Power Consumption Monitoring System using IoT

Srinivasan C[1], Balavignesh S[2], Hariprasanth S[3]

[1]*Saveetha Engineering College, Tamilnadu, India, srinivasanc@saveetha.ac.in*

[2]*Bannari Amman Institute of Technology, Tamilnadu, India, balavignesh@bitsathy.ac.in*

[3]*Independent Researcher, Tamilnadu, India, hariprasanth0820@gmail.com*

Abstract.

In today's scenario, everyone is leading a busy life. We do not have time to monitor the power consumption of each and every electrical appliance used in our home. Power Consumption increases in our home due to unnecessary usage of the appliances like Fan, Tubelight, TV, AC etc.,.. We fail to monitor the home appliances in ON State when we leave home. We do not know which appliance consumes more power and which appliance consumes less power. This paper provides you a Power Consumption Monitoring System using IoT to monitor the power consumed by the home appliances through Laptop/Mobile Phone using Wireless Communication Protocols

Keywords. Internet of Things, Wi-Fi, Power Consumption, Communication Protocols

1. INTRODUCTION

A network of physical and virtual objects interconnected together via the internet is Internet of Things. A greater level of accuracy and service can be obtained by using IoT based Real Time Systems. The data obtained through IoT devices can be used to resolve the real time problems. Traffic Management, Energy Management, Pollution Control, Healthcare, Security are the key sectors where the Internet of Things plays a vital role. Power Consumption Monitoring System using IoT provides the real-time monitoring of power consumed by home appliances and represent the data of power consumed by individual appliance[1]. Once, we start monitoring our own power consumptions, we have an idea about the power consumed by individual appliances. The IoT System includes physical layer, IoT middleware and application layer as shown in Figure 1. To collect the data in real time scenario; IoT devices, sensors, and actuators are used. IoT devices, sensors, and actuators forms the physical layer of the IoT System. IoT middleware layer is used for the exchange of information between the real time sensors and the application layer. The communication protocols transfers the sensed data through Wi-Fi, Ethernet, GSM, The gateway between the physical layer and IoT Middleware establishes the same. The application layer handled by the User is used to send commands to physical objects over the Internet via mobile applications, web applications. The IoT System includes various communication methods like Device to Device, Device to Cloud, Device to Gateway Communication and Back-End Data sharing[2]

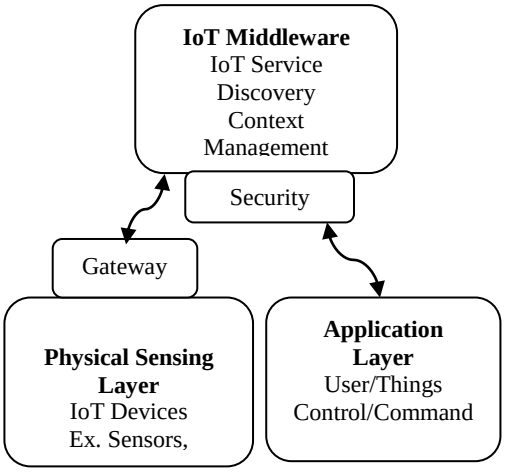


Figure 1. Architecture of an IoT System

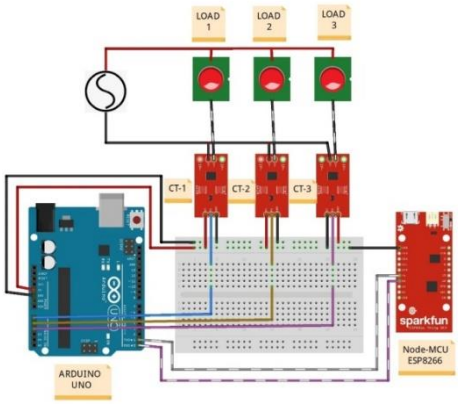


Figure 2. Power Consumption Monitoring System using IoT with three Loads

2. POWER CONSUMPTION MONITORING SYSTEM USING IOT

Power Consumption Monitoring System using IoT consists of Arduino Uno, NodeMCU, and Current Sensor (ACS-712). The current sensors(ACS-712) are connected to the analog pins of the Arduino. The V_0 pin of current sensors CT-1, CT-2 and CT-3 are connected to analog pins A6, A5 and A4 in Arduino respectively, which is responsible for the transfer of data from current sensor to Arduino. The current sensors CT-1, CT-2 and CT-3 are connected to their respective loads and these sensors are provided with 5V supply from Arduino. The NodeMCU – ESP8266 and Arduino is connected using TX and RX pins. These pins are responsible for establishing connection between them for transmitting and receiving the data. All the pins should be grounded properly.

