Smart Power Socket Using IOT with Energy Monitoring and Controlling of Socket Over the Cloud

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Abstract - This electronic paper describes the design and implementation of a smart power socket integrating IOT with cloud-based energy monitoring and control. Its main responsibility is to provide cloud-based mobile applications for services like monitoring, motion-based automation, remote control, and electrical protection. In addition, this IoT smart power socket is supported by state-of-the-art software for self-automation with sensors and power utilization analysis to lower energy expenses. Our technology can be used in a number of industries, including industrial automation, security, power usage management, and office management systems. It can also be used in smart and remote access home automation systems. The prototype of our power outlets is made of locally controlled sensors that use a cloud service to connect with a common central hub and exchange data and receive instructions. The user is subsequently given information via the Blynk programme over the Internet connection.

Key Words: PIR Sensor, NodeMCU, Current sensor, Temperature Sensor, Socket, LED.

1.INTRODUCTION

Natural resource depletion is a problem brought on by the expanding population. As a result, artificial resources like energy are unable to keep up with the demand, which is growing at an exponential rate In order to boost production, transmission, and power usage efficiency, numerous measures have been done in the last few decades to improve equipment and system design. The Internet of Things (IoT) and microcontrollers are the next-generation tools for overcoming the power restriction brought on by the emergence of the digital era. It provides real-time information on the many system and equipment factors, enabling more radical and precise approaches to improve power system utilization while lowering the demand for natural resources. The Smart Power Socket with IOT and Energy Monitoring and Controlling over the Cloud System, with a focus on end-user domestic consumers, aims to not only provide simple plug-and-play control of household devices, but also to provide useful consumption/utilization data that families can use to reduce electricity costs. With greater digitalization and application in the power sector, IoT systems can be incorporated into the entire system, giving power producers a more thorough understanding of consumption patterns and contributing in the development of more effective production and distribution systems.

It is usually referred to as a "smart socket," an electric socket that offers sophisticated functions for smartphone management, sensor-based control, and cloud-based appliance monitoring. It can be installed between the electrical system in your home and the necessary electronic device. Depending on the commercial product, these features could include everything from remote power usage monitoring to management of the appliance status (ON or OFF). The quality of life is improved by such a gadget and the adoption of IoT technology, while certain older appliances might not connect to the IoT network because they lack "smartness." These appliances will gain "smartness" when they are connected to the IoT network using solutions like smart plugs.

2.MOTIVATION

IoT is quickly turning into a need in our lives, often without our knowledge. From the most basic to the most complex devices (including PCs, laptops, cellphones, and tablets), its applications cover every aspect of computing and internet access. "Smart Homes" can be advantageous to homeowners, and assistive technology, such as voice control capabilities, can offer security and comfort to people with disabilities. These devices' sensor data uncovers intriguing patterns that are extremely valuable for business and marketing. Practically every sector of the economy and sphere of human activity has potential.

Home Automation simply means making your Home Smart. In actual sense it becomes smarter only when IoT, i.e., Internet of Things comes into the role. We have countless benefits as we can Save our energy and connect “n” number of appliances with its help. With help of IoT, everyone can have access to their home appliances through google clouds as it helps in passing the information. Technology is changing and today’s world demands “Smart Living”, using IoT it can be turned into reality. Smart Homes results into a Smart City & a Smart City result into a Smart world.

To increase the standard of living, the appliances must be fully automated with zero user interaction. Because the appliances can learn from the end user and respond to their demands without a physical button press, the end user can interact with them without any hassle.

3.LITERATURE REVIEW

The development of IoT technology has enabled the creation of smart devices that can be controlled and monitored remotely. One of the applications of IoT technology is the development of smart power sockets that can be controlled and monitored over the cloud. These smart power sockets can provide various functionalities, such as energy monitoring and control, which can help in reducing energy consumption and electricity bills.

