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Blynk 2.0 based Smart Electricity Monitoring Meter

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Abstract: ***Electricity is one of the basic needs of this society. Currently we have to go nearby the conventional meter and note the electricity consumption which is a tedious task when bill payer is in distant place. Thus, to automate this process IOT takes place which can save time by automating remote data collection.***
This paper gives the development of a cost-effective NodeMcu based smart electricity which includes the Internet of Things (IoT) technology. The NodeMcu board is employed element to coordinate the activities of the device and a Blynk server acting as a central server receiving all the data sent by the created system. Other components like AC voltage sensor (ZMPT101B), AC current sensor (SCT-013-030), LCD display which helps the user to read the values instantly from system and other RLC elements are used to measure the required quantities. Also, this paper has open source IOT server called Blynk 2.0 which is an analytic platform which can access the cloud and enables the user to live monitor the status of the meter using both Website and application.
The result of this paper is a functional system for electricity consumption monitoring system and detection of unknown overload consumption based on Internet of Things.
Keywords: ESP-32S, Electricity, Blynk 2.0, IOT, App view, web view, Serial monitor view.

I. INTRODUCTION

Currently, the drawback of the conventional system is that consumer must go nearby the Electricity meter which was installed at home by EB department to calculate the power usage that he has consumed regularly. Electricity is now more than necessary. The demand of electricity in our country is increasing continuously. With increasing electricity demand, power monitoring from distant place by consumer is still not installed by TNEB.

It has become important to improve the system performance and to avoid Theft, Electricity should be monitored efficiently and distantly. This Advanced measuring infrastructure can overcome the billing irregularities and requirements for more employees. This prototype calls for reduction of the massive labour force and consumer complaints in overload consumption. The use of the main observer meter at the secondary distribution terminals are some of the technological ways to detect technical faults. However, these technical approaches can be effectively implemented only if proper communication is ensured between the central control station and the appropriate consumer points.

This model is proposed to reduce the complex problems like heavy power consumption, revenue loss and power tapping that prevails while the power is being not monitored in the consuming side.

This system provided along with such type of sensors and whenever the overloading consuming attempt is happened immediately, it could be detected over internet with the help blynk cloud. Consequently, by the above proposed design of the system we can effectively and successfully minimize the problems that come under power consumption without any manual interference. In this work, I've created a web-based smart electricity metre using the ESP32S and tracked data on the Blynk Web cloud and application that automates the traditional technique of reading electricity.

We can use the Internet of Things, which automates distant data collection and saves time. In recent years, smart electricity metres have won widespread praise from all over the world. Voltage and current sensors are required so that the current and voltage may be measured and the power consumption and total power utilised are known.

SCT-013 is the top current sensor on the market. We can measure all the necessary parameters needed for an electricity metre using the SCT-013 current sensor and ZMPT101B voltage sensor.

We will interface the Current Sensor and Voltage Sensor with ESP32S which has inbuilt Wi-Fi Module & Send the data to Blynk Application. The Blynk 2.0 Application Dashboard will display the values of Voltage, Current, Power & total units consumed in kWh.

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II. METHODOLOGY

The methodology includes with topology, components specifications

A. Topology

The proposed model includes the sensors called Current sensor, voltage sensor and the main microcontroller called ESP32S, then for the displaying purpose Liquid crystal Display 16 cross 2 which uses I2C protocol for transferring data from the microcontroller to the LCD.

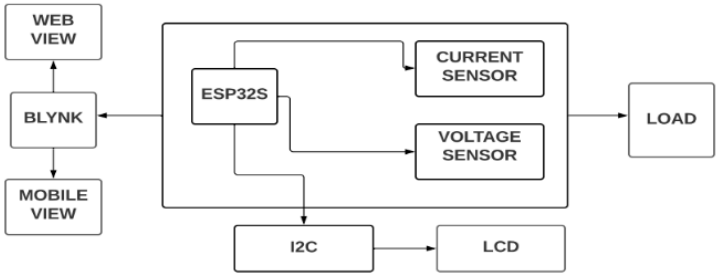


Fig-1 Topology of the proposed System

B. Components Specification

1) NODE-MCU ESP32-S

The ESP32S (Fig-2) is employed as a bifunction element to coordinate the activities of the system and a mobile acting as central server receiving all the data sent by the created system. Ai Thinkers ESP32S Wi-Fi and Bluetooth SoC Module has a highly competitive package size and ultralow power technology. Esp32S can be widely used in various networking and automation, industrial wireless control. Esp32S is packaged in SMD, through the standard SMT equipment to achieve rapid production of products with high reliability of the connections, especially for Automation, large scale, low-cost production modern methods.



