International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Home Automation Based on Internet of Things

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***Abstract*— In today's world, home automation systems have become an essential part of our daily lives. The Internet of Things (IoT) has provided us with the ability to control and monitor various appliances in our homes remotely. This paper proposes an IoT based home automation system that measures electric current used by a particular electric appliance using UNO 328, wifi ESP 8266, LCD 1602, current sensor ACS 712, 5v power supply. With the help of this project, we can easily identify which electric appliance uses how much electric current, enabling us to remove such devices which consumes lots of energy, reduce the cost of bills, save energy, and reduce human effort. The system is user-friendly and provides real-time data, which makes it easy to monitor the energy consumption of each appliance.**

Keywords*— *Internet of Things, home automation, electric current, UNO328, wifi ESP8266, LCD1602, energy consumption.

I. INTRODUCTION

The concept of home automation has been around for many years. It started with the invention of the first thermostat in 1883, which allowed homeowners to control the temperature of their homes remotely. Today, the technology has evolved significantly and has become more advanced and efficient. One of the latest innovations in this field is the Internet of Things (IoT) based home automation. This technology utilizes a network of devices, sensors, and software to create an interconnected home ecosystem that can automate various tasks and reduce human effort.

With the Internet of Things (IoT), home automation has become even more accessible and affordable. IoT refers to the connection of everyday objects to the internet, enabling them to send and receive data. IoT-based home automation systems have been designed to improve the energy efficiency of homes, reduce energy bills, and create a comfortable living environment. One of the most significant advantages of this technology is its ability to measure the electric current used by a particular electric appliance.

The UNO 328 microcontroller is the heart of the IoT-based home automation system. It is a compact and programmable device that can control and communicate with other devices in the home ecosystem. The wifi ESP 8266 module is responsible for connecting the home automation system to the internet. This allows users to monitor and control their homes remotely using their smartphones, tablets, or laptops.

The LCD 1602 display unit is used to display the current consumption of the electric appliance. This helps homeowners to keep track of their energy usage and make adjustments accordingly. The current sensor ACS 712 is used to measure the current flowing through the appliance. It is a non- invasive sensor that can be easily attached to the electric cable of the appliance without any electrical contact. The 5v power supply module is used to power the sensors and the microcontroller.

The IoT-base home automation system is a revolutionary technology that can help homeowners create a more energy-efficient, comfortable, and secure living environment. The use of UNO 328, wifi ESP 8266, LCD 1602, current sensor ACS 712, and a 5v power supply can help measure the electric current used by a particular electric appliance, thereby reducing energy bills, saving energy, and reducing human effort. With this technology, homeowners can have complete control over their homes, even when they are not physically present. The system is easy to install and can be implemented in any home without the need for specialized knowledge. This makes home automation a must have technology for every modern home.

II. LITERATURE REVIEW AND RELATED WORK

With the rapid growth of technology, Internet of Things (IoT) has become an emerging technology in the domain of home automation. The application of IoT-based home automation systems has become increasingly popular due to their ability to reduce the cost of electricity bills, save energy and reduce human effort. IoT-based home automation systems are designed to manage and control home appliances, such as lights, air conditioners, and other electrical appliances. The objective of this review is to discuss the related work and literature related to IoT-based home automation that measures the electric current used by particular electric appliances, reduces the cost of bills, saves energy, and reduces human effort.

Several studies have been conducted on the application of IoT-based home automation systems. One such study conducted by V. D. Vaidya et al.(2018) [1] proposed various modules GSM, Bluetooth and IOT. In GSM technology home appliances can be controlled by sending messages to system. Bluetooth technology uses smart phones with an android application. Whereas IOT that

is internet of things is somewhat a very big area. IOT can be defined as inter-networking of physical devices, buildings and other items embedded with electronics, software, sensors and internet connectivity nowadays.

In another study A. Shejal et al.(2019) [2] the accuracy of Implementations meets the expectation. This home automation system works according to user needs and demands and also the modes of function work as desired during the implementation. Users need to give respective commands through his/her smartphone and the system works according to the assigned algorithm. This project is flexible and user friendly and easy to use. So, it can be said that this system has higher accuracy with great efficiency.

R.K. Kodali and S. Yerroju (2018) [3] an intelligent home automation technique is implemented using Internet of Things which will overcome the existing energy usage problems to a great extent. IoT makes use of a combination of intelligent software applications along with electronic devices to build an effective data exchange network. To implement this, a low cost and low power consuming embedded Wi-Fi module ESP8266 is used to operate a relay channel, which acts as a switch to control household appliances. Here Thinger.io provides cloud infrastructure through which mobile and ESP8266 to communicate with each other via REST API.