Several research studies have been conducted in the area of smart power sockets using IoT technology. In a study titled "Smart Power Socket using Internet of Things," the authors proposed a smart socket that can be controlled and monitored using a mobile application. The socket was designed to measure the energy consumption of the connected device and provide real-time data to the user. The authors also integrated the socket with Amazon Alexa, which enables voice control of the socket.[1]

In a study titled "IOT Based Power Management and Controlled Socket Using Blockchain," the authors proposed a smart socket that can be controlled and monitored over the cloud. The socket was designed to measure the energy consumption of the connected device and provide real-time data to the user. The authors also developed a mobile application that can be used to control and monitor the socket remotely.[2]

In a study titled "Design and Implementation of Smart Socket Based on Internet of Things," the authors proposed a smart socket that can be controlled and monitored using a mobile application. The socket was designed to measure the energy consumption of the connected device and provide real-time data to the user. The authors also integrated the socket with Google Home, which enables voice control of the socket.[3]

In another study titled "A New Method of Controlling IoT Devices Based on Cloud Storage Service," the authors proposed a smart socket that can be controlled and monitored using a mobile application. The socket was designed to measure the energy consumption of the connected device and provide real-time data to the user. The authors also used the MQTT protocol for communication between the socket and the cloud server.[4]

Similarly, in a study "Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications", the authors proposed a smart home energy management system that could monitor and control the energy usage of various household appliances. The system was designed to provide real-time energy consumption data and allow users to remotely control the appliances using a smartphone application. The authors also highlighted the potential benefits of such a system, including cost savings, increased energy efficiency, and reduced carbon footprint.[5]

In summary, the development of smart power sockets using IoT technology has gained significant attention from researchers due to its potential to reduce energy consumption and electricity bills. These smart sockets provide various functionalities, such as energy monitoring and control, which can be controlled and monitored remotely using mobile applications or motion based self-automation through smart home assistants. Utilizing the electric meter that is put in every home is the conventional way to determine the amount of energy utilized. The energy meter continuously tracks the amount of energy used by various electrical devices.

4.TECHNOLOGY

4.1 Components

4.1.1 Software components

Blynk IoT Android Application

The Internet of Things platform Blynk enables users to remotely control gadgets like the Arduino, Raspberry Pi, and NodeMCU on their iOS or Android smartphones. A graphical interface or human machine interface (HMI) can be built with this application by compiling and providing the correct address on the various widgets.

Blynk is a tool developed for the Internet of Things. In addition to doing a variety of exciting tasks, it can store data, visualize it, display sensor data, and remotely control devices.

There are three primary components of the platform:

[1] Blynk App: - With the help of the many available widgets, it helps us to create beautiful user interfaces for our applications.

[2] Blynk Server:- Every communication between the smartphone and the hardware is controlled by it.Either the Blynk Cloud or a locally installed Blynk server can be used. It can quickly scale to thousands of devices, runs on a Raspberry Pi, and is open-source.

[3] Blynk Libraries: - It manages all incoming and outgoing commands and offers connectivity with the server for all commonly used hardware platforms.

When the button is pressed, the Blynk programme begins a process in which data is delivered to the Blynk Cloud and then suddenly appears on the installed devices. Everything happens quickly and moves the other way.

Arduino IDE

The Arduino Software (IDE) makes it easy to write code and upload it to the device when offline. We advise it for people with a poor or nonexistent internet connection. With this programme, any Arduino board may be utilized.

The Arduino IDE is currently available in two versions: 1.x.x and 2.x. The IDE 2.x is a more recent major version than the IDE 1.x.x, and it operates faster and more powerfully. It has a more contemporary editor, a dynamic user interface, and more sophisticated capabilities to aid users in their coding and debugging.

A connection and communication with the Arduino boards are established using the Arduino Integrated Development Environment, or Arduino Software (IDE). Computer programs, or sketches, are created using the Arduino IDE. These images are created using a text editor, then saved as files with the.ino extension. Programming languages used by the Arduino IDE include C++ and embedded C.

4.1.1 Hardware Components

Table 1. Required Hardware Components

S. No	**Product**	**Function**	**Qty**
1	NodeMCU	Controller with onboard ESP8266 Wi-Fi Chip	1
2	Relay Board	5V 10A 2 Channel Relay Module	1
3	Switch Box	Switch Box with 15 A Power Socket	1
4	PIR Sensor	Motion Detection	1
5	Current Sensor	Measures current and power	1
6	Temperature Sensor	Sense temperature and humidity	1
7	Miscellaneous	Plug, LED's, Wires, etc.	--

ESP8266 NodeMCU Wi-Fi module

NodeMCU, a LUA-based open-source programme, was given to the ESP8266 Wi-Fi chip. The ESP8266 Development board/kit, also called the NodeMCU Development board, has NodeMCU firmware that may be used to examine the chip's operation.