Fig-2 ESP32 S Module

2) Current Sensor

A non-invasive AC current sensor with a split core type clamp metre, the SCT 013 (Fig. 2) can measure AC current up to 100 Amperes. Alternating current can be measured using current transformers. They are incredibly helpful for calculating the total electricity consumption of a building. There is no need to perform any high voltage electrical work in order to clip these current sensors directly to live or neutral wire. Current Level Sensing: 0 to 30A AC. Level of the output signal: DC 0 to 1 V.to 1 V.



Fig-3 Current Sensor

3) Voltage Sensor

The ZMPT101B (Fig-4) AC Single Phase voltage sensor is based on very high precision voltage transformer, which used to measure the accurate AC voltage with voltage transformer. This is an innovative and efficient method to measure the AC voltage using ESP32S.The Modules can measure voltage within and up to 250V AC voltage and analog output can be adjusted with the help of multi trim potentiometer. By turning we could adjust and calibrate the ADC output. Operating temperature is between 40º Celsius to 70º Celsius. Supply voltage is 5 volts to 30 volts.

4) LCD With I2C Adaptor

An LCD display (16×2), it is basic module and is used in many devices and circuits. An LCD means it has ability to display 16 characters per line and there are 2 such linesI2C Interface Adapter Module used for 16×2 LCD -display. It uses the PCF8574T IC chip so that it can converts I2C serial data to parallel data for the displaying in LCD. This interface module connecting an ESP 32S to a 16 × 2 Liquid Crystal display can using only 4 wires.



Fig-4 LCD with I2C Adaptor

C. Hardware Setup

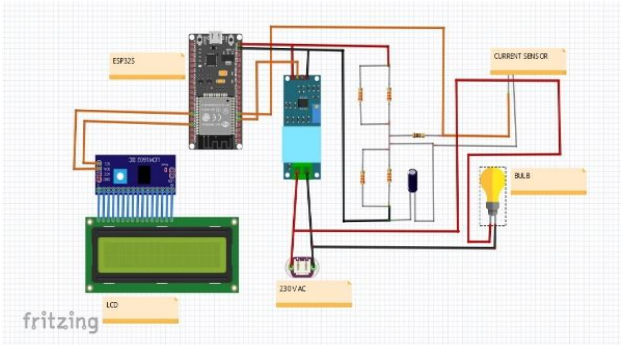


Fig-5 Connection Diagram

The circuit is made as per the schematics as shown in Figure 5. The output pin which is taken from Current sensor is connected to the 34th pin of the ESP-32S development board and the output pin of the voltage sensor is connected to 35th pin of the Esp-32S. Voltage sensor is connected parallel to the load. Current sensor is which non-invasive clamp type, so the load wire is clamped in the sensor. Few resistors and capacitor are connected across the sensors for safety purpose. SDA and SCL of LCD is connected to 21st and 22nd pin of the ESP-32S. Figure-5 is the schematic made with the help of Fritzing software. The sample load used here is Bulb. Node MCU module is given power by data cable of B-type which is connected to the laptop or 5V DC supply. Figure-6 shows the view of the hardware setup.

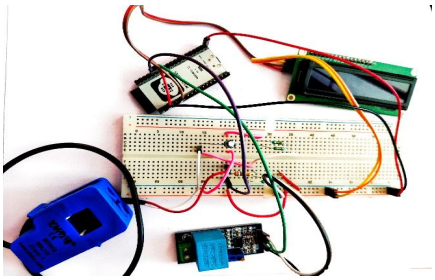


Fig-6 Hardware Connection Diagram

D. Software Setup

Fig-7.1 Arduino Logo

Fig-7.2 Blynk Logo

An application called Arduino (Fig-7.1), an open-source hardware and software company, project and user community which designs and manufactures single-board microcontrollers for building digital devices is used to boot the program to the ESP32S module in this paper.