A.Kapoor et al.(2020) [4] explore ESP8266 and its capabilities along with PIR sensors to make a home automation prototype that focusses on "Conservation of Energy". By establishing a Web Server which would record the data of the number of persons entering/exiting a given room, we explore the ability of this module to use wifi protocols, being a microcontroller. The setup process for the apparatus requires feasibility, perseverance and precision. Once accomplished we move on to the equally difficult process of setting up an Integrated Development Environment (IDE) and pushing our program for the server onto the module. Keeping in mind the potential of the project, the future scope including applications using the project has been discussed in this project.

H.K Singh et al.(2019) [5] the Internet of Things (IoT) using a Wi-Fi-based microcontroller. The earlier as technology is advancing rapidly in fields such as mobile, robotics, and machine learning, our homes should not be an exception to the full IoT capability of a home. The paper introduces the NodeMCU microcontroller and relays to remotely control electrical switches from a server built on Node.js, with the user controlling switches through a web application after authentication.

Vagdevi P., D. Nagaraj et al.(2017) [6] Information about the emerging technology of near field communication (NFC) and how it is being used in various domains, such as student attendance monitoring, ticketing systems, and home automation. The automation capabilities of NFC and how it can be used to control various home appliances and devices from a certain distance, making it a convenient and energy-efficient solution for users. The paper proposes an architecture for home automation using NFC and general packet radio service (GPRS), along with a mobile application, to provide users with a personalized and secure home environment.

P. Zhou et al.(2018) [7]a Privacy-preserving and Residential Context-aware Online ES (PRCOES) system as a solution to the challenges faced by Energy-saving (ES) systems developed on the basis of the Internet-of-Things (IoT) in smart and utilizes a tree-based structure to recommend energy offers (EOs) that could meet the users' satisfaction, task completion rate, and ES purposes for appliances. The author presents theoretical analysis and experimental results to validate that the proposed PRCOES system could enhance users' experience and guarantee privacy for both residents and utility providers.

D. Sindhanaiselv et al.(2018) [8] energy consumption and IoT-based home automation as scientists prioritize the need to reduce energy consumption due to various factors such as increasing energy demands, rising energy prices, global warming, and waste of energy. The paper highlights the need to increase visibility and awareness of energy consumption from homes using the Internet of Things paradigm to reduce energy consumption. The paper discusses a hardware prototype developed for home-level implementation that collects real-time energy consumption data from each appliance, analyzes it, and uses a control mechanism to save energy. The paper presents detailed calibrations and briefly discusses home-level implementation.

R.T. Mathew et al. (2018) [9] the issue of high energy demand and wastage, and to propose a solution to this problem by introducing an intelligent or smart meter that can monitor the usage pattern of household appliances and reduce the load during peak hours. Generating more power by installing power stations is not a feasible solution, and that major electrical wastages in household appliances can be considerably reduced with proper monitoring and control. The proposed smart meter is connected with a GSM module and uses IoT to turn on/off appliances, thereby reducing electricity cost by 25-30%.

In another study, Yadav et al. (2018) [10] presented an IoT-based home automation system that uses a wireless sensor network to measure the electric current used by particular electric appliances. The system uses an Arduino board and a current sensor to collect the data from the appliance and sends the data to the cloud server. The cloud server analyses the data and provides real-time information to the user about the energy consumption of each appliance.

Furthermore, the application of IoT-based home automation systems has been shown to reduce the cost of electricity bills. A study conducted by Niu et al. (2019) [11] presented an IoT- based home automation system that automatically controls the air conditioning system to reduce the energy consumption during peak hours. The system uses a smart thermostat to control the temperature of the room and adjusts the temperature based on the occupancy of the room. The system was found to reduce the electricity bills by up to 30%.

Similarly, the application of IoT-based home automation systems has been shown to save energy. A study conducted by Jung et al. (2018) [12] presented an IoT-based home automation system that automatically turns off the lights and air conditioning system when the room is unoccupied. The system uses a motion sensor to detect the occupancy of the room and turns off the lights and air conditioning system if the room is unoccupied for a certain period. The system was found to save up to 40% of energy consumption.