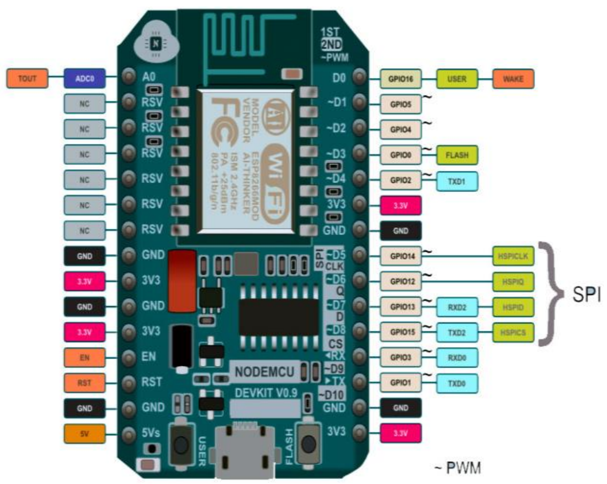

Fig.1 NodeMCU Development Board/kit v0.9 (Version1)

Considering that NodeMCU is an open-source platform, anyone can modify, create, or alter its hardware. The NodeMCU Development Kit/Board contains the ESP8266 Wi-Fi chip. A cheap Wi-Fi chip that utilizes the TCP/IP protocol is the ESP8266 from Espressif Systems.
The NodeMCU Development Board/Kit v0.9 (Version1) is depicted in Figure 1.

PIR Sensor

An electronic sensor that detects and measures infrared (IR) light generated by objects in its field of vision is known as a passive infrared sensor (PIR sensor). They are most typically utilised in PIR-based motion detectors. PIR sensors are frequently used in autonomous lighting and security alarm systems. PIR sensors can generally detect movement but cannot identify what or who moved. You'll need an image IR sensor to do it. In Figure 2, PIR sensor is displayed.

Fig.2 PIR Sensor

For "passive infrared detector," the term "PIR" or, less frequently, "PID," is frequently used to refer to PIR sensors. PIR devices are referred to as passive devices because they don't release energy to detect objects. Their sole mode of operation is the detection of infrared radiation (radiant heat) that is emitted or reflected from objects.

All items with a temperature over absolute zero release heat energy in the form of electromagnetic radiation, according to the PIR sensor's working principle. Because it emits at infrared wavelengths, this radiation is often invisible to the human eye, but it can be detected by special electronic equipment.

DHT11 Temperature and Humidity Sensor

As seen in Fig. 3, the DHT11 is a low-cost digital sensor for measuring humidity and temperature. Any micro-controller, such as an Arduino, Raspberry Pi, etc., can easily be linked to this sensor to quickly measure humidity and temperature.

A sensor and a module are included with the DHT11 humidity and temperature sensor. A pull-up resistor and a power-on LED help to distinguish this sensor from the module. The DHT11 is a relative humidity sensor. This sensor utilises a thermistor and a capacitive humidity sensor to measure the ambient air.

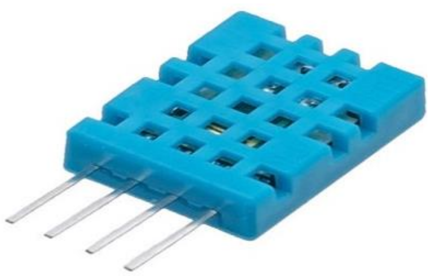

Fig.3 DHT11 Sensor

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ACS712 Current Sensor

The current sensor known as the ACS712 is used to gauge the flow of current in a circuit. A linear output voltage proportionate to the current being measured can be obtained from the Hall Effect-based sensor. Because of its low insertion impedance, the sensor has little impact on the circuit being tested.

