

IOT Based Automation of Electricity Billing Process

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Abstract:- In the recent years the electricity has become a staple need and steep rise in the demand of electricity has been observed in household with use of different appliances, industries, hospitals and other consumers. An electricity meter is a device that measures the consumption of energy units. The conventional method of electric billing process requires human operators to collect the data by visiting the house of each consumers. This task of collection of data in conventional method of billing is tedious and cumbersome. Human errors are more prevalent to occur during this process of data collection. Consequently, this billing process requires a large working hours and human operators.

The IOT based automation in billing process mitigates the trouble which arises in conventional billing process. In this process the consumption of units of energy is calculated through the pulses which are converted into energy units and further sends it to the server. The camera is installed in front of meter which captures the image and sends it to the server. The user by logging in the server using his unique ID and password can verify his consumption. This automatic billing process enhances the transparency in the billing process. It also reduces the mammoth working hours and decreases human intervention in billing process, thereby increases the accuracy.

Keywords:- Internet of things, Automation, Electricity Billing Process, human intervention, pulse counting circuit, energy meter units calculation, Raspberry pi programming.

I. INTRODUCTION

A. Review

Nowadays, there are a large number of customers in all industries who use electricity but are not satisfied with the services provided by energy distribution companies. Today, an employee of the energy supplier visits each house and takes a photo of the meter, increasing the time taken to take a picture of each home meter reading. All these photos must be handed in at the main office and the meter readings are kept by another employee of the energy suppliers for electricity billing. Manual errors occur throughout this complete billing process. Sometimes, when the door is closed for several months, the average of the meter reading of the previous month is taken as the reading of the electric board, and thus the consumer faces the problem of correcting the bill from the office.

This traditional meter billing technique requires a lot of work for the billing process. Moreover, it requires long working hours to collect complete data and to generate bills^[1]. Sometimes the meter is placed in a place where the reading is not easily accessible and when this data collection is not completed on the first visit and the employee has to visit again. Manual accounting is

sometimes limited and slowed down by weather conditions or various other topographical reasons. A printed bill tends to get lost in the mailbox. Population growth and industrialization in countries like India require huge human operators and long working hours to complete the task of meter reading, which increases the cost of operation of the energy provider for meter reading, hence the concept of Automatic Meter Reading (AMR) is used which is an efficient a means of data collection that enables savings through reduced repeated meter readings, greater data accuracy, enables frequent readings, accurate billing and customer service, long and timely updates of energy profiles and consumption trends, and better deployment of human resources^[2]. AMR is a technique for automatically collecting consumption, diagnostic and status information from energy metering devices and transferring this information to a central database for billing, troubleshooting and analysis purposes.

B. Problem Statement[6]

The Electricity Board has to send an employee to visit each consumer's house to read the electricity meter. Also, due to human errors after receiving a wrong invoice, it is a problem for the user to get it corrected from the electrical board. In such a case, the customer must visit the office, stand in line and get repaired. The problem is only because of human intervention. The tool has to spend so much effort to generate the account. The manual process of electricity billing has the following disadvantages. (i) Sometimes meters are installed in people's homes and if the consumer is not at home, the meter cannot record fortnightly or monthly consumption. (ii) Renting a number of meter readers by utility companies and providing transportation to them is a costly burden on utility budgets. (iii) Dissatisfaction of some customers who consider the entry of meters into their homes as a kind of invasion of their privacy.

To overcome these disadvantages of the traditional meter reading system, efforts are underway worldwide to automate meter reading. In this direction, this project performs meter reading without human intervention.

C. Objectives[6]

- The Process of manual meter reading and billing data entry is automated
- To reduce data collection costs.
- To improve meter reading accuracy.
- To enable faster, more efficient reading times and billing process.
- To improve customer service and enable conservation of resources.

II. LITERATURE SURVEY

Abhinandan Jain [1] represented the development of a fully automatic energy meter with capabilities such as remote monitoring and energy meter controlling. Here the Automatic Meter Reading System (AMR) continuously monitors the energy meter and sends the data through SMS on the request of the service provider. The system allowed customers to pay bills online through credit card, debit card or net banking.

Hopefully, Sudish N Gorge has proposed a system [2] that automatically reads the energy used and sends it to the service provider using existing short messaging services (SMS).

Manisha Shinde and, Pradip Kulkarni have proposed a system [3] of automatic electricity billing by means of capturing meter images after getting command from the server and operate by a ARM microcontroller. The used communication media is ZeegBee and GSM module.

Reference [4] represents the technical specifications of Raspberry Pi 3. The working operations of Raspberry Pi 3 and its interface with external devices have been described here.

Leila F. Rahman [5] represented the tutorial on interfacing of Raspberry Pi with Camera module, where the required applications and a sample programming have been discussed in order to monitor and control the camera.

III. BLOCK DIAGRAM AND HARDWARE CONFIGURATION

A. Block Diagram

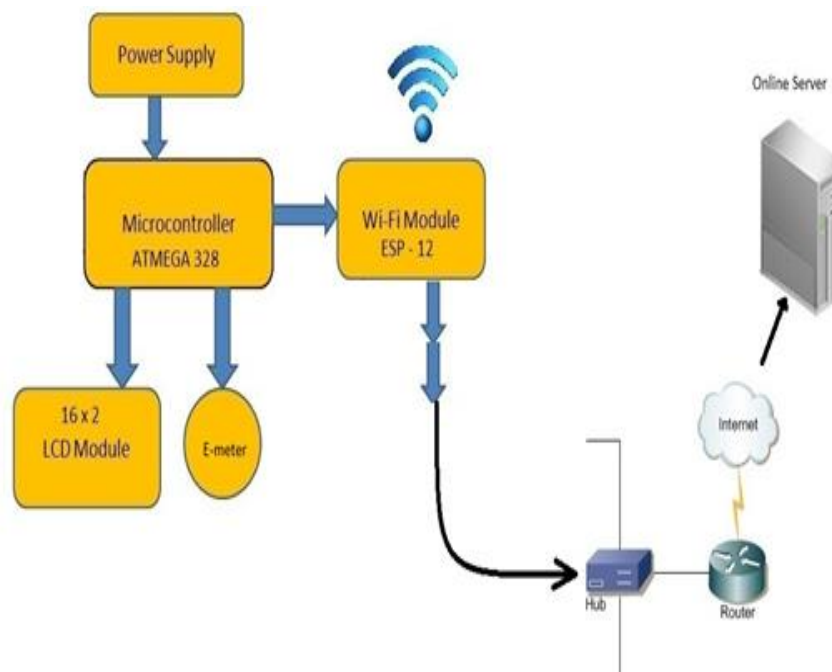


Fig. 1: Block diagram of automatic electricity billing process

B. Hardware components

- Raspberry pi
- Web camera
- LM7805
- Liquid crystal display
- ATmega328P
- Energy Meter
- Wi Fi Module
- Crystal Oscillator

➤ Raspberry Pi 3 Model B[4]

The Raspberry Pi was designed for the Linux operating system. Raspberry Pi is slower than a modern laptop or computer, but it is still a complete Linux computer and can provide all the expected capabilities that come with it, while using very little power. There are two Raspberry Pi models, A and B, which were also released in Model A and Model B. Model A comes with 256MB of RAM and one USB port. It is cheaper and consumes less power than B. Model B with a second USB port, Ethernet port for network communication and 512MB RAM.