3. INTERFACING THE IOT SYSTEM WITH CLOUD

In the system, we have to use MQTT broker to monitor our energy uses over the internet[3]. We will use AdaFruit IO platform as MQTT broker and follow the steps to monitor the Power Consumption

1. For storing data on Power Consumption, an AdaFruit account is created
2. Arduino and ESP12 Wi-Fi module is programmed to detect and transfer the data on Power Consumption to cloud

MQTT message headers are simple to enhance network data transmission. MQTT considers informing between gadget to cloud and cloud to gadget. Adafruit IO creates various learning assets, including live and recorded recordings identified with gadgets, innovation, and programming. IFTTT gets its name from the programming contingent proclamation "assuming this, that." What the organization gives is a product stage that associates applications, gadgets and administrations from various designers to trigger any one computerization[4]. The steps involved in creating the Adafruit Account[5] to store the real time data on Power Consumption is as follows

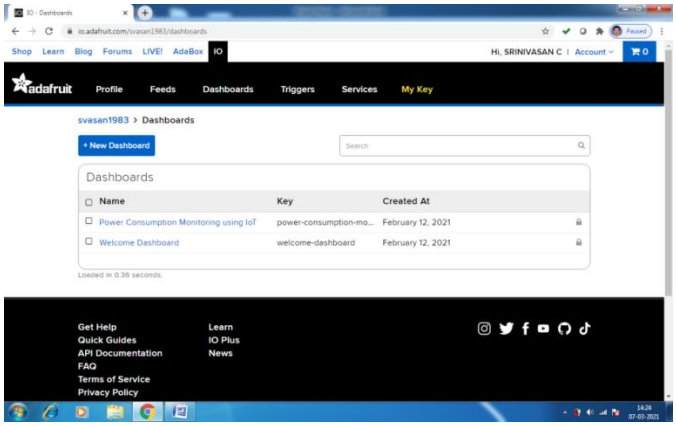


Figure 3. Create a Dashboard to monitor the Power Consumption

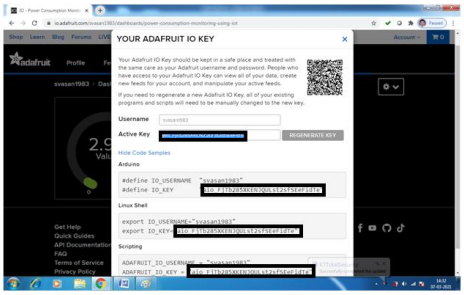


Figure 4. To setup Adafruit IO Key

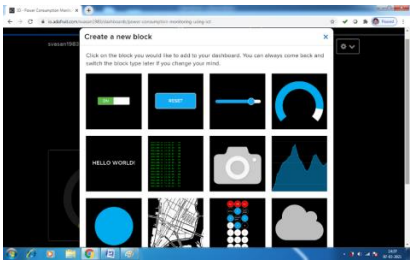
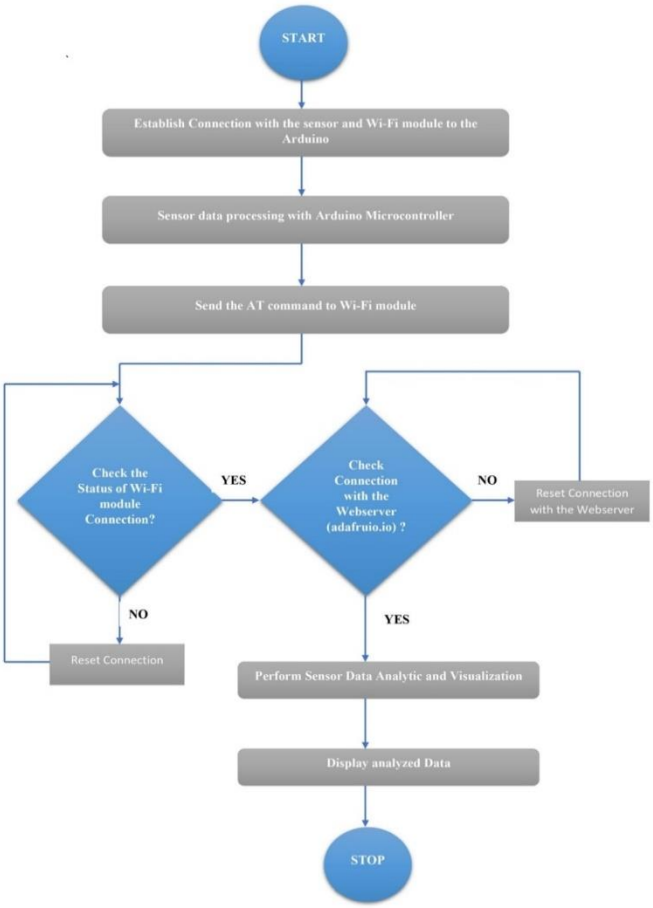