The sensor is typically designed to be used with a microcontroller or other electronics board, as it requires an analog input to read the output voltage. The output of the sensor is usually calibrated to correspond to a specific current range, which can be adjusted using external components. Fig.4 shows the 5A ACS712 Current Sensor.

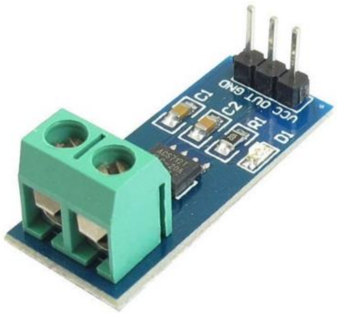

Fig.4 ACS712

The ACS712 sensor is available in different models that have different current measurement ranges, with the most common being 5A, 20A, and 30A. It can be used in various applications, including power supplies, motor control, and energy management systems.

4.2 Internet of Things

The Internet of Things (IoT) is a network of physical objects or devices, including sensors, actuators, household items, and vehicles, that have connectivity, software, sensors, and other features that enable them to collect and share data with other connected objects or systems over the internet.

IoT technology works by using sensors to gather data from the environment or from the objects themselves, which is then processed by the embedded software and transmitted to other devices or systems through the internet. Numerous physical characteristics, including temperature, humidity, air quality, energy usage, traffic flow, and equipment performance, can be monitored and controlled using this data.

IoT devices are connected through various wireless or wired communication protocols, such as Wi-Fi, Bluetooth, Zigbee, and cellular networks. These devices can be remotely managed and controlled through web or mobile applications, allowing users to monitor and adjust their operation in real-time from anywhere.

4.3 Cloud Service

Cloud Services are computing services that allow customers to access a variety of computing and Internet services. These resources can include servers, storage, databases, software, analytics, and networking. Cloud service providers manage the underlying infrastructure that supports these resources, and customers can access them on demand via a web browser or API.

The benefits of cloud services are many. For example, cloud services offer scalability, which means customers can expand or shrink their computing resources to meet changing needs. Cloud services are also cost-effective as customers only pay for the resources they use. Cloud services are also flexible and easily accessible from anywhere with an internet connection.

4.4 Embedded C

It is possible to create software for embedded systems using the programming language Embedded C. These systems are specialized computer systems built into specific devices and functions. Examples of embedded systems are medical devices, machinery, and automotive systems.

Embedded C language is a variant of C programming language designed for software development. It is a low-level programming language that allows programmers to access and control hardware devices such as memory, I/O ports, and interrupt handling.

One of the key features of embedded C language is its ability to generate efficient code that can run on resource-constrained embedded systems. The language supports a range of data types and operators, allowing programmers to write code that is optimized for the specific hardware platform. Embedded C language also includes specific libraries and functions that are tailored for use in embedded systems, such as functions for low-level memory management and bit manipulation.

5. IMPLEMENTATION

5.1 System Design

5.1.1 Flow Diagram

The IoT Power Socket was created with the intention of enabling monitoring and control of already-installed hardware all around the home. The IoT Power Socket will serve as a bridge to enable remote control of the power outlet via the Internet. The general flowchart of the system is displayed in Fig. 5 as follows:

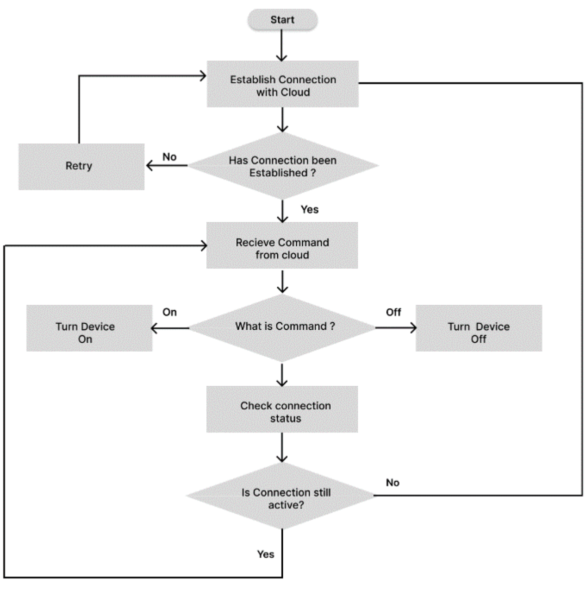

Fig.5 Flow chart of smart power socket

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First, a connection is made between the machine and the cloud server. When there was no connection, the system constantly tried to make one. The system waits for the application to issue a command after establishing the connection. The system uses the pertinent input to determine whether to connect or disconnect the electrical load. The connection's persistence is then confirmed once more by the system. The entire procedure is then repeated.