Finally, the application of IoT-based home automation systems has been shown to reduce human effort. A study conducted by Chen et al. (2017) [13] presented an IoT-based home automation system that automatically controls the lights, air conditioning system, and other electrical appliances based on the user's behaviour. The system uses a smartphone app to collect the user's behaviour data and automatically controls the appliances. The system was found to reduce the user's effort and improve the user's experience.

The literature review and related work presented in this review highlight the importance of IoT-based home automation systems that measure the electric current used by particular electric appliances, reduce the cost of bills, save energy, and reduce human effort. The application of IoT-based home automation systems has the potential to improve the energy efficiency of homes, reduce the cost of electricity bills, and improve the user's experience. Further research in this field is necessary to explore the potential of Iot-based home automation systems in the domain of home automation.

III. METHODOLOGY

A. *Hardware Components*

The first step is to gather all the required hardware components, which includes UNO 328, wifi ESP 8266, LCD 1602, current sensor ACS 712, 5v power supply, and the blink application feature. These components are readily available in the market and can be easily acquired.

1.Arduino: The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects. Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs light on a sensor, a finger on a button, or a Twitter message and turn it into an output - activating a motor, turning on an LED, publishing something online.

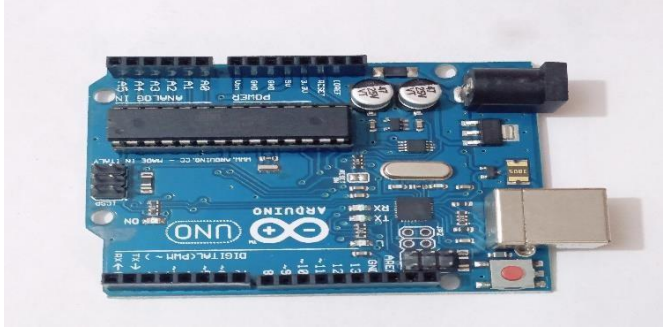


Figure.1. Arduino

2.ESP8266: In this Home Automation System, we will control home appliances connected to Relay using Application. The Wifi Module ESP8266 will Receive commands from the smartphone wirelessly through the internet.

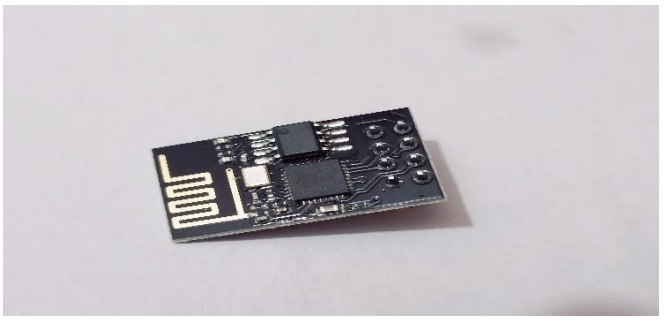


Figure.2. ESP8266

3.LCD Display: LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. LCD Display is use for our project to show current consume by particular devices it will show on the display.

Figure.3. LCD Display

4.Relays: The 5V relay module can be used to control a load such as a lighting system, motor, or solenoid. It can also be used to switch AC or DC voltages. The maximum voltage and current that the 5V relay module can control is dependent on the specifications of the relay. It is an automatic switch that is commonly used in an automatic control circuit and to control a high-current using a low-current signal.

Figure.4. Relay

5.*5V Power Supply:* 5V power supplies (or 5VDC power supplies) are one of the most common power supplies in use today. In general, a 5VDC output is obtained from a 50VAC or 240VAC input using a combination of transformers, diodes and transistors. 5V power supplies can be of two types: 5V regulated power supplies, and 5V unregulated power supplies.

Figure.5. Several Hardware Components of Home Automation

B. Circuit Diagram

The next step is to design the circuit. The ACS 712 current sensor is connected to the UNO 328 board, which is powered by the 5v power supply. The ESP 8266 is also connected to the UNO 328 board, which allows for wireless communication with the blink application.

1. First of all we connect 5v power supply module to the ardunio using 5V pin.
2. All the necessary code for our project is store into the Ardunio and control by the help of ardunio.
3. Then we connect the seven segment LCD disply to the Ardunio pin no 3 and pin 8.
4. After that we place current sensors between arduinio and relays to sense the current.
5. Then connect the VCC, GND and OUT of the ASC712 board to +5V, GND and A0 of Arduino.
6. Now we use relay r1,r2 as a switch that open and close the circuits by receiving electrical signals from outside sources.
7. Then connect the relays r1 and r2 to the D1 and D2 respectively.
8. Then we connect the ESP8266 to the Arduino to provide Wi-Fi connectivity.
9. Now Track Hourly/Daily/Monthly energy consumption with the help of Blink Cloud Server.