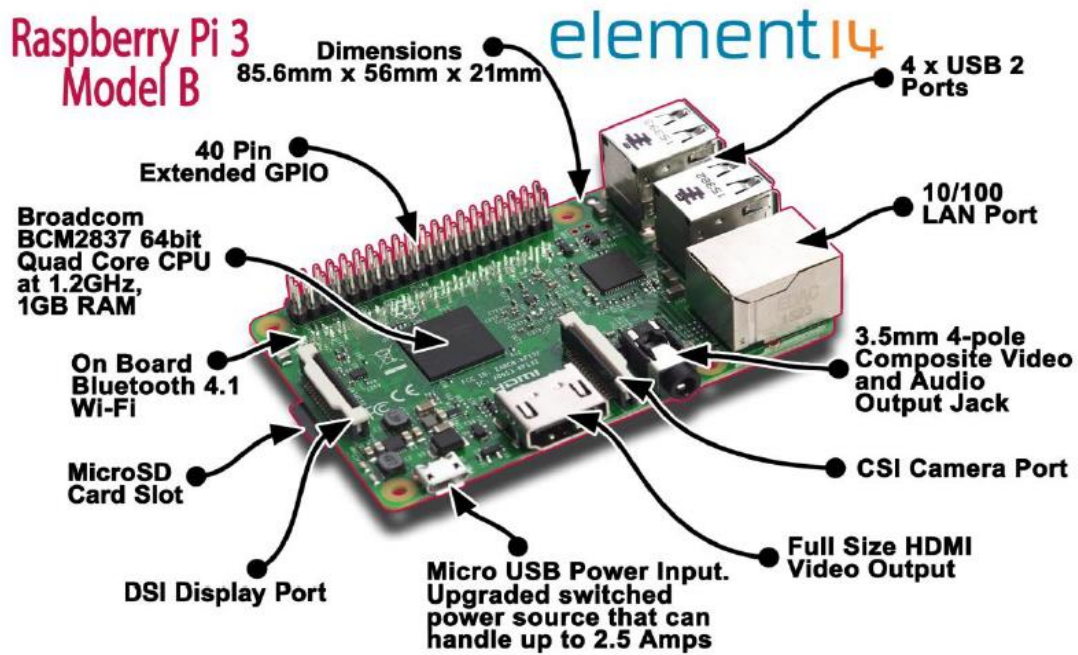


Fig. 2: Raspberry Pi 3 Model B

Raspberry Pi A and B boards have been upgraded to A+ and B+ respectively. These upgrades offer small improvements, especially on the B+, such as more USB ports and improved power consumption. The biggest changes made to the Raspberry Pi 3 are the upgrade to the next-generation core processor and improved connectivity with Bluetooth Low Energy (BLE) and BCM43143 Wi-Fi. In addition, Raspberry Pi 3 has improved power management with an upgraded switching power supply up to 2.5 amps to support more powerful external USB devices.

The Raspberry Pi 3's four built-in USB ports provide enough connectivity for a mouse, keyboard, or anything else your Raspberry Pi needs. Pi 3 performance is about 50-60% faster than Pi 2. It's 10x faster than the original Pi. All connectors are in the same location, have the same function, and the board can be powered from a 5V Micro USB power adapter.

➤ *Web Camera[5]*

A webcam is a digital camera that is connected to your computer. No matter where you are, you can send live images to another location in real time. Here the camera is connected to the Raspberry Pi 3 using a USB cable. And all the image recording operations are controlled by the programmed code installed on the Raspberry Pi. Unlike digital cameras, webcams do not contain memory chips or flash memory cards. It's designed to capture images and send them to your computer instantly, so there's no need to "remember" them. So the webcam USB cable comes out of the back. The USB cable powers the webcam from your computer and returns the digital information captured by the webcam's image sensor to your computer.



Fig 3: Web Camera

➤ *Voltage Regulator 7805 IC[7]*

The voltage source in the circuit may vary and as a result you may not get a constant voltage output. A voltage regulator IC keeps the output voltage constant. The 7805 IC, a voltage regulator integrated circuit (IC), is a member of the 78xx series of fixed linear voltage regulator ICs used to maintain such fluctuations. The xx in 78xx represents the fixed output voltage provided. The 7805 IC provides a +5V regulated power supply and can also add a heatsink. Here are the preliminary ranges:

Input Voltage Range = 7V-35V
 Current Rating = 1A
 Output Voltage Range $V_{max}=5.2v, V_{min}=4.8v$

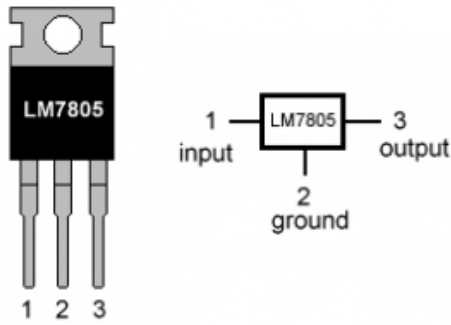


Fig. 4: LM7805 Pinout Diagram

- *Applications of Voltage Regulator 7805 IC*
 - Current regulator
 - Regulated dual supply
 - Building circuits for Phone charger, UPS power supply circuits, portable CD player etc.
 - Fixed output regulator
 - Adjustable output regulator etc.

Table 1: Pin Description of Voltage Regulator

Pin No	Pin	Function	Description
1	Input	Input voltage (7V-35V)	In this pin of the IC positive unregulated voltage is given in regulation.
2	Ground	Ground (0V)	In this pin where the ground is given. This pin is neutral for equally the input and output.
3	Output	Regulated output; 5V (4.8V-5.2V)	The output of the regulated 5V volt is taken out at this pin of the IC regulator.