Figure 5. To create a New Block to monitor the Power Consumption

The process flow is as illustrated below;

1. When the power is turned on the Arduino establish connection with ESP8266 – NodeMCU and with current sensor ACS-712. The Arduino microcontroller gets input for current sensor and process the data from the sensor. The Arduino transfers the processed data to the NodeMCU Wi-Fi module.
2. NodeMCU Wi-Fi module first check the status of Wi-Fi connection, if there is a problem with the connection NodeMCU will reset the Wi-Fi connection. When the Wi-Fi connection made successfully then NodeMCU will check the connection with webserver (adafruit.io), if there is a problem with the connection webserver (adafruit.io) will reset the webserver connection.
3. When the webserver connection is successfully made, NodeMCU will transfer the processed data received from the Arduino to the cloud platform (adafruit.io)
4. In ADAFRUIT.io platform the received data is visually presented to the viewer. Through the data obtained from the NodeMCU the data is categorized into different forms like pie-chart, graph etc.,
5. ADAFRUIT.io platform may be used to trigger IFTTT platform to send E-mails and SMS to the respective person. This IFTTT platform record the time when the triggered is send. It also records electricity bill amount in it[6].



The flowchart provides the process flow of Power Consumption Monitoring System using IoT.

4. RESULTS AND DISCUSSIONS

The hardware implementation of the Power Consumption Monitoring System using IoT is shown below;

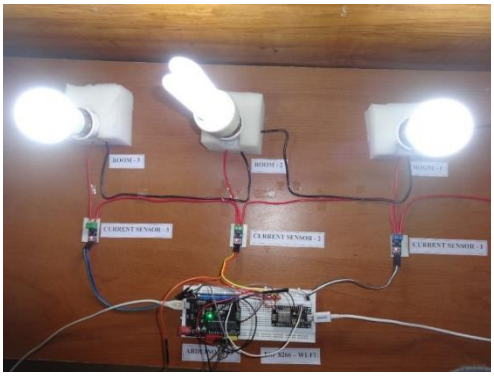


Figure 6. Hardware Implementation of the Power Consumption Monitoring System using IoT

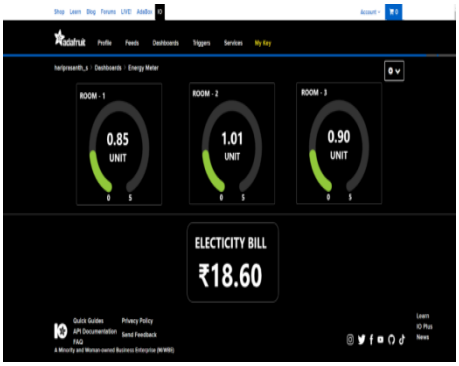


Figure 7. Adafruit Dashboard

The output of power consumption monitoring system is displayed in the adafruit.io platform

We can clearly see that the units consumed by each bulb vary deepening upon the time. The experiment was conducted periodically for around nine days to monitor the power consumption. Here three bulbs were used to act as three different loads. At the end of ninth day the electricity bill for the power consumed by the bulbs were generated as Rs.18.60. The graphical representation shows us how much power consumed in a room in a day. The adafruit platform creates individual graph for room 1, room 2 and room 3 as shown below.

