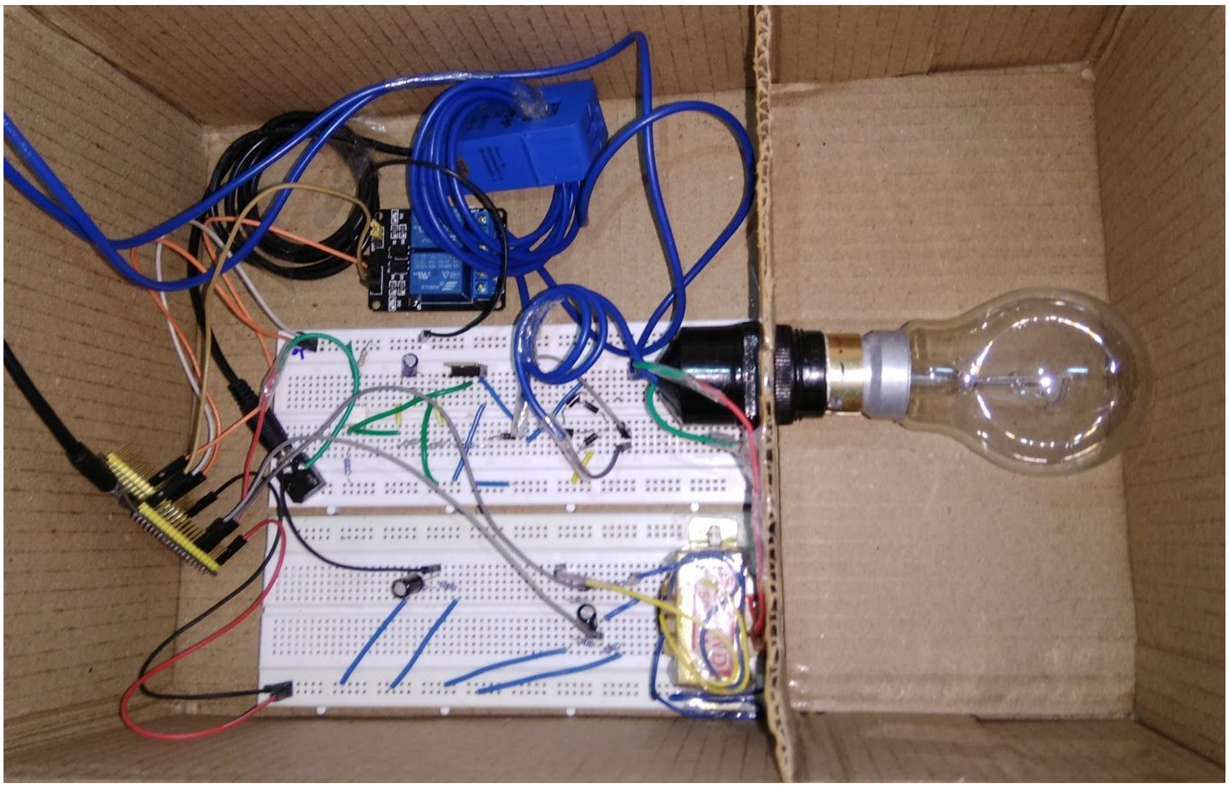
SMART APPLIANCES IN SMART HOMES

Third semester IDP



Snehith	**:**	**EE16BTECH11041**
Sumanth	**:**	**EE16BTECH11009**
Mani Teja	**:**	**EE16BTECH11018**
Roshni	**:**	**EE16BTECH11032**

08.12.2017

AIM

Procuring and simulating the real time values of the current and voltage used up / required by the domestic load at any point of time and interfacing this data to a server that is accessible to any hand-held device that can be connected over Wifi. Any domestic appliance connected to this network can also be toggled on/off according to the requirement or whenever there is an excess usage of power. The energy monitoring system precisely calculates the power consumed by various electrical devices and displays it through a server.

PURPOSE OF THE PROJECT

To reduce the power consumption of the connected devices, when high power consumption electrical loads are switched on simultaneously or the power consumption exceeds a specified threshold value, user should be guided to take smart steps. Energy bills are generated on monthly basis and the user has the option of analysing the consumption details every month.
As excess consumption of power in a particular device can lead to tripping of the meter or its detachment from the network of appliances, the circuit regulates and avoids this stage.