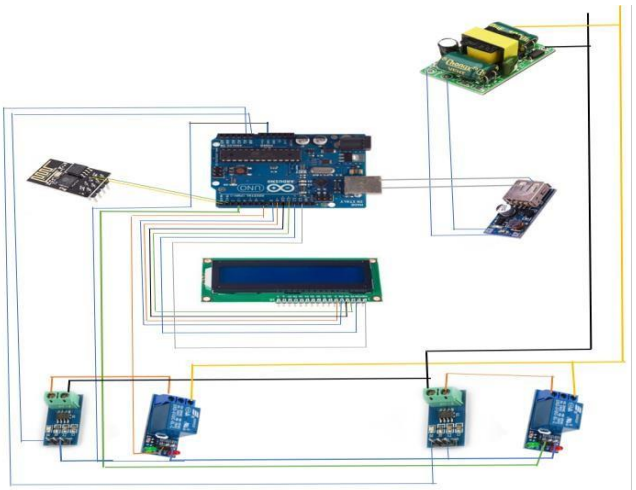


Figure.6. Circuit Diagram of Home Automation

C. Software Development

After designing the circuit, the software for the system is developed. The code is written in the Arduino IDE, which allows for easy programming of the UNO 328 board. The code reads the current data from the ACS 712 sensor and sends it to the ESP 8266, which is then transmitted to the blink application.

In this project, current is measured using two current sensors - cs_total and cs_theft - and the current is calculated using the formula:

AmpsRMSTotal = (VRMS * 1000)/mVperAmp

where,

VRMS is the RMS voltage, and
mVperAmp is the millivolt per ampere sensitivity of the current sensor.

The function getVPP() is used to get the peak-to-peak voltage from the current sensor. This function takes the current sensor pin as an input and returns the peak-to-peak voltage measured by the current sensor.

The CH_PD pin is not used in this code. It is used to enable or disable the power to the ESP8266 module. When CH_PD is connected to VCC, the module is powered on, and when it is connected to GND, the module is powered off.

D. Integration

The next step is to integrate all the hardware and software components into the system. This includes connecting the UNO 328 board, the ACS 712 sensor, the ESP 8266, and the LCD 1602 display.

E. Testing and Validation

The final step is to test and validate the system. The system is tested by connecting various electric appliances and measuring their energy consumption. In the case of IoT-based home automation systems that measure electric current usage, proper testing and validation ensure the accuracy and reliability of the system. The following points outline the testing and validation process for this project:

1. Hardware testing: The hardware components of the system, such as the UNO 328, wifi ESP 8266, LCD 1602, current sensor ACS 712, and 5v power supply, must be tested to ensure they are functioning correctly and communicating with each other.

2. Software testing: The software code that controls the system must be tested for errors and bugs. Unit testing and integration testing should be performed to ensure the code is functioning as intended.

3. Calibration testing: The current sensor ACS 712 must be calibrated to provide accurate current measurements. The system should be tested to ensure that the current readings are consistent with the actual current usage of the appliance.

4. Validation testing: The system's accuracy and reliability should be validated by comparing the current usage readings generated by the system with the actual energy consumption of the appliance measured using a power meter.

5. Hourly, weekly, and monthly record generation testing: The system should be tested to ensure that it can generate accurate hourly, weekly and monthly records of the energy consumption of the appliance. These records should be compared with actual energy bills to ensure their accuracy.

6. Usability testing: The system should be tested to ensure it is user-friendly and easy to operate. Feedback from users should be gathered to improve the system's usability.

7. Security testing: The system should be tested for vulnerabilities and security risks to ensure that it is secure and protected from unauthorized access.

By conducting these testing and validation procedures, the accuracy, reliability, and usability of the IoT-based home automation system that measures electric current usage can be ensured.