➤ *ATmega328P[8]*

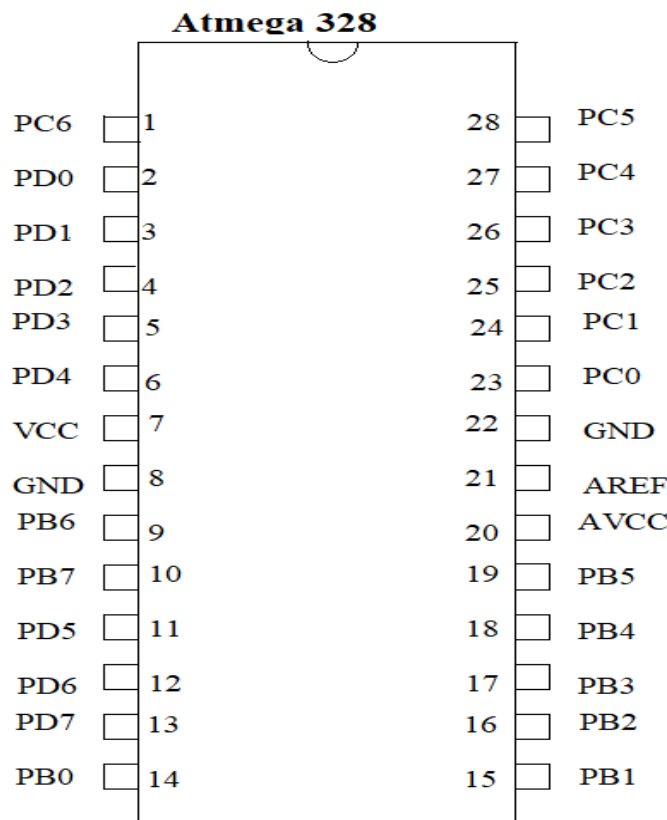


Fig. 5: ATmega328P Pin out Diagram

Atmega328P is a very popular microcontroller chip manufactured by Atmel. The Atmega328 is an upgraded, more advanced chip. Unlike the Atmega168 which has 16K flash program memory and 512 bytes of internal SRAM, the Atmega328P is an 8-bit microcontroller with 32K flash program memory and 2K internal SRAM. Atmega328P has

28 pins. It has 14 digital I/O pins, 6 of which can be used as PWM output and 6 as analog input pins. This I/O pin accounts for pin 20. Pin out for Atmega328P is shown below. The table below gives a description for each pin along with their function.

Table 2: Pin Description of ATmega328P

Pin Number	Description	Function
1	PC6	Reset
2	PD0	Digital Pin (RX)
3	PD1	Digital Pin (TX)
4	PD2	Digital Pin
5	PD3	Digital Pin (PWM)
6	PD4	Digital Pin
7	Vcc	Positive Voltage (Power)
8	GND	Ground
9	XTAL 1	Crystal Oscillator
10	XTAL 2	Crystal Oscillator
11	PD5	Digital Pin (PWM)
12	PD6	Digital Pin (PWM)
13	PD7	Digital Pin
14	PB0	Digital Pin
15	PB1	Digital Pin (PWM)
16	PB2	Digital Pin (PWM)
17	PB3	Digital Pin (PWM)
18	PB4	Digital Pin
19	PB5	Digital Pin
20	AVCC	Positive voltage for ADC (power)
21	AREF	Reference Voltage
22	GND	Ground
23	PC0	Analog Input
24	PC1	Analog Input
25	PC2	Analog Input
26	PC3	Analog Input
27	PC4	Analog Input
28	PC5	Analog Input

20 pins act as I/O ports. This means that they can act as an input or as an output in a circuit. Whether it is input or output is set in software. 14 pins are digital pins, 6 of which can function to provide PWM output. 6 pins are for analog input/output. 2 pins are for crystal oscillator. This is to provide the clock pulse for the Atmega chip. Synchronization requires a clock pulse to enable synchronous communication between the Atmega chip and the device it is connected to. The chip needs power so 2 pins, VCC and GND, give it power so it can work. The ATmega328P is a low-power chip, so it only needs power between 1.8-5.5V to operate.

Inside the ATmega328P chip is an analog-to-digital converter (ADC). This must be otherwise the ATmega328P will not be able to interpret analog signals. Because there is an ADC, the chip can interpret analog input, that's why the chip has 6 pins for analog input. The ADC has 3 pins set

aside for operation – AVCC, AREF and GND. AVCC is the power supply, positive voltage for the ADC. The ADC needs its own power supply to operate. GND is the power supply ground. AREF is the reference voltage that the ADC uses to convert the analog signal to its corresponding digital value. An analog voltage greater than the reference voltage will be assigned a digital value of 1, while an analog voltage below the reference voltage will be assigned a digital value of 0. Because the ADC for the ATmega328P is a 10-bit ADC, that is, it produces a 10-bit digital value, it converts an analog signal to its digital value, with the AREF value being a reference for which the digital values are high or low. Thus, a portrait of the analog signal is shown by this digital value; Thus, it is its digital correspondent value. The last pin is the reset pin. This allows the program to be rerun and restarted.

➤ *Liquid Crystal Display[9].*

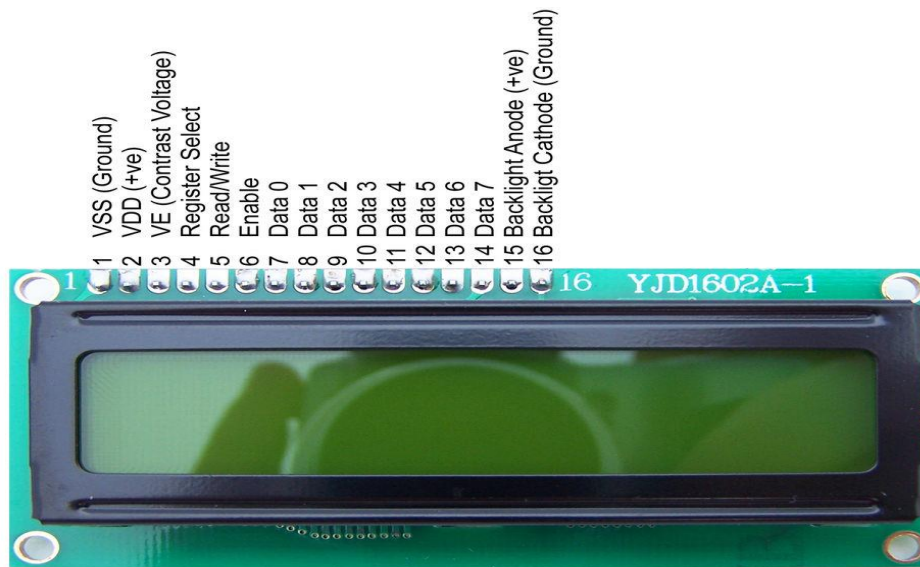


Fig. 6(a): Liquid Crystal Display

LCD can work in two different modes, namely 4-bit mode and 8-bit mode. In 4 bit mode data will be sent nibble by nibble, first upper nibble and then lower nibble. A nibble is a set of four bits, so the lower four bits of a byte (D0-D3) form the lower nibble while the upper four bits of the byte (D4-D7) form the higher nibble. This enables us to send 8 bit data. While in 8 bit mode, 8-bit data is sent

directly in a single stroke because all 8 data lines are used. 8-bit mode is faster and flawless than 4-bit mode. But the main drawback is that it requires 8 data lines connected to the microcontroller. This will exhaust the I/O pins on the MCU, so 4-bit mode is widely used. No control pins are used to set these modes.