Controls and information received by the server:

1. Power monitoring of any appliance connected to the circuit. (Average values of consumption)
2. Power consumption at each dimming level. (A slider to dim the brightness of lamps according to convenience)
3. Real time power consumption graph(s).
4. On/Off button and status of the appliance (Concluded from the graph).
5. Alerts (eg: overloads, damaged appliances info if any, appliances running in unusual times etc)

COMPONENTS USED AND THEIR SPECIFICATIONS:

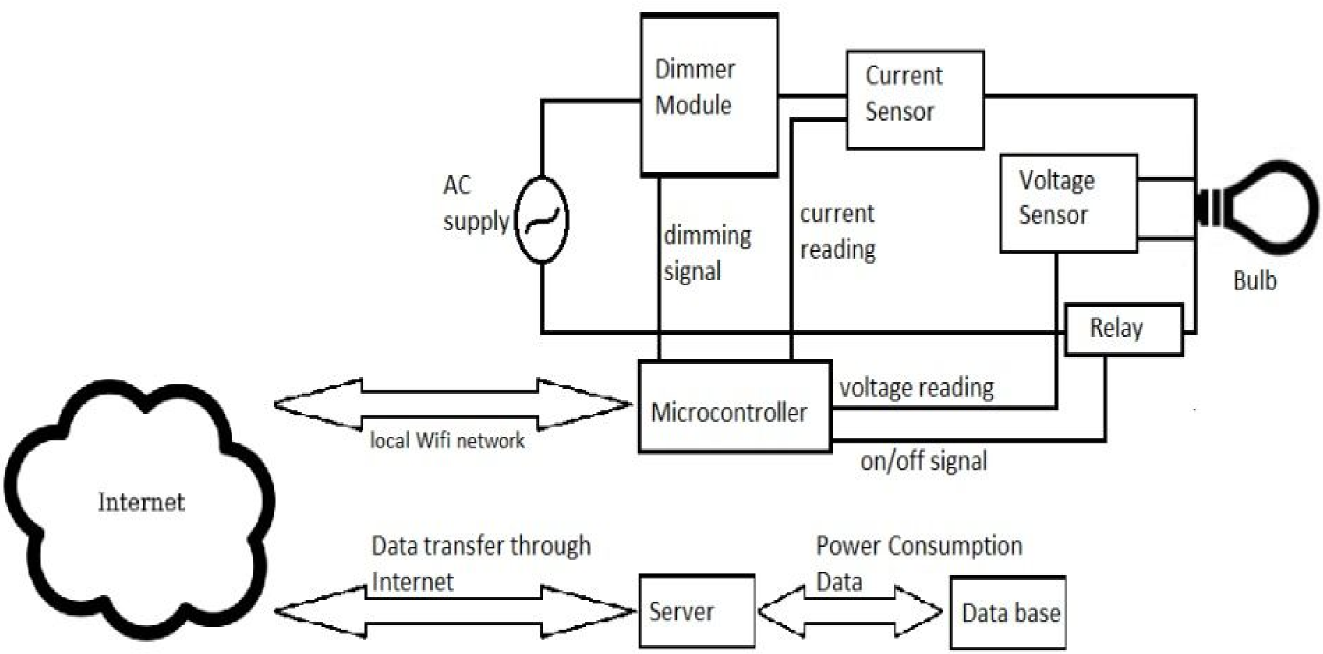
1. ESP-32
2. Zener Diode - 10v
3. Diodes - 1N4007

4. Capacitors - 2.2uF/63V , 220nF/275V
5. Resistors - 330 ohm, 33k ohm, 22k ohm, 220ohm.
6. AC current clamp sensor - ST-013-030
7. Transformer (230:9)
8. Mosfet - IRF830 - N - CHANNEL 500V - 1.35Ω - 4.5A
9. Opto coupler - 4N35

ADVANTAGES

A user can visualize the power consumed by any connected electrical appliance, from the web app and take further steps to control it; thus conserving energy. Further, the users can monitor the power consumption and the approximate value of the bill on daily basis (with an already specified cost of unit). A smart energy monitoring system can help a user analyse the energy consumption data at device level and manage it, rather than assuming it to be a fixed monthly expenditure. Also, it helps a user to replace the regular appliances by energy efficient ones. Importantly, the monitoring system can alert the user on unexpected excess consumption caused by equipment malfunctions, lack of proper maintenance,etc. Further, proper energy management can make proper budgeting possible.