IV. WORKING OF SYSTEM AND CODE

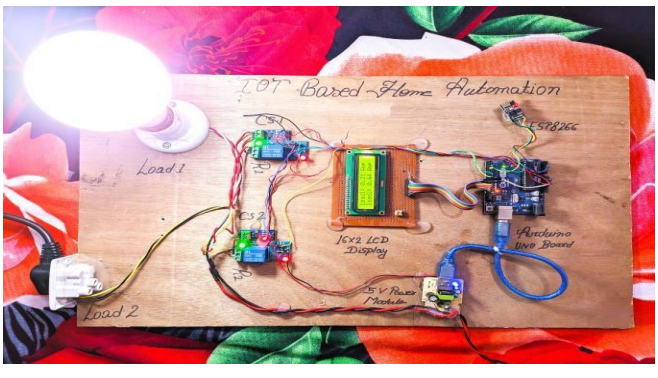


Figure.7. Working of Home Automation

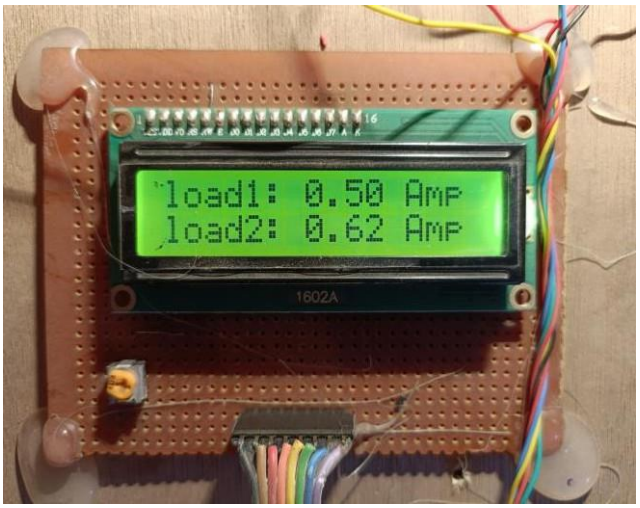
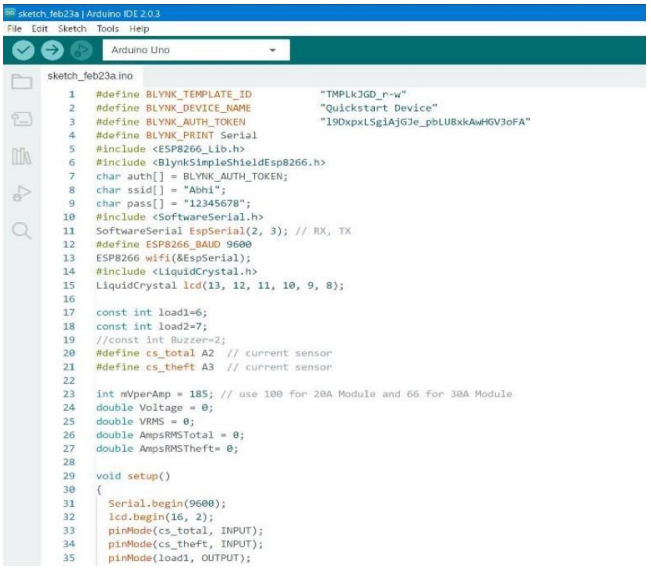


Figure.8. LCD Display read current utilization



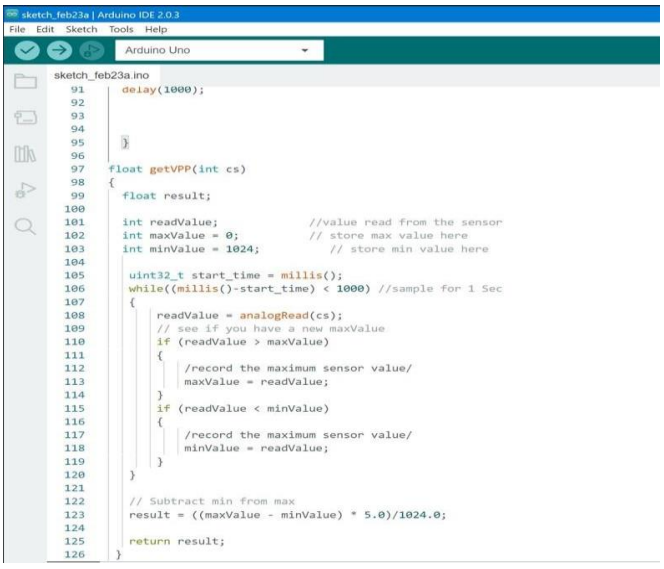
```
#define BLYNK_TEMPLATE_ID           "TMPLkJGD_r-w"
#define BLYNK_DEVICE_NAME           "Quickstart Device"
#define BLYNK_AUTH_TOKEN            "19DxpxLSgiAjGJe_pbLU8xkAwHGV3oFA"
#define BLYNK_PRINT Serial
#include <ESP8266_Lib.h>
#include <BlynkSimpleShieldEsp8266.h>
char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "Abhi";
char pass[] = "12345678";
#include <SoftwareSerial.h>
SoftwareSerial EspSerial(2, 3); // RX, TX
#define ESP8266_BAUD 9600
ESP8266 wifi(&EspSerial);
#include <LiquidCrystal.h>
LiquidCrystal lcd(13, 12, 11, 10, 9, 8);

const int load1=6;
const int load2=7;
//const int Buzzer=2;
#define cs_total A2  // current sensor
#define cs_theft A3  // current sensor

int mVperAmp = 185; // use 100 for 20A Module and 66 for 30A Module
double Voltage = 0;
double VRMS = 0;
double AmpsRMSTotal = 0;
double AmpsRMSTheft= 0;

void setup()
{
  Serial.begin(9600);
  lcd.begin(16, 2);
  pinMode(cs_total, INPUT);
  pinMode(cs_theft, INPUT);
  pinMode(load1, OUTPUT);
```