Also Blynk 2.0 (Fig-7.2) platform is the unified and easiest way that provide powerful web dashboard with drag and drop UI editor to manage devices, users and data and also provides Blynk IOT mobile application which provides user friendly addable widget. Figure(7.3) shows the topology of the blynk 2.0 operations.

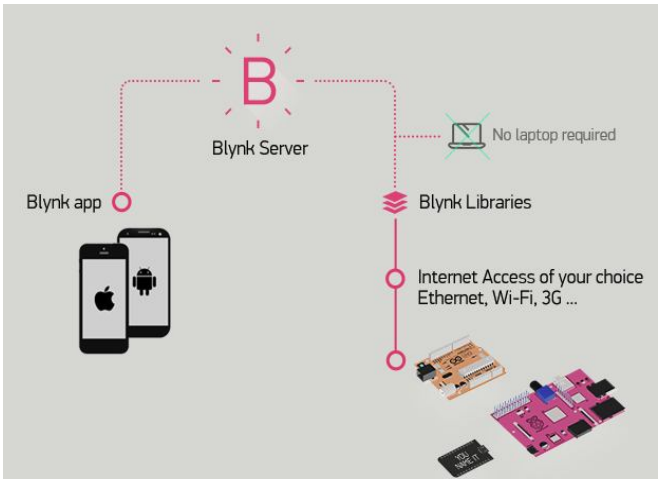


Fig-7.3 Blynk Configuration Topology

III.BLYNK 2.0 CONFIGURATION

A. Web Dashboard Config

First of all need to sign up and create a template for the user requirement where the datastreams of different virtual pins have to be created. Here, a template "SMART ELECTRICITY METER " has been created. In that a four data streams are assigned for four values (Voltage,Current,Power,kWh) to Virtual pins V0,V1,V2,V3 (Fig-8.1).

Search datastream

Id	Name	Alias	Color	Pin	Data Type	Units
1	kWh	Power_kWh		V3	Double	W
2	Power	Apparaent_Power		V2	Double	kW
3	Voltage	Voltage		V0	Double	V
4	Current	Current		V1	Double	A

Fig-8.1 Assignment of data streams

The minimum and maximum values are declared initially. Also the S.I units of the parameters have mentioned. Then the template is saved.

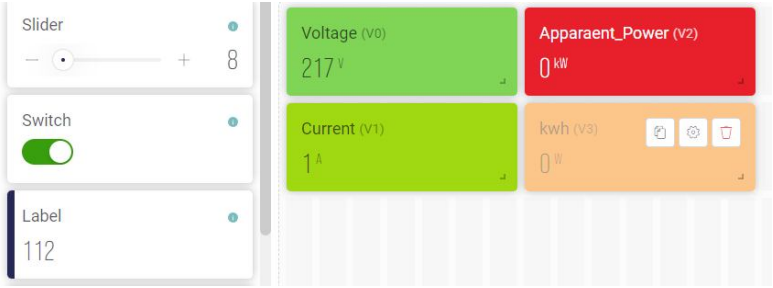


Fig-8.2 Web dashboard View

In web dashboard tab, four widgets are created using label widget for respective (Fig-8.1.2) data streams. According to user requirement, it can be created.

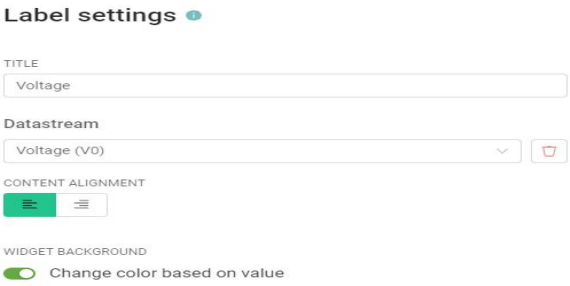


Fig-8.3 Label setting of the corresponding virtual pin

In Label Setting tab(Fig-8.3), the data stream is to be selected to particular virtual pin as it was assigned in data stream settings.The widget background color can be changed according value that was fixed in range of values.

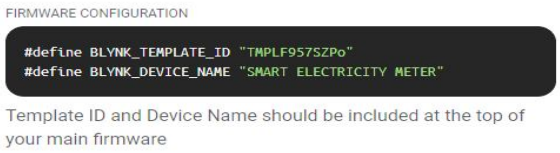


Fig-8.4 Firmware configuration

After completing web dashboard, firmware configuration (Fig-8.4) will be automatically given by blynk 2.0 and it should added in main firmware.

