IOT Based Prepaid Power Meter Billing Via SMS and Android

Introduction

Electricity is one of the vital requirements for sustainment of comforts of life. It should be used very judiciously for its proper utilization. But in our country, we have lot of localities where we have surplus supply for the electricity while many areas do not even have access to it. Our policies of its distribution are also partially responsible for this because we are still not able to correctly estimate our exact requirements and still power theft is prevailing. On the other hand, consumers are also not satisfied with the services of power companies. Most of the time they have complaints regarding statistical errors in their monthly bills.

Thus, we are trying to present an idea towards the minimization of technical errors and to reduce human dependency at the same time. With the help of this project, we are aiming to receive the monthly energy consumption from a remote location directly to a centralized office. In this way we can reduce human efforts needed to record the meter readings which are till now recorded by visiting every home individually. This results in considerable loss of human hours and also provides considerable details regarding the average consumption of a locality so that power supply can be made according to these data. This will help the officials in deciding the specifications of transformers and other instruments required in power transmission. This idea is economically efficient as well because we can get the meter reading at a very low cost. The implementation is done in such a way that a SMS is delivered to the Modem whose reading is to be noted and then that meter replies to the server in the SMS format.

The purpose of this project is to remote monitoring and control of the Domestic Energy meter. This system enables the Electricity Department to read the meter readings regularly without the person visiting each house. This can be achieved using Microcontroller unit that continuously monitors and records the Energy Meter readings in its permanent memory location. This system also makes use of a GSM modem for remote monitoring and control of Energy Meter. The Microcontroller based system continuously records the readings and the live meter reading can be sent to the Electricity department on request. This system also can be used to disconnect the power supply to the house in case of non-payment of electricity bills. A dedicated GSM modem with SIM card is required for each energy meter. This project takes the advantage of available GSM infrastructure nationwide coverage and the Short Messaging System (SMS) cell broadcasting feature to request and retrieve individual houses and building power consumption reading back to the energy provider wirelessly.

LITERATURE REVIEW

General Introduction

A literature survey is a fundamental practice, to understand and develop an idea. A literature survey not only summarizes the knowledge of the area or field but also gives us an idea of what had to be done. In the following section, we discuss the issues and works related to problems of the existing traditional meter reading system and its applications in several sectors.

Literature Survey

To overcome the problems of the existing traditional meter reading system, efforts are underway around the world to automate the meter reading systems and to provide comprehensive information to the consumer for efficient use of utilities. Researchers have proposed different implementation techniques for AMR [1]. One is the SMS-based Reconfigurable Prepaid Meter Reading System which uses the GSM network for sending the Meter data [2]. The other technique is secure and scalable automated reading system which uses the existing local ISPs instead of requiring its own proprietary set communication infrastructure. The gateway node basically consists of an embedded microprocessor system, based on embedded Linux, and a modem. The remote real time automatic reading system employs distributed structure based on wireless sensor networks which consists of measure units, sensor nodes, data collectors, server and wireless communication network.

Prepaid Energy Meter using GSM Module [3] To minimize the power cuts and to distribute the energy equally to all areas, some restriction should have over the power consumption of every energy consumer, and according to that the Government should implement a policy, by introducing Autonomous Energy Meters everywhere in domestic sector. Hence, the need has come to think on this line and a solution must be emerged out the author elaborates these issues and solution towards this.

Design and Implementation of an Efficient Smart Digital Energy Meter [4] The author elaborates issues related to energy meter while some people use energy meter on purpose, others are ignorant that someone else is using some of the electricity they are paying for. A new technique that will significantly cut down on the quantity of electricity used is being developed to stop this excessive use of electricity.

Detecting anomalous activities in spatio-temporal region anomaly [5] This paper elaborates detection system using Machine Learning helps to detect the anomalies like accidents etc. Detecting anomalies in videos is important but it is an unsolved problem. This system will automatically detect the anomaly by image analysis from the surveillance videos. This system is capable of tracking abnormal event in each frame and generates a notification of such event. The proposed K-means algorithm performs existing anomaly detection techniques, while being comparatively time efficient.

Managing the keys for security reasons [6]: Security in different area is an important aspect incurrent scenario in the today's internet era. As the today's communication there are different mechanisms is available for sending huge data. So, data security is important in the current scenario. The need of security and robustness in the use is increasing and it is the current demand with the ease from the user side. The main two mechanism used for the image data security are cryptography and steganography.

A comparative analysis of secret sharing schemes with special reference to e-commerce applications [7] In many applications, particularly in Group Communication, there is a need to hide secret data like passwords, encryption key, recipes etc. Here, efficient key management protocols are required to provide security for group's secret data, because it is very challenging to provide security especially when group of more members and those members are present in different locations with diverse mechanisms of protection. One among them is Secret Sharing Schemes (SSS) which allow to split and share the group's secret among group members. The data shared by energy meter also need to implemented using above technique.