Figure.9. Home Automation code 1



```
  delay(1000);


}

float getVPP(int cs)
{
  float result;

  int readValue;              //value read from the sensor
  int maxValue = 0;           // store max value here
  int minValue = 1024;          // store min value here

  uint32_t start_time = millis();
  while((millis()-start_time) < 1000) //sample for 1 Sec
  {
      readValue = analogRead(cs);
      // see if you have a new maxValue
      if (readValue > maxValue)
      {
          /record the maximum sensor value/
          maxValue = readValue;
      }
      if (readValue < minValue)
      {
          /record the maximum sensor value/
          minValue = readValue;
      }
  }

  // Subtract min from max
  result = ((maxValue - minValue) * 5.0)/1024.0;

  return result;
}
```

Figure.10. Home Automation code2

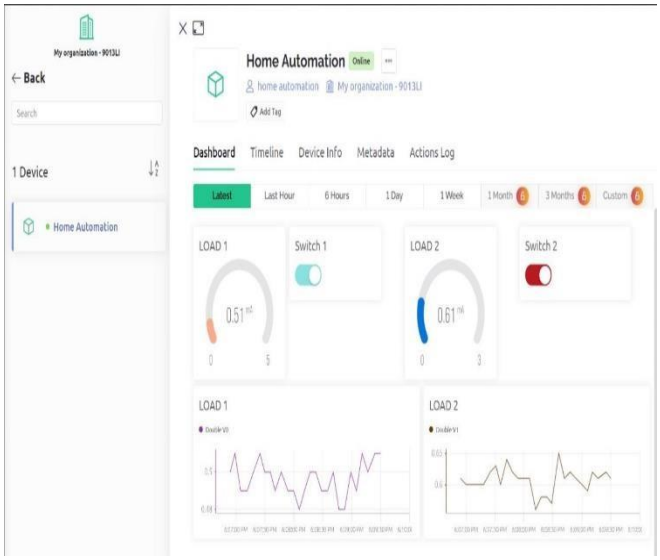


Figure.11. Home Automation Blynk cloud server

V. CONCLUSION

The proposed system provides an efficient way to monitor the energy consumption of different devices in the home. With the help of this project, we can easily identify which electric appliance uses how much electric current, enabling us to remove such devices, reduce the cost of bills, save energy, and reduce human effort. The system is user-friendly and provides real-time data, which makes it easy to monitor the energy consumption of each appliance. The project utilizes advanced technologies such as IoT, sensors, and wireless communication, making it a cost-effective solution for home automation. The system is reliable, secure, and has the potential to be scalable to accommodate more devices in the future.

VI. FUTRUE WORK

Future work for this project can include implementing machine learning algorithms to predict future usage patterns and suggest efficient ways to manage energy consumption. The system can be extended to control the appliances remotely using voice commands. Integration with renewable energy sources like solar panels and wind turbines can be explored to make the system more sustainable. The system can also be expanded to monitor water consumption, temperature, and humidity levels to provide a comprehensive home automation solution. An additional feature can be added to detect any electrical faults or short circuits in the appliances and alert the user. This project can be further enhanced by incorporating security features to prevent unauthorized access to the system.

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