5.1.2 Block Diagram

The block diagram shown in Fig. 6 is a translation of the system's flowchart. Android apps transmit input signals to the cloud, as seen in Fig. 6. The data is sent to the cloud via the Wi-Fi module and microcontroller once they connect to the switch and receive data from the cloud.

The microcontroller and Wi-Fi module receive the input data from the PIR sensor, process it on the cloud, and send back the output signal to a relay, which serves as a switch for the appliance.

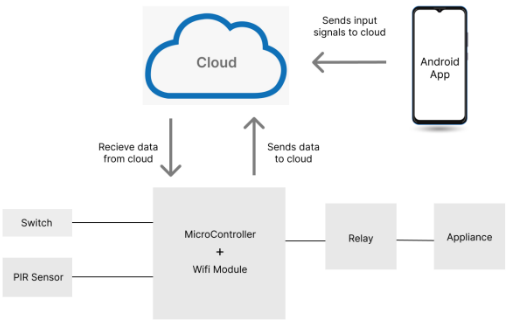


Fig.6 Block diagram of smart socket

5.1.3 Circuit Diagram

Fig 7 illustrates the circuit diagram of the Smart Power socket. Here AC current is converted to DC and then supplied to the Wi-Fi module. The PIR sensor detects the motion when the appliance is connected to the socket and turns on the appliance. After the very first detection, it stops detection and gets rescheduled for the next 24 hrs. Red LED indicates that the appliance is connected but it is off whereas the green LED shows the appliance is connected and it is ON.

The Wi-Fi module is connected to Blynk mobile app. Input command to ON and OFF the appliance is given to the Wi-Fi module through the Blynk app. The Wi-Fi module then processes the input and sends a signal to relay module to ON or OFF the connected appliance. Here current sensor monitors the energy consumed as well as the temperature sensor senses the room temperature which will be notified using the Blynk app. An external button in the case is provided to switch the ON or OFF the appliance if a mobile is not present.

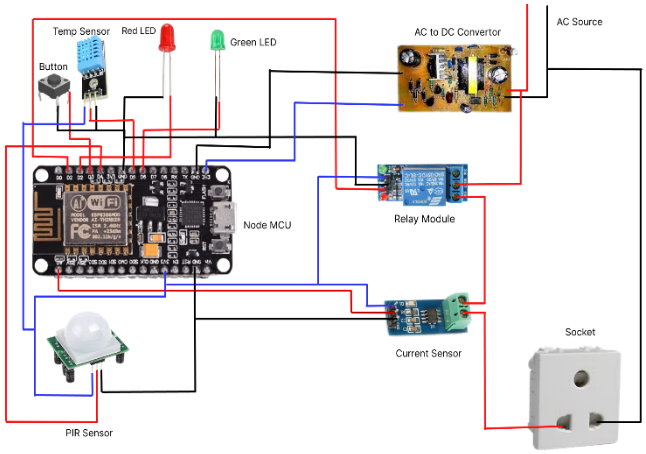
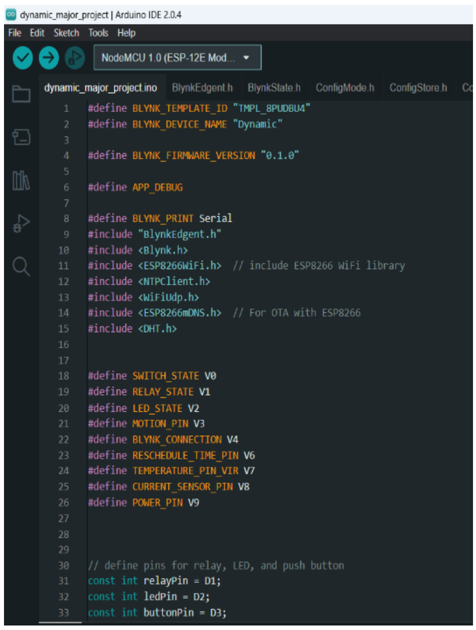


Fig.7 Circuit Diagram of smart power socket

Fig.8 Smart Power Socket Prototype.