CIRCUIT OVERVIEW



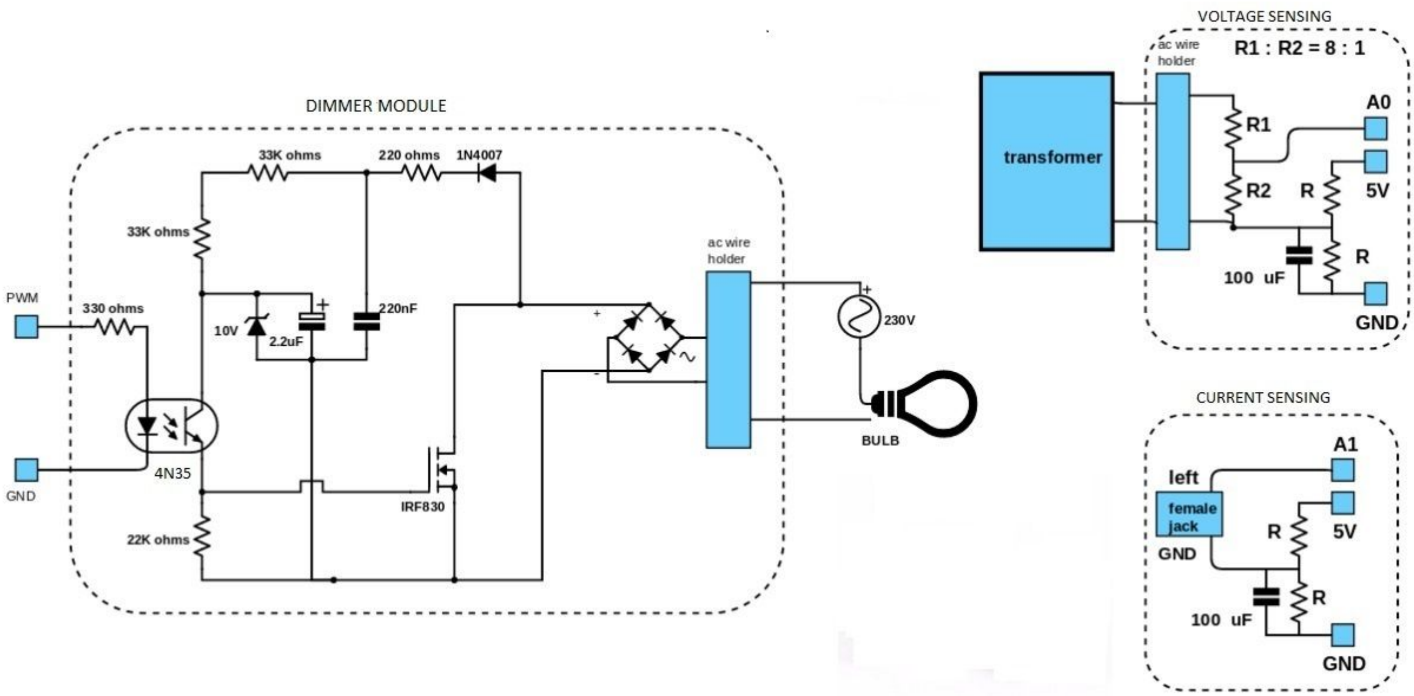
ARDUINO CODE

```
#include <HTTPClient.h>
#include <WiFi.h>
#include <ArduinoJson.h>

int freq = 2000;
int channel = 0;
int resolution = 8;

void setup() {
 Serial.begin(115200);
 pinMode(32 , INPUT);
 pinMode(34 , INPUT);
 pinMode(35 , INPUT);
 pinMode(21,OUTPUT);
 pinMode(17,OUTPUT);

 ledcSetup(channel, freq, resolution);
 ledcAttachPin(21, channel);

 WiFi.begin("snehith","iknowyou");

 while (WiFi.status() != WL_CONNECTED)
 {  //Wait for the WiFI connection completion

          delay(500);
          Serial.println("Waiting for connection");
 }
}

int bulb_on = 0 ;
int val_i = 0 , bright = 0 , val_v =0 , val_ref=0;
float tempv_i=0 , tempv_v=0 ,rms_v=0 , rms_i = 0 , sum_i = 0 , sum_v = 0 , inst_v = 0, inst_i = 0;
float sum_p = 0 ,real_p = 0 , appr_p = 0 , pf = 0 ;

void loop() {
 val_i = 0 , bright = 0 , val_v =0 , val_ref=0;
 tempv_i=0 , tempv_v=0 ,rms_v=0 , rms_i = 0 , sum_i = 0 , sum_v = 0 , inst_v = 0, inst_i = 0;
 sum_p = 0 ,real_p = 0 , appr_p = 0 , pf = 0 ;

 if (WiFi.status() == WL_CONNECTED)
 { //Check WiFi connection status
Serial.println("connected");
for(int i = 0 ; i < 1010 ; i++)
{
 val_v = analogRead(35);
 val_i = analogRead(34);
 inst_v = (((((val_v - 1840) * 3.3)/4095.0) * (9.2))) * (230.0/9.0) ;
 inst_i = (((val_i - 1840 ) * 3.3)/4095.0 )*30.0/7.0;
  sum_p = sum_p + abs(inst_i * inst_v) ;
   sum_v = sum_v + inst_v * inst_v ;
   sum_i = sum_i + inst_i * inst_i ;
}
```

```
rms_v = sqrt(sum_v / 1010.0) ;
rms_i = sqrt(sum_i / 1010.0) ;

real_p = sum_p / 1010.0 ;

appr_p = rms_v * rms_i ;

pf = real_p/appr_p ;

  StaticJsonBuffer<200> jsonBuffer;

  JsonObject& root = jsonBuffer.createObject();