Fig. 6(b): Liquid Crystal Display with command and data registers

A 16X2 LCD has two registers, command and data. Register Select is used to switch from one register to another. (Resistor Select) RS=0 for command register, while RS=1 for data register. (i) Command Register: The command register stores the command instructions given to the LCD. A command is an instruction given to the LCD to perform a predefined task such as initializing it, clearing its screen, setting the cursor position, controlling the display, etc. Processing of commands takes place in the command register. (ii) Data Register: The data register stores the data to be displayed on the LCD. Data is the ASCII value of the character to be displayed on the LCD. When we send data to the LCD it goes to the data register and is processed there. When RS=1, the data register is selected.

➤ *Electric Energy Meter*

An electric meter, electric meter, electrical meter, or energy meter is a device that measures the electrical energy consumed by a residence, business, or electrical appliance. Electric utilities use electric meters installed at customers' premises for billing purposes. They are usually calibrated in billing units, the most common being kilowatt hours (kWh). They are usually read once per billing period. When energy savings are desired during a certain period, some meters can measure the demand, the maximum use of power in a certain interval. "Time of day" metering allows electric rates to change over the course of a day, to record consumption during peak high-cost periods and off-peak, low-cost, periods. Also, meters in some areas have relays for demand response load shedding during peak load periods.

Electronic meters display the energy used on an LCD or LED display, and may even transmit some readings to remote locations. Apart from measuring the energy consumed, electronic meters can also record other parameters of load and supply such as instantaneous and

maximum rate of consumption demand, voltage, power factor and reactive power consumed etc. They can also support time billing, for example, recording the amount of energy used during on-peak and off-peak hours.



Fig. 7: Energy Meter

➤ *WiFi Module*

Using ESP 12 as a WiFi module to create a connection to the Internet. The ESP8266 WiFi module is a self-contained SOC with an integrated TCP/IP protocol stack that can give any microcontroller access to a WiFi network. The ESP8266 is capable of either hosting the application or offloading all Wi-Fi networking functions from another application processor. The module comes with AT

command firmware that allows it to have the same functionality as the Arduino WiFi Shield, although it can load different firmwares to build its own applications on the module's memory and processor [11].

This module has an 80 MHz low power 32 bit processor on board which can be used for custom firmware

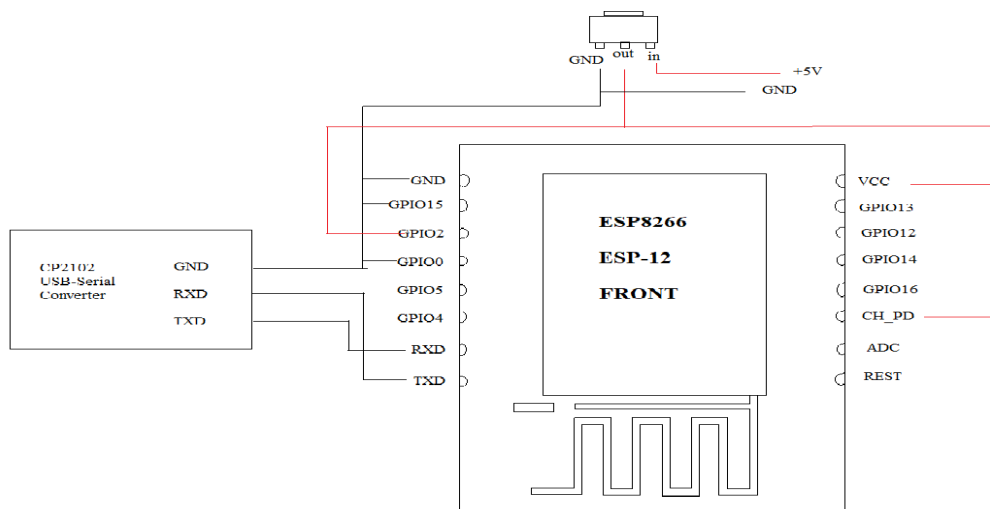


Fig. 8: ESP-12 WiFi Module

To connect a few GPIO pins on the ESP-12 to 3.3V or Ground, to set it in the right mode for communicating with it^[10]. The connections need to make:

- VCC - 3.3V Power supply (Vout of LM1117)
- GND - Ground of power supply
- CH_PD - HIGH (3.3V)
- GPIO2 - HIGH (3.3V)
- GPIO15 - LOW (GND)

GPIO0 - HIGH or Floating for AT Mode (3.3V)

The connections between the CP2102 and ESP-12 are straight-forward.