B. Mobile Dashboard Config

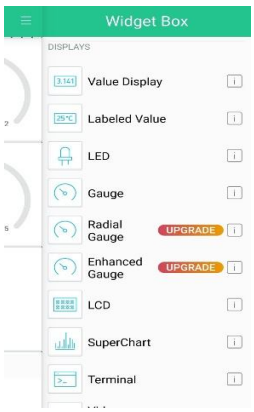


Fig-8.5 Widget Box setting

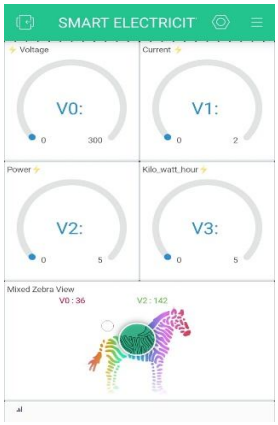


Fig-8.6 Mobile Dashboard View

First of all, Latest Blynk IOT mobile application should be installed.The same login creditials should entered. Then the template will be displayed which was created in web dashboard, by entering into it, the required widgets are added from widget box (Fig-8.5). Widget box option will enabled only when developer option at the right top of the display is clicked. Then, a mobile dashboard view tentatively made. Then the parameters should be assigned to respective datastreams.(Fig-8.6).

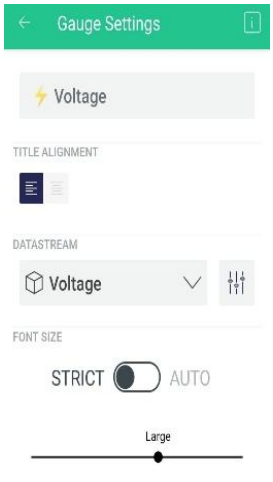


Fig-8.7 Widget names

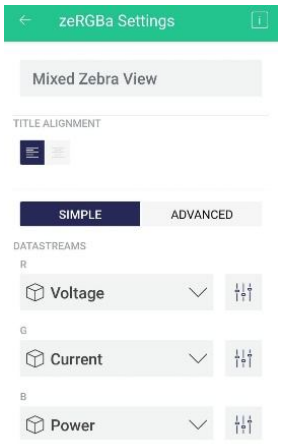


Fig-8.8 zeRGBa Settings

Then the Widget names (Fig-8.7) and font size of the display names should be assigned for individual datastreams. For mixed Zebra view the multiple parameters should be selected for our conveinance(Fig- 8.8).

To get your hardware online and connect it to Blynk Cloud, we would need a device Authentication Token. Once we download the app you will be able to generate Auth Token for every device.

We should make sure that device is powered on and waiting for connection. Then Tapping Ready, we could choose our device and tap its name. Once the app is connected to the device, the next step is to send to the device the Wi-Fi credentials for it to use. By Tapping choose Wi-Fi network and select the network your mobile device is connected to: We need to type selected Wi-Fi password; Then there's an option to Remember this network for other devices by enabling it helps to save time if you need to add multiple devices. Then By clicking continue, device will be connected.

On successful connection (Fig-8.8), mobile will connect to the device and transfer the credentials, consequently, the device will try to connect to the internet and subsequently to the Cloud.

C. Arduino IDE Setup

In Arduino IDE, the ESP-32S board should be configured initially. Then preferences should be changed to. json boards in additional board URL.

