet();
else
without_internet();
}
```

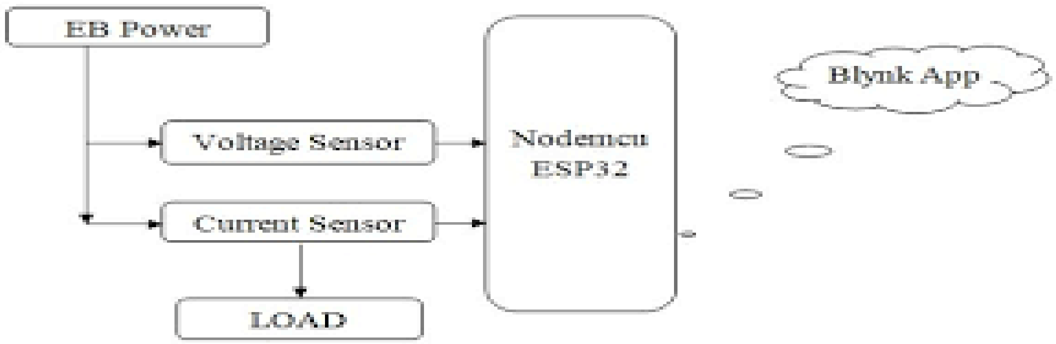
IV RESULTS

It has been observed that smooth output has been seen , when sensors play their role its been observe on screen easily and hence proper calculation are been done.

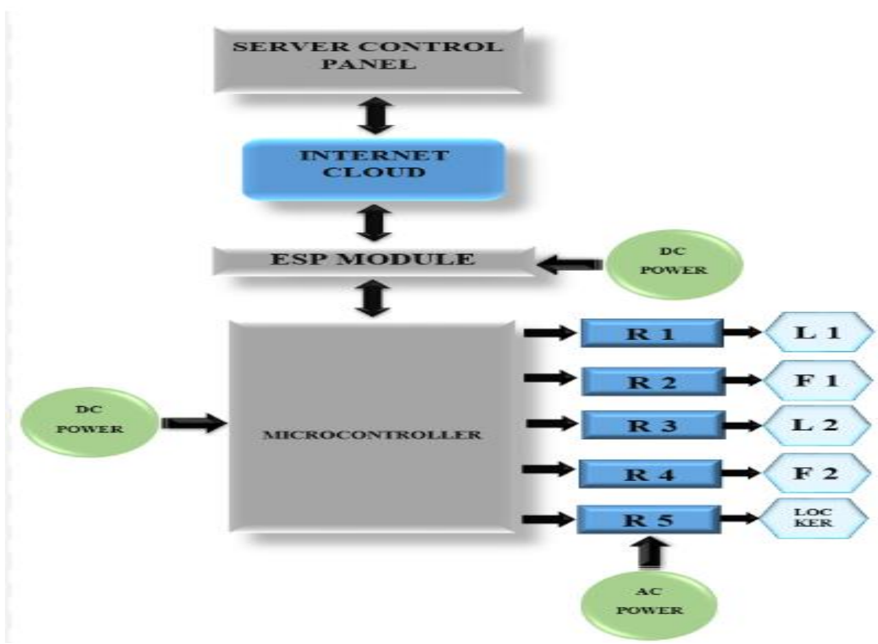
Below shown figure seems that how application works on screen and gives us proposed results.