root["current"] = rms_i;
root["voltage"] = rms_v;
root["power factor"] = pf;
root["power"] = real_p;
root["bulb_status"] = 0;

  root.printTo(Serial);

char JSONmessageBuffer[300];
root.prettyPrintTo(JSONmessageBuffer, sizeof(JSONmessageBuffer));

HTTPClient http;              //Declare object of class HTTPClient
 http.begin("http://teamzeus.tech/api");      //Specify request destination
http.addHeader("Content-Type", "application/json");  //Specify content-type header
int httpCode = http.POST(JSONmessageBuffer);   //Send the request
String payload = http.getString();                              //Get the response payload

Serial.println(httpCode);   //Print HTTP return code
Serial.println(payload);    //Print request response payload

int len = payload.length() - 1;

for(int i = len-1 ; i>=0 ; i--)
{
  if(i == len-1)
  {
        if(payload[i] == '0')
        {
        bulb_on = 0;
        digitalWrite(17 , LOW);
        }
        if(payload[i] == '1')
        {
        bulb_on = 1;
        digitalWrite(17 , HIGH);
        }
        }
        else if(i == len -3)
        {
        bright = bright + (payload[i]- '0');
        }
        else if(i == len -4)
        {
        if((payload[i] - '0') >= 0 && (payload[i] - '0') <=9 )  bright = bright + (10 *(payload[i]- '0'));
```

```
        }
        else if(i == len -5)
        {
        if((payload[i] - '0') >= 0 && (payload[i] - '0') <=9 )  bright = bright + (100 *(payload[i]- '0'));
        }
        }

        bright = brightness(bright);
        ledcWrite(channel, bright);
        Serial.print("  brightness = ");
        Serial.print(bright);

        Serial.println();
        delay(1000);
}
```