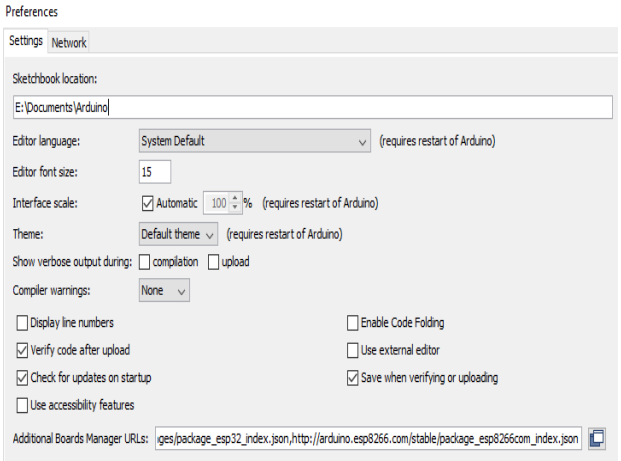


Fig-9.1 Preference setting in Arduino

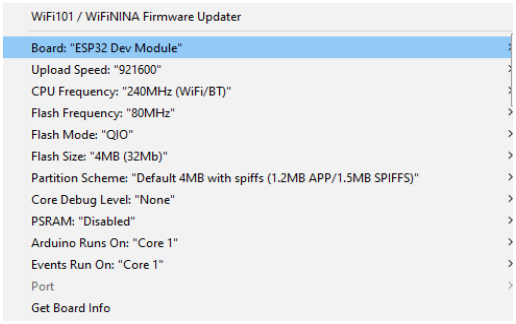


Fig-9.2 Board selection

Then the ESP-32S library should be installed from boards managers in tools.

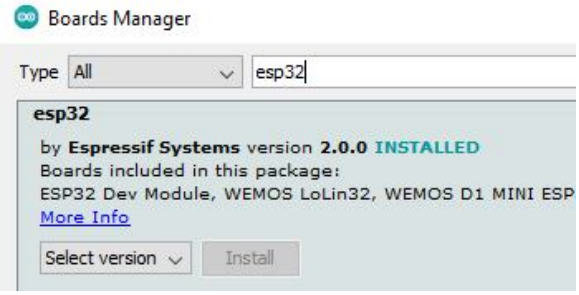


Fig-9.3 ESP32-S Library Installation

D. Libraries

1) Emon Library

This library is called as Open Energy Monitor which is used for many purposes like energy use monitoring, on site solar PV, Realtime monitoring of EV charging. The main objective of Open Energy Monitor system is that can be used as a simple home energy monitoring system for understanding energy consumption. By Viewing and exploring real-time power and daily energy consumption in kWh. There are multiple libraries like emonPi, emonTx, emonTh, emonCMS etc. As these libraries are open-source libraries can be downloaded from GitHub, Arduino reference etc.

2) Blynk Library

This library is created by Blynk corporation which provides a digital dashboard where we could build a graphic interface for the paper by simply dragging and dropping available widgets. We can use Blynk's platform quickly which can support both Arduino and NodeMcu over Wi-Fi, Ethernet, or an ESP8266 chip. This library can download from open-source forum and can be manually added from Arduino library manager. While adding manually the esp32 chip must be selected. However, as we see the Cloud Blynk server has imposed limitations which are due to the topology of the server: depending on your geographical location, the server may be in a different continent, which makes communications between the app, the devices, and the server slow due to the amount of time it takes packets to travel across the Internet.

3) Liquid Crystal I2C Library

This library has many built-in functions to make programming the LCD fast and easy. In this library I2C stands for Inter-Integrated Circuit. It is a bus interface connection protocol incorporated into devices for serial communication, so data is transferred bit by bit along a single wire (the SDA line). I2C is synchronous, so the output of bits is synchronized to the sampling of bits in transmission by a clock signal shared between the master SCL and the slave SCL. The clock signal is always controlled by the master SCL. The latest version of this library can be found on GitHub, or it can be downloaded from Arduino reference. he LiquidCrystal_I2C library works in combination with the **Wire.h** library which allows you to communicate with devices with I2C communication. This library comes pre-installed with the Arduino IDE which is to be updated.

4) WIFI Library

The Library supports Wired Equivalent Privacy (WEP) and WPA2 Personal encryption, but not WPA2 Enterprise. Also note, if the Service Set Identifier (SSID) is not broadcast, the shield cannot connect. This Library is optional for this project. The Wi-Fi library is very similar to the Ethernet library, and many of the function callings are the same.

ESP8266 is all about Wi-Fi. The thing is to connect the new ESP8266 module to a Wi-Fi network to start sending and receiving data, this is a starting place to start communication. This Library will refer through several classes and properties of the ESP8266WiFi library.