5.2 Working and Output

Fig.9 shows the code implementation used to control the connections done with the microcontroller. This code is done in Arduino IDE using embedded C.

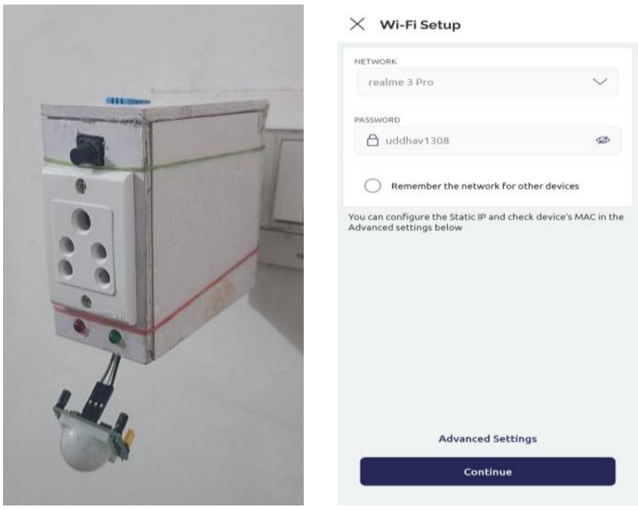



```
#define BLYNK_TEMPLATE_ID "TMPL_8PUDBU4"
#define BLYNK_DEVICE_NAME "Dynamic"

#define BLYNK_FIRMWARE_VERSION "0.1.0"

#define APP_DEBUG

#define BLYNK_PRINT Serial
#include "BlynkEdgent.h"
#include <Blynk.h>
#include <ESP8266WiFi.h>  // include ESP8266 WiFi library
#include <NTPClient.h>
#include <WiFiUdp.h>
#include <ESP8266mDNS.h>  // For OTA with ESP8266
#include <DHT.h>


#define SWITCH_STATE V0
#define RELAY_STATE V1
#define LED_STATE V2
#define MOTION_PIN V3
#define BLYNK_CONNECTION V4
#define RESCHEDULE_TIME_PIN V6
#define TEMPERATURE_PIN_VIR V7
#define CURRENT_SENSOR_PIN V8
#define POWER_PIN V9



// define pins for relay, LED, and push button
const int relayPin = D1;
const int ledPin = D2;
const int buttonPin = D3;
```

Fig 9 Code for Smart Power Socket

The hardware was set up in accordance with the Fig. 7 circuit schematic. The switch box in Fig. 10(a) served as a storage space for the components.

The NodeMCU code was uploaded to the gadget using a USB cable and the Arduino IDE. The IoT Power Socket was then used to supply power to the NodeMCU from an external source.



(a) (b)

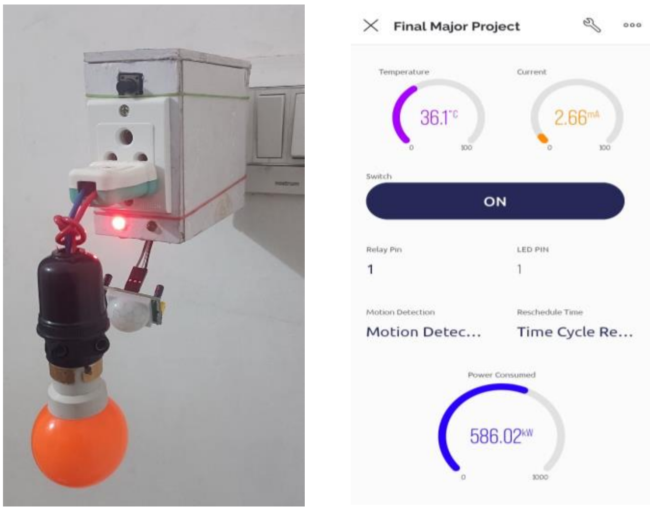
Fig.10 Proposed Prototype and Wi-Fi credentials interface

Fig.10(a) shows the Proposed Prototype of the Smart Power Socket And 10(b) WiFi setup that sets WiFi credentials to the WiFi module to establish a connection between the Blynk and WiFi module.