- CP2102 <-----> ESP-12
- RX<-----> TX
- TX<-----> RX
- GND<-----> GND

IV. OPERATION OF AUTOMATIC ELECTRICITY BILLING

A. Flow Chart (Operation)[1]

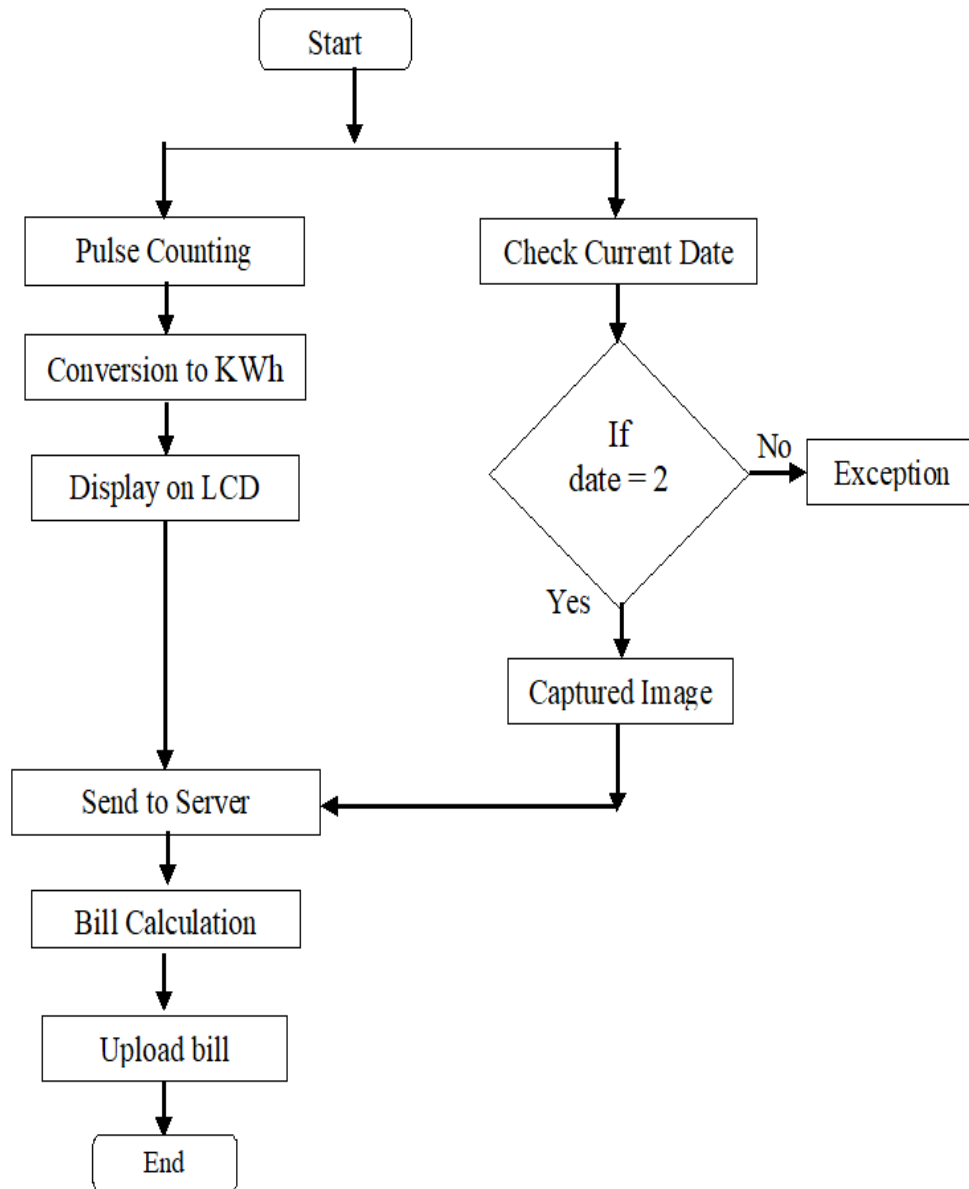


Fig. 9: Flow chart of Automatic Electricity Billing

The whole process of Automatic Billing consists of major three sections namely energy measuring unit, image capturing unit and server unit. The commencement of the billing process initiates with the energy measuring unit. This energy measuring unit involves energy meter and the pulse circuit. The pulse circuit is interfaced with energy meter and value of units of energy consumed is determined with the aid of pulses generated for each unit of energy consumed in energy meter. This data in the form of pulses is collected by virtue of pulse circuit. This pulse circuit interfaced with the energy meter converts the high pulse to low pulse with the help of optocoupler. The optocoupler converts the high pulse to light signal which can be observed in the circuit. The light signal which was primarily a high pulse is further converted into a low pulse signal. A low pulse signal is given to the microcontroller at pin 6. The microcontroller continuously counts the pulses

received from the optocoupler. The number of pulses generated is displayed on a display installed in the circuit. This data is sent to server after the prescribed time gets completed.

Meanwhile during the completion of prescribed time there is an occurrence of another unit simultaneously with the previous unit. This unit is image capturing unit and it involves two components i.e., camera and raspberry pi. A camera is placed in front of the energy meter and positioned so that an image of the reading can be clearly captured. The camera requires a signal for its operation of capturing the snapshot of the readings in energy meter. Moreover, it is desired that the snapshot of readings to be taken after the particular time interval and at the precise moment expected. The energy meter shows the readings of various parameters along with the units of energy

consumed. This makes it necessary for camera to take a snapshot at the moment when the energy meter shows the reading of the unit consumed. The raspberry pi which is interfaced with energy meter caters this desire. The raspberry pi primarily performs two main operations. Firstly, it gives the signal to camera to take the snapshot after the prescribed time interval and at the particular moment when meter shows the reading of energy consumed. The raspberry pi accomplishes this task with the aid of the programme which is installed in it. The burning of programme takes place at the time of installation after which it follows the instruction incorporated in it. Now the image captured has to be sent to the server has to send to the server so that the user can assess the image. The Raspberry Pi sends the captured image to the server. Both data is sent to the server in the form of pulses and images. Data on the server can be evaluated by both the utility and the consumer. Based on the current tariff rate the utility works such that units of energy consumed, cost of energy consumed will be displayed in the server. The consumer also has the access to the image of the reading in the uploaded images section in the server. Each consumer has its unique ID and password. The consumer now can easily see the energy consumed, cost and image at the server^[12].

B. Meter Billing Calculations[12]

The meter is always connected to the microcontroller through a flashing pulse in the meter. Also, it is calculated based on the pulse flash period, using this principle we have calculated per unit and accordingly what charge will be taken per unit. After a power of 0.3125 watts, the Meter LED (calibration) blinks. If we use a 100 watt bulb for one minute, the pulse flashes 5.2 times per minute. This can be calculated using the given formula.

Pulse= (Pulse speed per meter* watt * 60) / (1000 * 3600)
 If the pulse rate of meter is 3200 imp/kWh and watt used is 100, we have
 Pulse = (3200 * 100 * 60) / (1000 * 3600)
 Pulse = 5.333333333 per minute
 If 5.333333333 pulses occur per minute pulses will appear in an hour.
 Pulse = 5.333333333* 60
 Pulse = ~320
 ~320 Pulses will occur in an hour
 So, a 100 watt bulb consumes 100 watts of electricity in an hour and burns for almost 320 pulses.
 Now we can calculate the electrical energy consumed per pulse in watts
 One pulse (watt) = 100/320
 One Pulse (watt) = 0.3125
 A pulse of 0.3125 watts of electricity is consumed.
 Now Units
 Unit = (energy per pulse (electricity))* pulse/ 1000 although
 One pulse = 0.3125 watts
 Pulses per 10 hours = 3200
 Then there will be a calculation for unit
 Unit = (0.3125 * 3200)/1000
 Unit = 1
 That is, one unit in 10 hours for a 100 watt bulb.
 Now assume that the price per unit rate is 7 rupees
 There will be a charge per pulse
 Pure pulse cost = (7 * energy consumed per pulse) / 1000
 pulse value = (7 * 0.3125) / 1000
 Price per pulse = 0.0021875 Rupees