E. Flowchart

This flowchart (Fig-10) explains about the workflow of the project mentioned in the paper. In the beginning the microcontroller ESP32S is initialized which initialize the inbuilt Wi-Fi module. Then LCD 16*2 is initialized. Then the sensors are ready to read the values and the values are printed using different outputs like serial monitor. The Values are transmitted to the Blynk cloud. Then if continuous values are sensed, they will be printed in the LCD and blynk output portals like web and mobile dashboard.

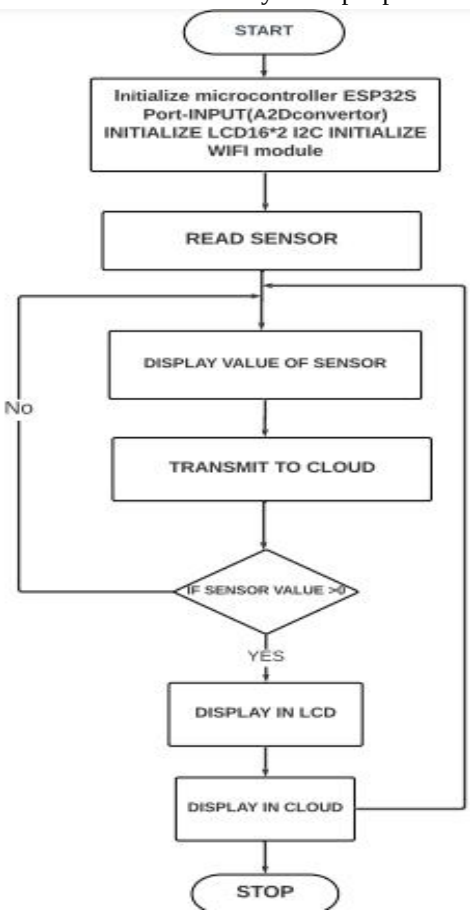


Fig-9 Flowchart of the System

IV. RESULTS AND CONCLUSION

A. Results

After switching ON the load mains, current sensor and voltage sensor senses the Ampere and Voltage from the load, then gives output in analog form. The output of the sensor is supplied as input to the analog input part in the ESP32S Board which has inbuilt analog to digital convertor which converts analog input of power to digital output. This digital output which is calibrated to calculate apparent power and kWh is displayed on LCD display, Serial monitor in form of Voltage, Current, Power, kWh as shown. The NodeMcu which has inbuilt Wi-Fi module is used to connect internet with the monitoring hardware system. The power utilized by the load is displayed in the web view and mobile application view of the Blynk cloud for every 5 seconds.

B. Output Views

1) LCD View



Fig-10.1 RMS value in LCD Display



Fig-10.2 Power and kWh in LCD Display

In this Paper, the program is written to print the measured instantaneous voltage, current, power,kWh on the LCD through I2C protocol for every 3 seconds.

2) Serial Monitor View

Serial monitor is a bridge between Arduino and computer for serial communication as the ESP32S is connected to Port COM 10 of the laptop. It does a job to display messages continuously sent from ESP32S. Here, when the supply turns on, the ESP32S receive the data and send messages serially to print Vrms, Irms, power and kwh in serial monitor.

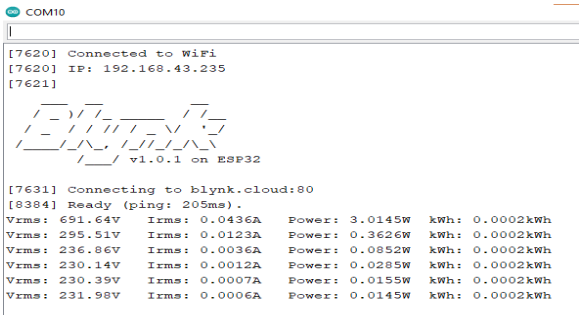


Fig-11 Serial Monitor View

3) Mobile View

As I have created four widget named voltage, current, power, kWh, in mobile blynk 2.0 IOT platform to monitor the instantaneous value. It displays the similar value like in LCD, serial monitor.