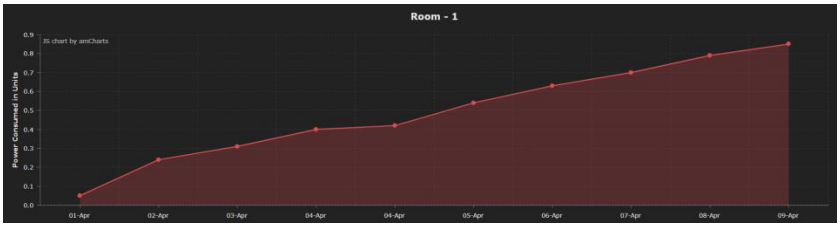


Figure 8. Graphical representation of power consumed in Room 1

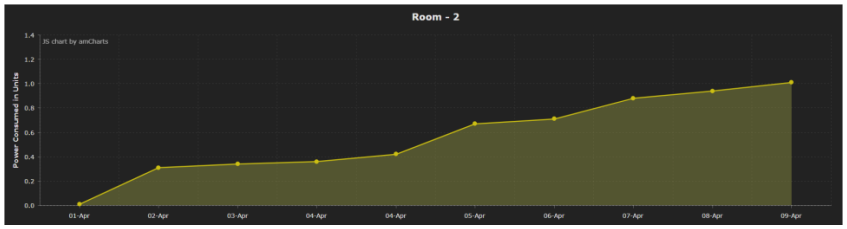


Figure 9. Graphical representation of power consumed in Room 2

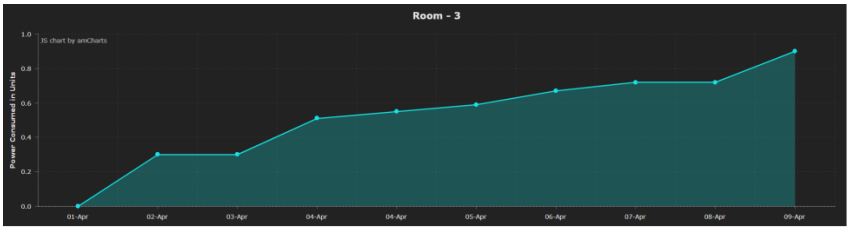


Figure 10. Graphical representation of power consumed in Room 3

5. CONCLUSION

The system may be deployed in home or industry for monitoring the power consumption and track the usage of power by different appliances. The system may help you in giving out real time data of power consumed in past and present. To end up a perfect smart home a perfect smart meter with enhanced technology is required. The design proposed has an error of around 3% to 4% in three phase power supply. Thus, the accuracy has reached 95% which means most of the time the results obtained is precise. The data collected throughout the month can be accessed from anyplace in the cloud platform and the data is used for bill generation at the end of each month. IFTTT plays its role of triggering the

communication via Email or SMS and it pings the customers. The major issue of stealing power can be eradicated by the system.

6. REFERENCES

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Biographies

Srinivasan C received the bachelor's degree in electrical and electronics engineering from Adhiyamaan College of Engineering, Hosur affiliated to Anna University, Chennai in 2005, the master's degree in applied electronics from Government College of Technology, Coimbatore affiliated to Anna University, Chennai in 2007, and pursuing the doctorate degree in Information and Communication Engineering from Anna University, Chennai since 2019, respectively.

Balavignesh S received the bachelor's degree in electrical and electronics engineering from Institute of Road and Transport Technology, Erode affiliated to Anna University, Chennai in 2007, the master's degree in power systems engineering from College of Engineering, Guindy affiliated to Anna University, Chennai in 2010, and pursuing the doctorate degree in Electrical Engineering from Anna University, Chennai since 2019, respectively.

Hariprasanth S received the bachelor's degree in electrical and electronics engineering from Bannari Amman Institute of Technology, Sathyamangalam affiliated to Anna University, Chennai in 2021. He is a Independent Researcher and his research areas include Smart Grids, Dynamic Pricing, Energy Management, Internet of Things etc.,.