V. CIRCUIT DIAGRAM DESCRIPTION

A. Working^[3]

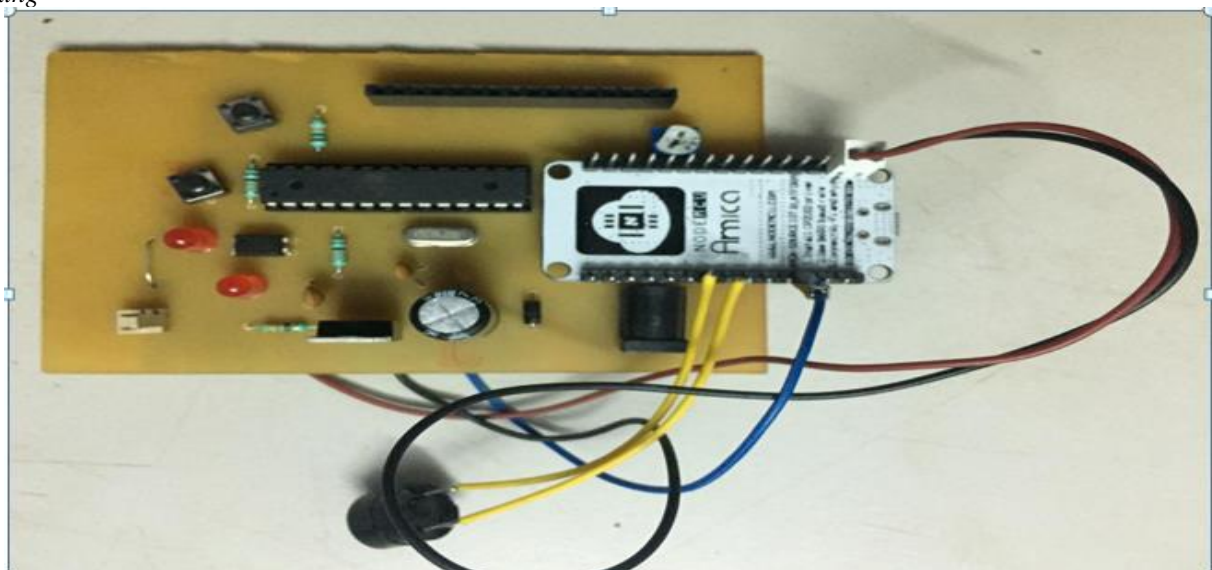


Fig. 10: Circuit diagram of automatic electricity billing

The LCD will be used to show the operations performed by the microcontroller and Node MCU.

- We are going to use the 9 volt as the input power supply for the circuit but our circuit needs 5 Volt supply so we are going to use 7805 voltage regulator IC and that IC will convert that 9 volt supply to 5 Volt.
- This 5 volt supply will be given to all the sensors LCD and the microcontroller and complete system runs onto that power supply. We have interfaced the microcontroller with a 16X2 LCD and its purpose is to show all the operations to the user so that the user knows what the current process is running. And we need 6 pins to interface the microcontroller with LCD and along with them power supply will be provided to the LCD. We can adjust the Brightness of the LCD using the 5K Ohm potentiometer.
- ATmega328 will be interfaced with display meter.
- Node MCU and the Microcontroller communication will be done on the serial pins and the rate of communication will be 9600 bits per second.
- We will send data to the Node MCU on the transmit pin.
- Transmit pin of the Node MCU will receive the signal from the ATmega328. And it keeps on checking for the “%” symbol as it gets that symbol it determine there is incoming data from the micron roller.
- “%” symbol we mentioned in above statement is to avoid the reception of the unwanted signals and we have to make Node MCU alert when we are going to send data so we send data from Microcontroller with “%” symbol at the start and even Node MCU identifies the incoming data from that symbol.
- So there will never be false data detection and all readings will get accepted accurately
- Node MCU is already has created connection with the nearest Wi-Fi hotspot. And using that hotspot data will be sent to the server.
- For sending data GET requests are used same as the Web Pages does that while sending data from one page to another.
- We have a PHP file which is going to accept data continuously from the Node MCU and that data will be added into the data base.
- Database queries are used to collect the data we will also note down the time stamp when data is sent so that will create logs of data.
- Now all the readings are present inside the database.
- We have created web page using the PHP and the HTML that will keep the data posted on the web page.

B. Web portal Functionality

Web portal will be having Twofunctionalities

- *Adding user*
- *Checking Bill*
- *Database:*
In database we will be having user information and reading for that user.
- *Adding user:*
In order to manage any user via web portal we should have that user entry in Web portal. So we will create one login form and we will gather all details. Web portal will be having the login for the electricity board authority. They can login with the credentials and check the bills for selected user.
- *Checking Bill:*
Once logged in all users will be listed and any user can be picked up for readings we have to give month and user so we generate bill for that month and show it on web portal.

VI. METHODOLOGY, COSTING AND RATING OF COMPONENTS

A. Methodology

The project consist of following sections i.e.

- *System overview*
- *Operation of automatic electricity billing*
- *System Overview*
The whole system of IoT based automatic billing process can be divided into three executive categories. These categories are:
 - Energy measuring unit
 - Image capturing unit
 - Server Unit
- *Operation of Automatic Electricity Billing*
In IoT based Automation in billing process the system involves the use of web camera, pulse circuit, Raspberry Pi. The camera is incorporated in the often for capturing the images at the prescribed interval of time. The images obtained will be sent to the server. Pulse circuit is used for the purpose of measurement of pulses. The measured pulses gives the amount of energy consumption. This pulse circuit interfaced with the energy meter gives the data regarding the consumption of unit of energy. The Raspberry Pi accomplished primarily two functions. Firstly, it gives signal to the camera to take the snapshot of the energy meter at the predefined moment. Secondly, Raspberry Pi is send the image captured at the predefined moment to the server.

B. Rating and costing of components

➤ Pulse counting circuit components:

Table 3: Pulse counting circuit components

Sr. No	Components	Ratings	Costings
1	Printed Circuit Board (PCB)	-	500
2	Connecting Wires	-	20
3	Soldering Wires	-	50
4	Resister	330 Ω	20
5	Capacitors	470 μ F 25 V, 104 μ F	20
6	Crystal Oscillator	KDS16.000 MHz	30
7	Push Button type Switches	Current Rating – 50 A Withstand Voltage – AC 250 V Rated Load – DC 12 V, 50 mA	10
8	Liquid Crystal Display	16 \times 2 Display 5 \times 7 Pixel Matrix	130
9	Energy Meter	1 Phase, 2 Wire, 240 V, 50 Hz Static Multifunction KWh Meter 3200 Imp / kWh	1500
10	Adapter and Adapter Jack	9V, 1A	130
11	Wi Fi Module	ESP8266 Wi Fi Module	340
12	Regulator	LM7805 Input voltage : 7-35 V Current : 1A Output Voltage : 5V	11
13	Diode	IN1407	1
14	ATmega328P	CPU type Performance Flash memory Max. Operating Frequency Operating Voltage EEPROM SRAM	8 – bit AVR 20 MIPS 32 Kb 20 MHz 1.8 - 5.5 V 1 KB 2 KB
Price			2927