2.5 Block diagram

IoT Based Smart Energy Meter

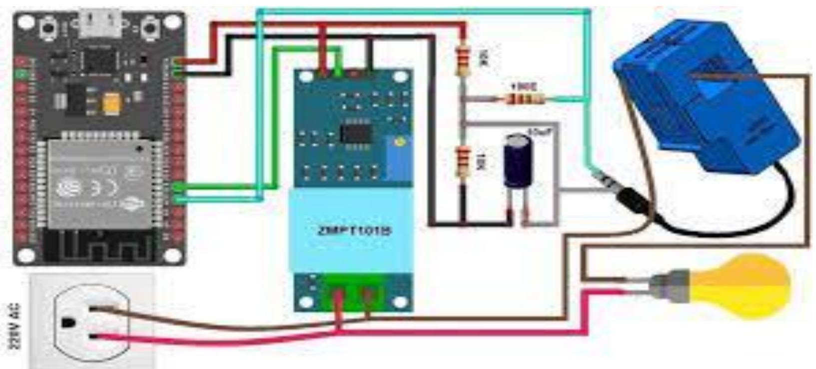


IoT Based Home Automation

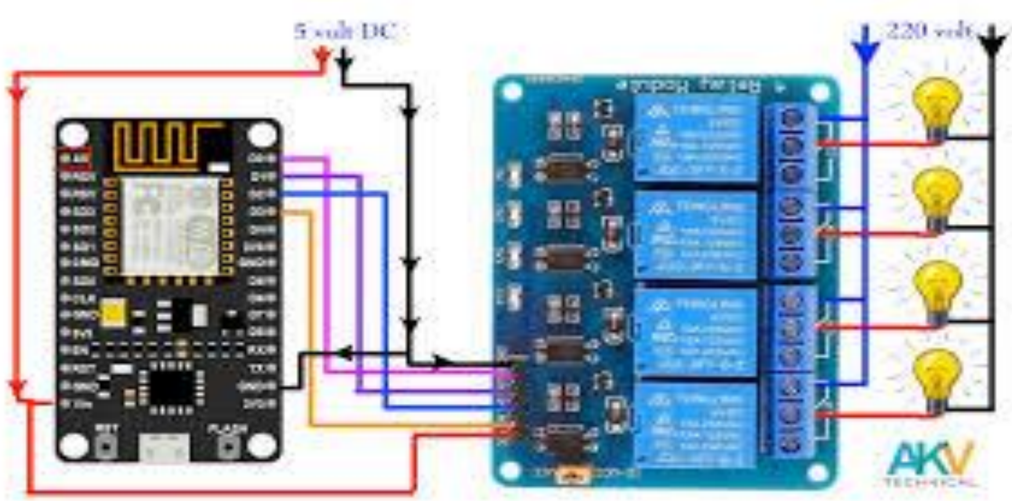


2.6 Circuit Diagram

IoT Based Smart Energy Meter

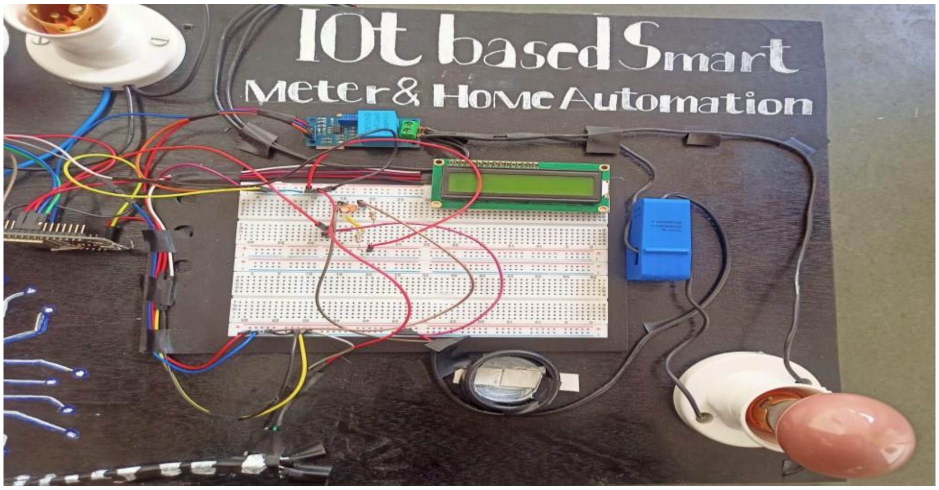


IoT Based Home Automation



CHAPTER-3

RESULTS AND DISCUSSION



IOT BASED SMART ENERGY METER

The results obtained are based on a constructed circuit that is simulated using real-life power system data and hardware prototype trials at the power socket. Monitoring power consumption problems are pervasive in household electric appliances. Therefore, a sustainable design and implementation of smart electricity management of every consumption have been top prioritized to reduce usage and cost for a sustainable society.
The proposed smart home electricity monitoring system is sustainable that utilizes the most advanced Internet technologies to impact electric consumption performance. Monitoring the consumption of electrical appliances,including advanced digital appliances, can directly regulate the usage of air conditioners, water heaters, heaters, dry iron, washing machine, music systems,and lighting systems. Therefore, the proposed system can positively improve lifestyles and habits for a sustainable urban lifestyle with accessible functionalities that can connect the house to an extraordinary remote monitoring center or a mobile device through a mobile app; it is environmentally friendly.
Using the proposed system can create awareness of energy usage for the appliances like air conditioners, bulbs, and other home appliances. The significant advantage is that the proposed system can be customized at the controller for future expansion. However, IoT-

based systemsfor the smart home have a few disadvantages, especially concerning the challenge of privacy, bandwidth, and Internet security.