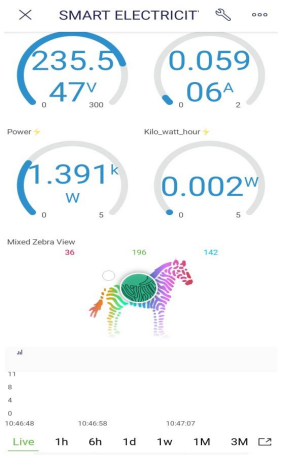


Fig-12 Mobile View of the output

4) Web View

Created a template name called smart electricity meter (Fig-13) where we have created DataStream in blynk 2.0 to monitor the reading simultaneously in webpage which is connected to hardware Esp32S with blynk via Wi-Fi.

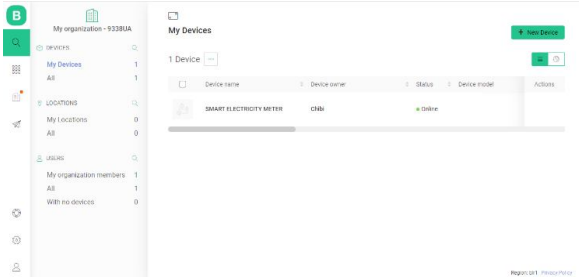


Fig-13 Web Dashboard View of the Output

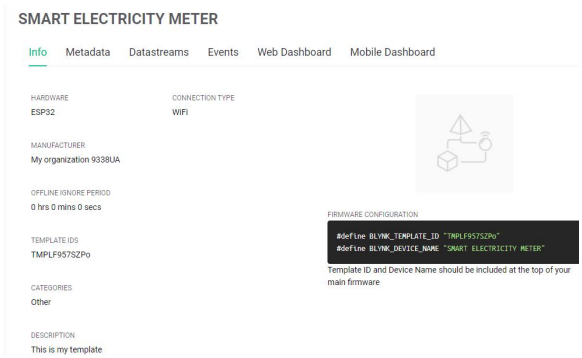


Fig-14 Web Dashboard Template View

Figure 14 shows after connecting with Wi-Fi, the blynk become offline to online then webpage display the value of voltage, current, power and kwh in webpage. The template name, blynk device name, authentication token will be provided, to be copied and pasted to the beginning of the entire program. It is also possible to view much information like metadata, events etc. Also, the device status like ON time could be viewed. Template description could be added.

Figure 15 shows the final web dashboard view in online status.

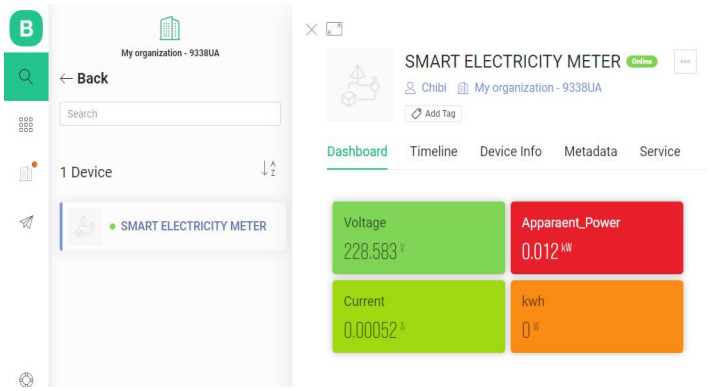


Fig-15 Complete Output View in Web dashboard

V. CONCLUSION

In present electricity billing system, workers from EB visit each consumer's home to take the readings for consumption and get back to the office. This project will eliminate this requirement of manpower and will be able to generate the bills more conveniently and from distant place. The consumers also consume lot of energy, therefore using Internet of things the system will enable users to track their consumption on daily basis which will help them reduce their consumption and they will be understand value of energy consumed is reached.

VI. FUTURE SCOPE

This paper mainly aims at providing overall infrastructure of the electricity meter presently used for the smart city concept. The main improvement for the future is going to make electricity meter readings, overload detection and the pre-information providing to the users all will be going to happen on Internet. Also, in future we can go with some standard apps or standard tools, which makes the Eb department work easy for people by noting the meter readings faster than the present method of calculating the usage Also, Bill calculation can be done in program, and it also displayed if needed. GSM module can be used to intimate the overload consumption Depending on user requirement overload can be notified using Bluetooth module and the overall improvement information will be providing to the electricity meter, so the portal will be easy for them to handle the things. This device can be installed in electricity board to implement both side calculation and cross check it.