IMPLEMENTATION



This project is to bring out a smart home energy system which senses the current and voltage values on real time basis, computes the instantaneous power and uploads the values to the cloud using the ESP-32 (with an inbuilt Wi-Fi module).

1.Server Interfacing:

The server has a toggle button to toggle the equipments on/off, a graph plotting the real time plot of power consumed against time. The server also has a button to access the datasheet which has the values jotted down of the particular value of power consumed at an instant of time.

2. Current Sensing:

When 30A of AC current is passed in a wire which is clamped with a non-invasive AC current sensor (SCT 013-030), it gives out an output of voltage value 1V , which is then shifted by 1.75V using a voltage divider (since, microcontroller cannot take the negative values), and is the backtracked to find the actual current.

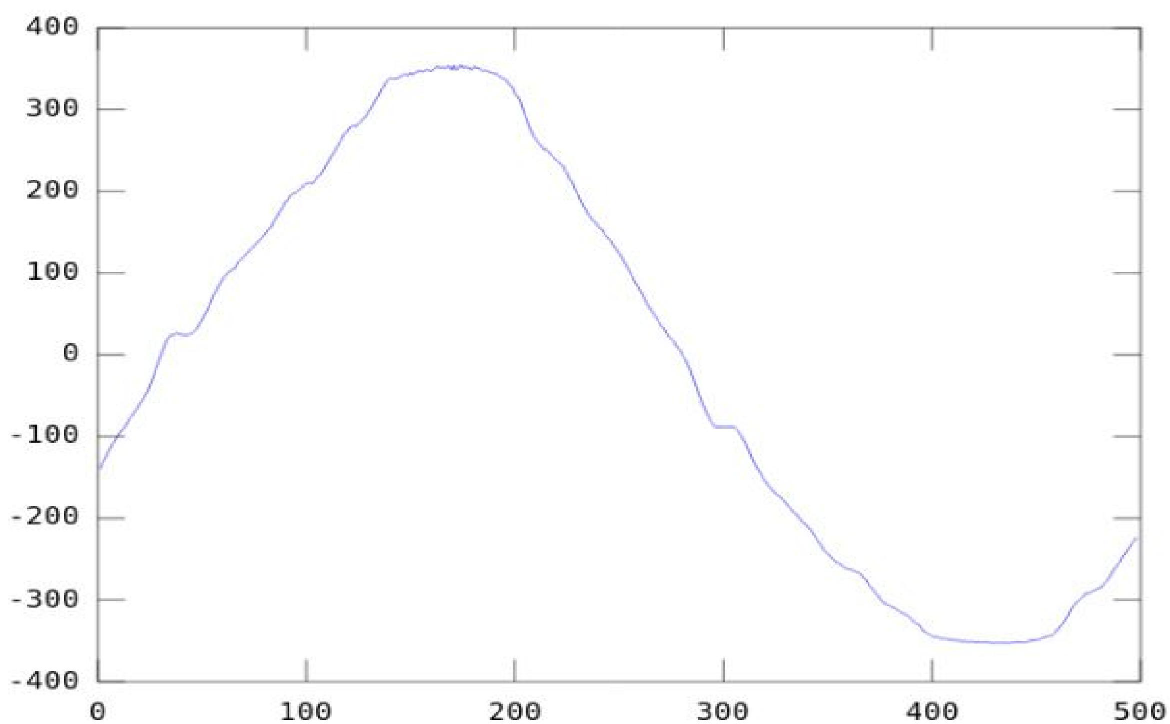
3. Voltage sensing:

The source current has a step down transformer connected across its terminals which is connected to a desired resistor-voltage divider (In the given implemented circuit, resistors of the ratio 1:1 are used such that the output voltage values vary from 3.3±input voltage.) and the output values are sent to the microcontroller (ESP-32).