➤ Raspberry Pi Model B

Table 4: Raspberry Pi Model B

Processor	Broadcom BCM2387 chipset, 1.2 GHz Quad-Core
Memory Card Slot	Push / Pull Micro SDIO
GPU	400MHz Video Core IV
RAM	1 GB SDRAM
Storage	Micro-SD
Ethernet	10 / 100 Base T Ethernet Socket
Video Output	HDMI / Composite
Audio Output	HDMI / Headphone
Operating System	Linux
Dimensions	85 \times 56 \times 17 mm
Power	Micro USB Socket 5V, 2.5 A
Camera Connector	15 pin MIPI Camera Serial Interface
Price	3500

➤ Web Camera

Table 5: Web Camera

Image Sensor	High quality COMS Sensor
Image Resolution	25 mega pixels
Image Control	Color saturation
Anti – Flicker	50hz, 60hz or outdoor
Image Quality	RGB24 or 1420
Exposure	Auto or Manual
Angle Of View	58°
Interface	USB 2.0
Frame Rate	30 fps (MAX)
Lens	f = 6.0 and F = 2.0
Night Vision	6 bright lights switch on through switch
Focus Range	4 cm to infinity
System Requirement	Win XP, Win Vista, Win 7, Win 8, Win 10
Price	615

VII. SOFTWARE AND PROGRAMMING

Arduino programs are used to write in any programming language with a compiler concept that produces executable binary machine code. Atmel improves this environment for proposed systems microcontrollers, AVR Studio and the new Atmel Studio. Arduino development using projects with IDE is useful for beginners of any programming languages. The Arduino programmer is known as Sketch. The Arduino library is most useful for adding many ready-made predefined inputs to a project. It supports C and C++ using specially organized code. A typical Arduino C/CC++ sketch consists of two functions that are compiled and linked to the program stub main() in an executable cyclic executable program.

Advanced IP Scanner software is used to get IP Address of Raspberry Pi network. VNC Scanner is used for login in Raspberry Pi as well as to get command to Raspberry Pi. Circuit wizard is a revolutionary new system that combines circuit design, PCB design and simulation in one complete package.

A. ATmega 328

```
#include <SoftwareSerial.h>
#include <LiquidCrystal.h>
#include <EEPROM.h>
LiquidCrystal lcd(8, 9, 10, 11, 12, 13);
#define INTERRUPT_INPUT 2
int pulse_counter = 0, false_pulse=1;
int count = 0;
float amount_per = 0;
float meter_reading = 0, meter_cost = 0;
int Exit=0;
int a,b,c,d=0;
const int EEPROM_Erase= A0;
const int Meter_connect= 2;
int buttonState = 0;
void setup()
{
  Serial.begin(9600);
  while (!Serial) {
    ;
  }
  pinMode(EEPROM_Erase, INPUT_PULLUP);
```

```
lcd.begin(16, 2);
lcd.print(" Smart Energy ");
lcd.setCursor(0, 1);
lcd.print(" Meter System");
  Exit=0;
while(Exit<40)
  {
  buttonState = digitalRead(EEPROM_Erase);
  if (buttonState == LOW)
  {
  lcd.clear();
  lcd.print("Erasing EEPROM...");
  Serial.println("Erasing EEPROM...");
  a=0;b=0;c=0;d=0;
  EEPROM.write(1, a);delay(10);
  EEPROM.write(2, b);delay(10);
  EEPROM.write(3, c);delay(10);
  EEPROM.write(4, d);delay(10);
  delay(3000);
  Exit=50;
  }
  Exit++;
  delay(100);
  }
  a = EEPROM.read(1);
  b = EEPROM.read(2);
  c = EEPROM.read(3);
  d = EEPROM.read(4);
  Serial.print(a);Serial.print(b);Serial.print(c);Serial.print(d);
  Serial.println();
  pulse_counter=((a*1000)+(b*100)+(c*10)+(d));
  meter_reading=(pulse_counter*0.3125);
  amount_per=(meter_reading/1000);
  meter_cost=(amount_per*7);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Pulse Count:");
  lcd.setCursor(0, 1);
  lcd.print(pulse_counter);
  delay(2000);
  pinMode(Meter_connect, INPUT);
  //digitalWrite(Meter_connect, HIGH);
  false_pulse=0;
```

```

}
void loop()
{
lcd.setCursor(0, 0);
lcd.print("Reading:");
lcd.print(meter_reading,2);
lcd.print("wh ");
lcd.setCursor(0, 1);
lcd.print("Cost:");
lcd.print(meter_cost,4);
lcd.print("Rs ");
  a=((pulse_counter/1000)% 10);
  b=((pulse_counter/100)% 10);
  c=((pulse_counter/10)% 10);
  d=(pulse_counter% 10);
EEPROM.write(1, a);delay(10);
EEPROM.write(2, b);delay(10);
EEPROM.write(3, c);delay(10);
EEPROM.write(4, d);delay(10);
Serial.print(a);Serial.print(b);Serial.print(c);Serial.print(d);
Serial.println();
delay(1000);
buttonState = digitalRead(Meter_connect);
  while(buttonState==HIGH)
  {
buttonState = digitalRead(Meter_connect);
  }
  if(buttonState==LOW)
  {
pulse_counter++;
meter_reading=(0.3125+ meter_reading);
amount_per=(meter_reading/1000);
meter_cost=(amount_per*7);
  }
String data = "";
  data+="% ";
  data+=a;
  data+=b;
  data+=c;
  data+=d;
  data+="@ ";
  data+="1 ";
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Sending data..");
Serial.println(data);
delay(1000);
  data = "";
}

```

B. Raspberry pi

```

#from poster.encode import multipart_encode

#from poster.streaminghttp import register_openers

import urllib2
import requests
import time
import RPi.GPIO as GPIO
import datetime
import time
import datetime
import time

```

```

import urllib2
import requests
import time
import cv2, sys, numpy, os
import io
ramp_frames = 5 #The number of frames to shoot when the
camera is adjusted to the light level
size = 4
path = "capture"
now = datetime.datetime.now()
def capture():
  webcam = cv2.VideoCapture(0)
  for x in range(5):
    (rval, frame) = webcam.read()
time.sleep(0.0001);
  frame=cv2.flip(frame,1,0)
  t = str(time.time())
  file = "capture/"+t+".jpg"
  cv2.imwrite(file, frame)
  files = {'myimage':open(file, 'r')}
  r = "";
  try:
    # Create the Request object

#https://testmap.000webhostapp.com/emeterrasp/upload_back.php
    r =
requests.post("https://testmap.000webhostapp.com/emeterrasp/upload_back.php", files=files)
    # r = requests.post("https://rightful-tick.000webhostapp.com/WSUS/upload_back.php", files=files)
    # Actually execute the request and get the response
    a = (r.text[0:1500])
    print(a)
time.sleep(0.01)
  except:
    print("expection")
print("Connection Error");
time.sleep(2)
def request():
  r = "";
  try:
    print(now.day)
    a = now.day
    if(a==19):
      print("capture");
capture()
time.sleep(4)
capture()
time.sleep(4)
capture()
time.sleep(4)
capture()
time.sleep(20000)
  except:
    print("expection")
if __name__ == '__main__':
  try:
    while True:
      request()
      print("request")

```

```
time.sleep(1)
except KeyboardInterrupt:
GPIO.cleanup()
```

VIII. PROBLEM FACED

Initially while designing the automatic billing process image processing was being incorporated in it. The camera installed in front of energy meter would take the snapshot and send it to the server. This image captured would be proceeded and the number in the image would be produced but with the advent of new digital meters the image processing become an inevitable challenge. The processing of digital numbers is quite cumbersome as it involved the complex operations of truth table.