This paper has succeeded in designing a cost effective ESP32S electricity monitoring system using the Internet-of-Things technology by using a single board to act as a controller and a network interface. The paper also verifies the designed system by constructing and testing a prototype of the system using the components outlined in this paper.

VII. RECOMMENDATION

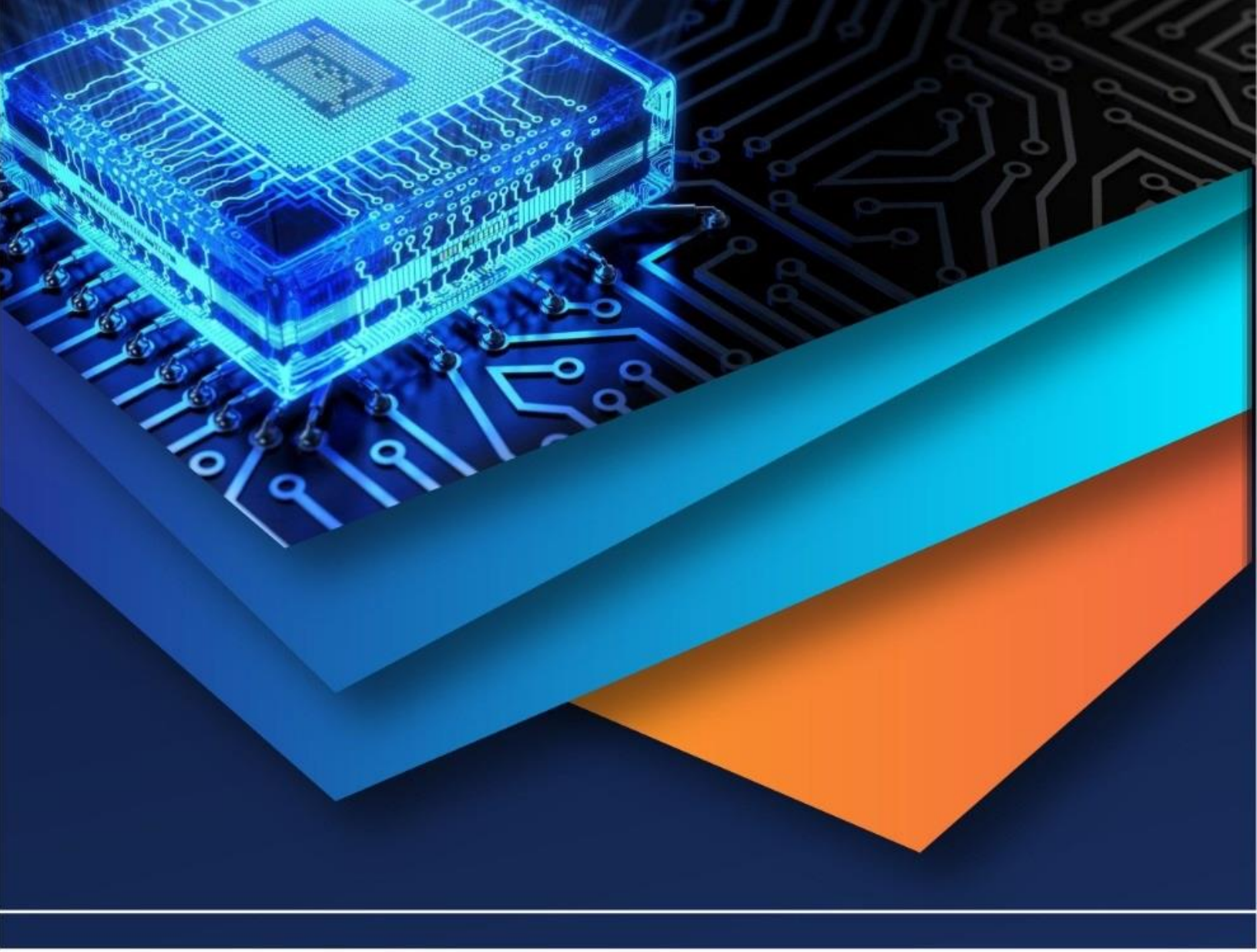
This study only developed a system that to monitor the electricity, recommendation is made on any study that will develop the system using other IOT platform. This is necessary because can also be programmed to detect the load consumption using this meter; This prototype has made to monitor for 24*7.

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