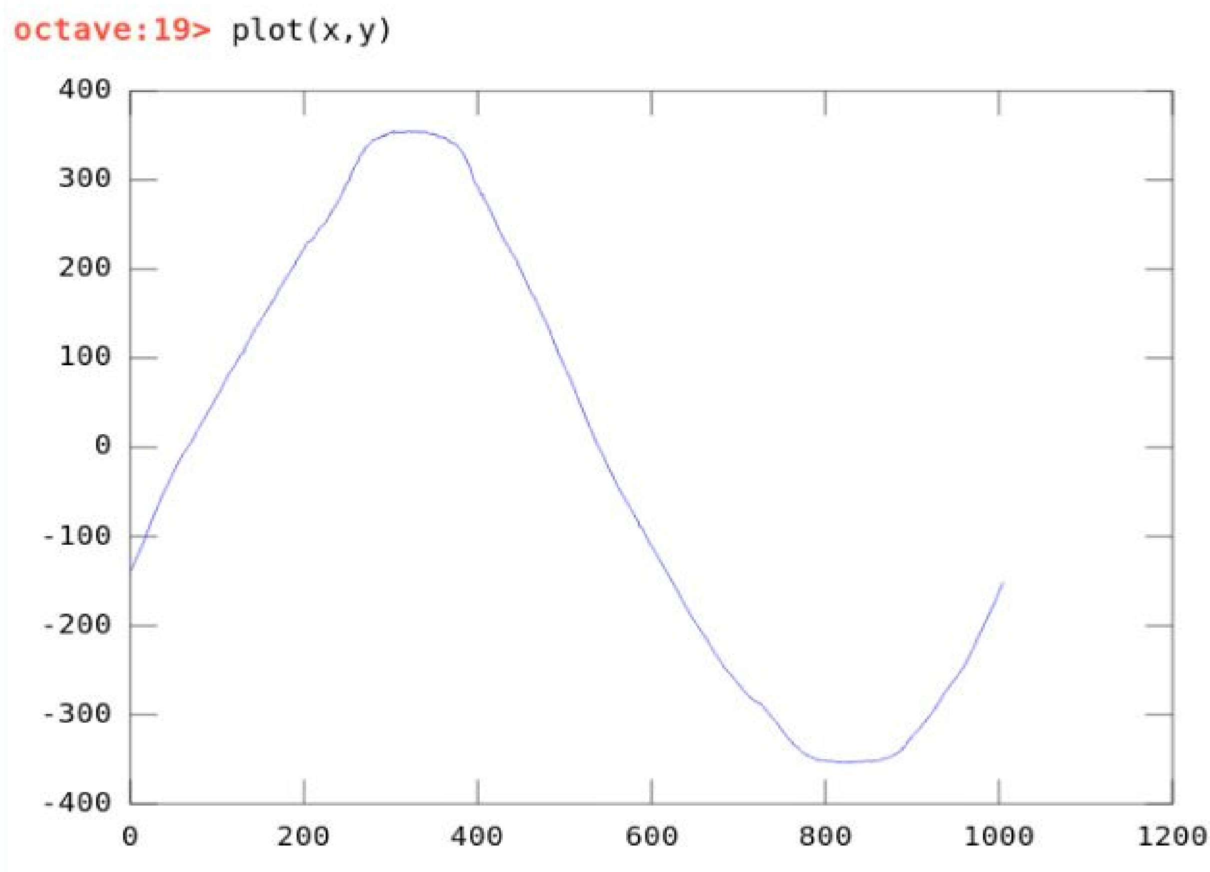
4. Sampling:

Trying out different sampling rates for the voltage and current values, as expected we get a smoother and much predictable graph when the sampling rate is high.