As the image processing posed a problem in digital meter, this propelled the need for other alternative means, the pulses measurement turned out to be the effective mean to cater this problem. This task of pulse measurement required designing of pulse circuit. The circuit has to be designed in eagle software which required assistance of the experts in it.

Soldering which was desired in the circuit is much fine as compared to the general soldering as the distance between the pins of microcontroller and other components is less. The fine soldering requires the help of some experts for some of the quite critical positions.

While pressing the reset push button which enables the erasing of EPROM, does not operate properly. The function of reset button is to make the pulse count zero but the phenomenon of key debouncing occurs which makes this task of resetting difficult. In the key debouncing phenomenon the metal plate which completes the circuit is contacted at different area every time it is pressed, which

leads to variation of generation of pulses magnitude. This difference in the magnitude of pulses makes the resetting difficult. When low pulse is being generated then the resetting problem is evolved.

IX. ADVANTAGES AND DISADVANTAGES

A. Advantages

- It offers a paperless mode of transaction which is also environmentally friendly and clutter free for both receiver and sender of electronic billing.
- Real time bill monitoring.
- Cost effective system.
- Online billing services are one of the least expensive forms of billing compared to traditional billing.
- Electronic billing services are customer friendly and also beneficial for the bill generators as the focus is on the process rather than the mode of bill dispatch.
- Electronic billing also provides a huge advantage of saving time and effort that is usually lost in a traditional billing systems. Also, there is no loss of bills while using electronic mode of billing.

B. Disadvantages

- Complex System.
- Data based handling is difficult.

C. Applications

- Residential and Commercial buildings in a public energy supply systems
- Municipal Corporation
- Government Energy Plant
- Public Power Sources
- Maharashtra State Electricity Distribution Company Limited

X. OBSERVATION

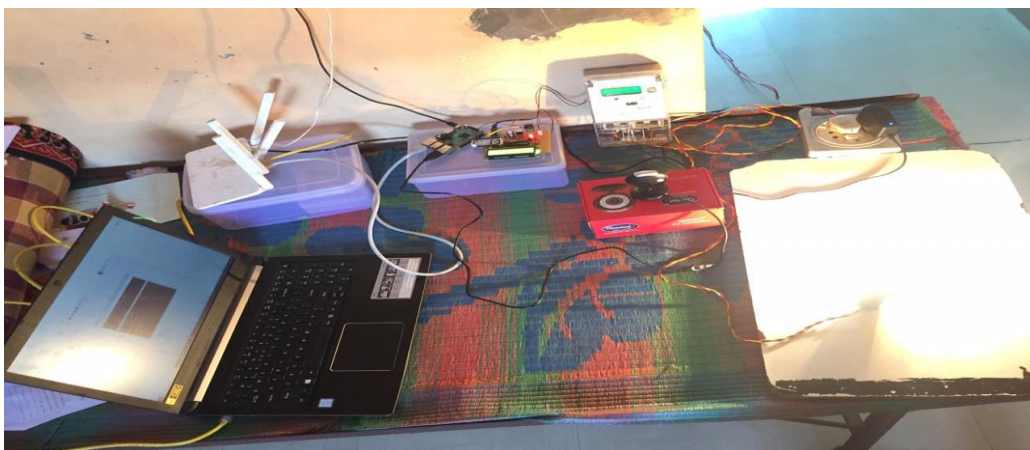


Fig. 11: Project set up

Actions are taken to validate the proposed project. A 200W lamp was used as a load and five measurements were taken at 3 minute intervals. Pulse rate is converted to Wh

units. These units are multiplied by the relevant tariff rate to calculate the cost of electricity. The whole process runs automatically.

An observation table for the same is shown below:

Sr. no	Pulse	Wh	Bill (₹)	Time Interval (Minute)
1	19	5.94	0.04158	3
2	36	11.25	0.07875	6
3	53	16.56	0.11375	9
4	69	21.56	0.14875	12
5	85	26.56	0.18375	15

A. Calculation:

1Kwh = 3200 pulses
 1 pulse = 1000/3200 wh
 One Pulse (watt) = 0.3125 wh
 (1) For 3 minutes pulses are 19
 Wh = 0.3125*19
 Wh=5.9375wh
 Single pulse cost = (7 * single pulse energy consumption) / 1000
 Single pulse cost = (7 * 0.3125) / 1000
 Single pulse cost = 0.0021875 rupees
 For 19 pulse cost = (7 * 5.9375) / 1000
 For 19 pulse cost = 0.4158 Rupee
 (2) For 6 minutes pulses are 36
 Wh = 0.3125*36
 Wh = 11.25wh
 Single pulse cost = (7 * single pulse energy consumption) / 1000
 Single pulse cost = (7 * 0.3125) / 1000
 Single pulse cost = 0.0021875 rupees
 For 19 pulse cost = (7 * 11.25) / 1000
 For 19 pulse cost = 0.07875 Rupee

XI. FUTURE SCOPE

This project is primarily to provide the general infrastructure of energy meters used in smart city concepts. A major development in the future is that energy meter reading, tamper detection technology, connection and disconnection, and early notification to users will all be done via WiFi. In the future, we plan to create several Wi-Fi hotspots in each area that will set 4-5 parameters to which all energy meters will be connected and monitored. And the overall improved information provided to the energy meter makes it easier for utilities. In the future, we will also have some standard programs or standard tools that will make things easier for people. And connecting and disconnecting all meters, both paid and non-paid, will be faster compared to the current methods.

XII. CONCLUSION

This report describes the basic structure, system design, operation and operation of an IOT-based automated electricity billing process. In addition, basic block diagrams, flowcharts and related system components are also provided. The report presents the calculations which acts as a witness of enhancement in the accuracy and reduction in the required time. Based on the results obtained and which are being presented in the report, it can be concluded that this

system of automatic billing reduction in time required on contrary to the conventional billing process is achieved in leaps and bounds. This system has proved to be one of the effective means of billing process as it reduces human intervention involved in the data collection and consequently eradicating the human errors, thereby increasing accuracy. In this report process of image uploading is also explained as this image renders help in bestowing the faith of customers. The transparency of the billing process, which is extensively desired by the customer is satisfied by the system.

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