As illustrated in Fig. 11(a), the connected appliance is not turned on at first, but the red LED indicator indicates that the power socket is ON.

For establishing a connection with the Blynk, we have to set up the WiFi credentials for the first time as shown in Fig 10(b). Later it automatically connects with that network and the Blynk every time on its own.

Once the connection has been established, we can operate the appliance with the Blynk application on the mobile. The green LED indicates that the connected appliance is turned ON as shown in Fig 12(b).



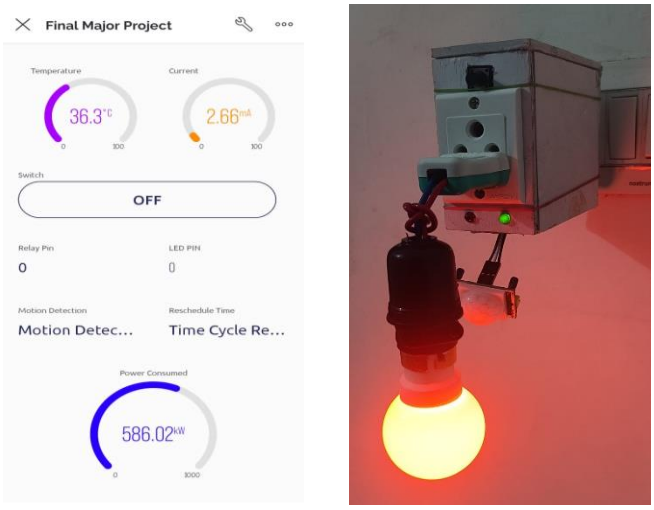
(a) (b)

Fig.11 Blynk connection established, appliance is OFF.

For the motion-based automation, the Smart Power Socket whenever switched ON detects the motion for the first time and turns ON the appliance, and stops detecting the motion. After 24 Hrs. cycle, it resets to 0 and continues to check whether the appliance is ON or OFF and again starts detecting the motion for the set scheduled time.

A lightbulb was connected as a load on the IoT Smart Power Socket in order to conduct testing.

Current and power usage by the appliance are measured by the Smart Power Socket's current sensor, which then shows the data on the app's user interface.The power consumption of the load linked to the Smart Power Socket is visualised using the Blynk Superchart in Fig. 13.



(a) (b)

Fig.12 Blynk connection established, appliance is ON

Fig.13 Blynk superchart for the visualization of the consumed power

6. CONCLUSION AND FUTURE SCOPE

This article examines in depth the use of IoT in smart power sockets for energy monitoring and socket control via the cloud. The smart socket system has been conceived and implemented as a fully functional prototype with remote control capabilities. Easy to programme, install, and use is the Smart Power Socket integrating IoT with energy monitoring and managing of the socket through the cloud. The IoT Smart Power Socket can be easily adopted because to these advantageous qualities.

This Project proposed a smart power socket using IOT with energy monitoring and controlling of the socket over the cloud allowing users to access and control the socket anywhere anytime using the Blynk android application with the help of the cloud. This system also monitors and controls the appliance with the help of the user using a mobile application physically as well as with the help of PIR motion detection. PIR motion turns off the system if the motion is not detected. This system provides the total energy consumed and heat generated during the use of the socket.

As part of the upcoming scope of work, more work will be done to further reduce the final output. The gadget will also go through more research in order to support heavier loads and various applications, such as plumbing and heating, ventilation, and air conditioning (HVAC). Another area that will be improved in the future is enhancing the socket's security and encryption features to prevent malicious use.

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[8] International Journal of Scientific & Engineering Research Volume 10, Issue 11, November-2019 1179 ISSN 2229-5518 IJSER © 2019 http://www.ijser.org Advanced Smart Power Socket Using IOT R. Santhoshkumar1, M. Anusuya2, N. anand3, G. Ezhilarasan4 1,2,3,4 Assistant professor, Dhanalakshmi Srinivasan institute of technology, Samayapuram- Trichy

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