Some limitations for this work, such as the voltage, were assumed to be 240 Vac since no sensor was included for the voltage sensor. However, in our future study, a voltage sensor is considered to measure the real-time voltage from the incoming voltage supply. Thus, the accuracy of the result can be improved further. Other than that, Undervoltage and overvoltage detection can also be included in the voltage sensor used. The control system can be improved further by considering time scheduling, remote switching, automatic switching,temperature switching, and sensor controlling. This will help the users to reduce electricity consumption as well as make life easier.

IOT BASED HOME AUTOMATION

Home automation using the ESP32 module has revolutionized the way we interact with our homes. ESP32, a powerful and versatile microcontroller, is widely used for building smart home systems that offer convenience, efficiency,and security.One of the key benefits of using the ESP32 module for home automation is its wireless connectivity options, including Wi-Fi and Bluetooth, which allow for seamless integration with various devices and platforms. With ESP32, you can control and monitor different aspects of your home, such as lighting, temperature, security, and appliances, using a smartphone, tablet, or any internet-connected device.
ESP32& ability to communicate with sensors, actuators, and other devices makes it an ideal choice for automating tasks such as turning lights on/off, adjusting thermostats, managing door locks, and controlling home entertainment systems. The ESP32 module can also be integrated with voice assistants like Amazon Alexa or Google Assistant, enabling voice-based commands for controlling home devices.
Moreover, ESP32& low power consumption and robust processing capabilities make it energy-efficient and capable of handling complex automation tasks. It can also be easily programmed using Arduino IDE or other programming environments, making it accessible to hobbyists and developers alike.

Another advantage of using the ESP32 module for home automation is its scalability. You can start small with a basic setup and gradually expand your automation system to include more devices and functionalities as your needs evolve. ESP32's modular design and compatibility with various sensors and actuators make it flexible and adaptable to different home automation scenarios.
In terms of security, ESP32 offers features like secure Wi-Fi communication,data encryption, and user authentication, ensuring that your home automation system is secure and protected from unauthorized access.

Overall, the result of a home automation project using the ESP32 WiFi module can be a convenient, efficient, and personalized smart home system that offersremote control, monitoring, and automation of various aspects of your home.

CHAPTER-04

CONCLUSIONS AND FUTURE SCOPE

CONCLUSION:

IoT-based energy meter and Home automation using ESP32 WiFi modules have a lot of potential to revolutionize the way we consume and monitor energy usage in our homes. By leveraging the power of WiFi connectivity and IoT technology, this system can provide a range of benefits including increased energy efficiency, cost savings, and improved control and monitoring of energy usage.With the ESP32 WiFi module, users can easily connect their devices to the internet and remotely control various home appliances and devices, such as lights, air conditioners, and water heaters. This enables users to adjust theirenergy consumption according to their needs and preferences, thereby reducing wastage and improving efficiency.The energy meter aspect of this system allows users to monitor their energy consumption in real-time and identify areas where they can reduce usage to save costs. Additionally, the system can also alert users when their energy consumption exceeds a predetermined threshold,helping them to stay within their budget and avoid overuse.

Overall, the combination of home automation and IoT-based energy meter using ESP32 WiFi modules has the potential to provide significant benefits to users,including cost savings, energy efficiency, and improved control and monitoring of energy usage. With the continued advancement of technology and the increasing demand for sustainable living, it is likely that this system will become more prevalent in homes around the world.

FUTURE SCOPE:

The future scope for IoT-based energy meter and home automation systems using the ESP32 Wi-Fi module is vast and promising. As technology continues to advance, these systems will become more accessible and affordable, making them an increasingly popular choice for homeowners. One area of future development is energy efficiency, as IoT-based energy meters can monitor energy usage patterns in real-time, leading to better-informed decisions about energy consumption. Integration with smart grids is another potential area for growth, as IoT-based energy meters can provide more accurate energy consumption data to utility companies, enabling them to better manage their energy distribution. There is also scope for increased automation, with AI and ML algorithms enabling systems to learn user preferences and automate routine tasks. Remote monitoring is another area of future development, enabling homeowners to monitor their energy consumption and home appliances from anywhere in the world. Finally, data analytics can be applied to gain insights into energy usage patterns, appliance performance, and user behavior, leading to better energy management and more personalized home automation solutions. Overall, the future for IoT-based energy meter and home automation systems using the ESP32 Wi-Fi module is bright, with potential advancements in energy efficiency, automation, remote monitoring, and data analytics.

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