Sampling rate = 505



Sampling rate =1010



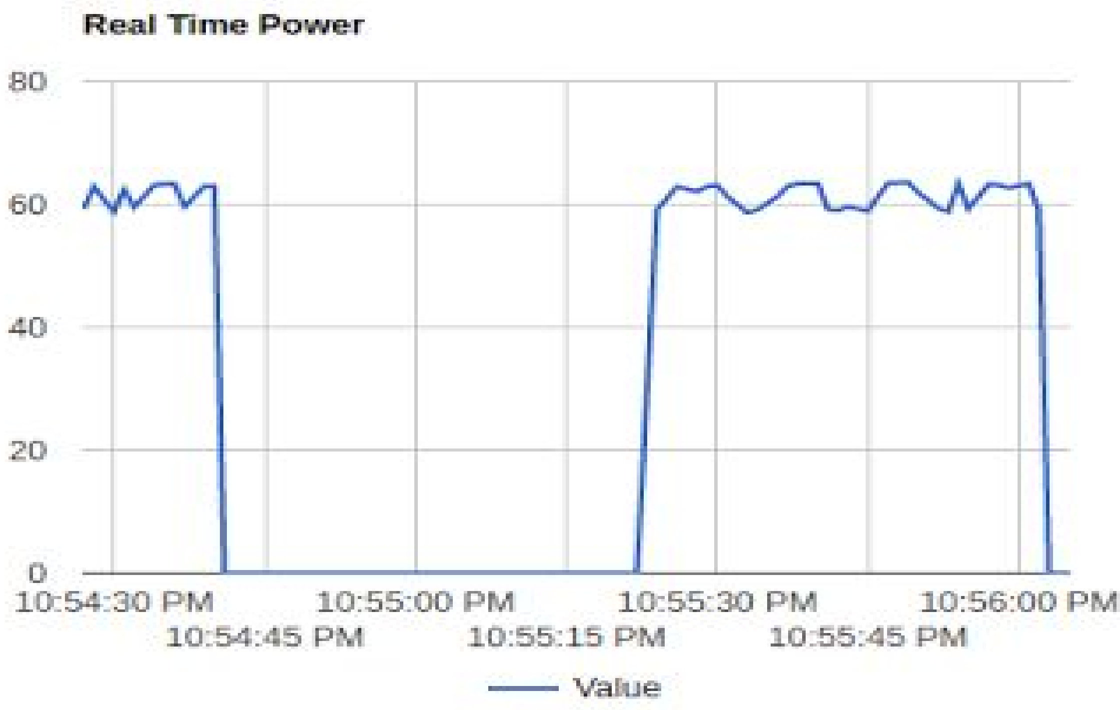
FUTURE SCOPE

1. **Cost alerts:**

   When the total cost of power consumed by an appliance exceeds a given threshold value, user can be alarmed by either adding a GSM module to send an SMS or sending push alerts through the server itself.

2. **Unusual "ON" timings of appliances:**

   This application be visualized as the implementation of a machine learning algorithm which can learn as to when a given appliance is generally in on/off mode. With respect to this, whenever an appliance is switched on during a time period it is generally turned off, the user is alerted.



In the above graph of the power consumed by a bulb in a particular period of time, the machine learning algorithm can be trained to generate an alert if the bulb is turned “ON” for a reasonable time gap around 10:55:00 PM. Similarly the dataset is generalized to all the appliances.

3. Detecting damaged appliances:

When any appliance is damaged, it tends to draw unusually high amounts of power. When this occurs, the sudden peak readings of the power consumed by the appliance can be detected and the user can be alerted.The huge variance of the power suddenly can be detected as failure of appliance.

DATABASE

79	12/07/2017 21:50:16	47.22504
80	12/07/2017 21:50:17	46.15077
81	12/07/2017 21:50:19	51.09074
82	12/07/2017 21:50:20	53.01189
83	12/07/2017 21:50:12	41.71846
84	12/07/2017 21:50:21	55.05124
85	12/07/2017 21:50:23	53.43722
86	12/07/2017 21:50:24	55.66944
87	12/07/2017 21:50:25	54.43418
88	12/07/2017 21:50:27	53.21348
89	12/07/2017 21:50:28	53.187
90	12/07/2017 21:50:29	53.49998
91	12/07/2017 21:50:31	52.90105
92	12/07/2017 21:50:32	49.56144
93	12/07/2017 21:50:34	49.42264
94	12/07/2017 21:50:35	49.02471
95	12/07/2017 21:50:36	0.011982
96	12/07/2017 21:50:37	0.011947
97	12/07/2017 21:50:39	42.38268
98	12/07/2017 21:50:41	42.84491
99	12/07/2017 21:50:43	48.38392
100	12/07/2017 21:50:44	49.42302
101	12/07/2017 21:50:45	52.71339
102	12/07/2017 21:50:47	51.79298
103	12/07/2017 21:50:40	43.76772
104	12/07/2017 21:50:48	53.78624
105	12/07/2017 21:50:50	54.91389
106	12/07/2017 21:50:51	55.33611
107	12/07/2017 21:50:52	55.73165
108	12/07/2017 21:50:54	49.81524
109	12/07/2017 21:50:55	49.59977
110	12/07/2017 21:50:56	50.53087

CONCLUSION

Conservation of energy is one of the most important need of the day. Minimal power consumption is the main design aspect of any appliance. A survey into the power consumed by common domestic loads provides an awareness to the common customers which helps further in energy conservation.

INDIVIDUAL CONTRIBUTION

Circuit Building: Mani Teja,Roshni, Sumanth
Arduino coding: Snehith, Mani Teja,Roshni
Server: Sumanth, Snehith
Interfacing: Snehith
Project theory: Snehith, Mani Teja, Sumanth,Roshni

REFERENCES

1. https://www.elprocus.com/opto-couplers-types-applications/
2. http://www.irf.com/product-info/datasheets/data/irf830.pdf
3. https://www.digikey.com/schemeit/project/
4. http://myelectronichome.altervista.org/blog/en/too-much-current-detector-absorbed-from-the-house-made-with-arduino-and-sct-013-020-or-013-030-sct/?doing_wp_cron=1509538957.9767251014709472656250
5. https://images.google.com/