Enhanced cipher text-policy attribute-based encryption and serialization on media cloud data [8] This paper uses the Cipher text-Policy Attribute-Based Encryption (CP-ABE) technique with proper access control policy which is used to provide the data owner's control and share the data through encryption process in Cloud and IoT environment. The data are shared with the help of cloud storage, even in presence of authorized users. The main method used in this research is Enhanced CP-ABE Serialization (E-CP-ABES) approach.

The above-discussed papers presented us with a broad perspective on how to tackle what we have aimed for and gave us the different possible approaches to follow to build our project i.e., IOT Based Prepaid Power Meter Billing.

Problem Statement and Objectives

Problem Statement

Now a days, the energy consumption and energy distribution has become a big subject for discussion because of huge difference in energy production and consumption. In this regard, energy consumers are facing so many problems due to the frequent power failures; another important reason for power cuts is due to the un-limited energy consumption of rich people. In this aspect, to minimize the power cuts and to distribute the energy equally to all areas, some restriction should have over the power consumption of every energy consumer, and according to that the Government should implement a policy, by introducing Autonomous Energy Meters everywhere in domestic sector. Hence, the need has come to think on this line and a solution has to be emerged out.

Objectives

Microcontroller unit that continuously monitors and records the Energy Meter readings in its permanent memory location. This system also makes use of a GSM modem for remote monitoring and control of Energy Meter. The Microcontroller based system continuously records the readings and the live meter reading can be sent to the Electricity department on request. This system also can be used to disconnect the power supply to the house in case of non-payment of electricity bills. A dedicated GSM modem with SIM card is required for each energy meter. This project takes the advantage of available GSM infrastructure nationwide coverage and the Short Messaging System (SMS) cell broadcasting feature to request and retrieve individual houses and building power consumption reading back to the energy provider wirelessly.

Methodology

Prepaid metering system is the one in which the consumer pays money in advance to the utility and then feeds this information into his meter. The meter then updates the credit available to the consumer and starts deducting his consumption from available credit. Once the credit reaches a minimum specified value, meter raises an alarm. If the credit is completely exhausted, the meter switches off the loads of the consumer. Due to the intelligence built into the electronic meters, introduction of prepaid metering becomes much easier than in the case of electromechanical meters. The project has an electric meter which will work and a GSM modem which is the latest technology used for communication between MODEM and embedded systems. The modem will send a message as and when desired to the electricity officials through the Subscriber Identity Module inserted inside the MODEM.

Working of Block Diagram

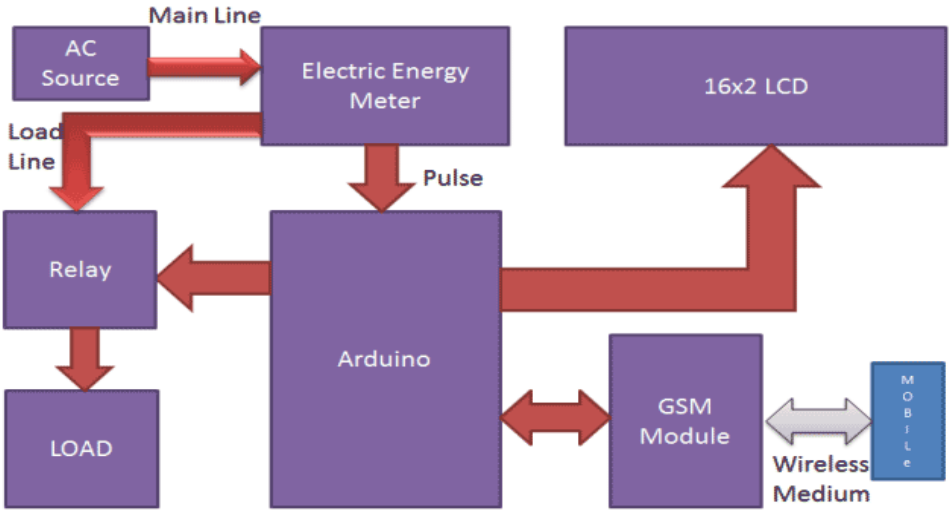


Figure.1 Block Diagram of project

Figure.1 represents the Working of Block Diagram here we have interfaced electricity energy meter with Arduino using the pulse LED (Calibration or Cal) of electricity Energy meter. We only need to connect this CAL LED to Arduino through an Optocoupler IC. When we power up the system then it reads previous values of rupees stored in EEPROM and restores them into the variables then checks the available balance with the predefined value and act according to them, like if available balance is greater than 15 rupees then Arduino turns ON the electricity of home or office by using relay. And if the balance is less than 15 rupees then Arduino sends an SMS to the user phone regarding low balance alert and requesting to recharge soon. And if balance is less than 5 rupees then Arduino turns OFF the electricity connection of home and sends an SMS to user's phone for 'Light Cut' alert and requesting to recharge soon. GSM module has been used to send and receive messages. Now when we need to recharge our system, we can recharge it simply by sending an SMS to the system, through our Cellphone. Like if we want to recharge it for 45 bucks. then we will send #45*, here # and * are prefix and suffix to the recharge amount. System receives this message and extract recharge amount and updates the balance of system. And the system again turns on the electricity of the house or office. This flow of working can be understood through the video at the end.

The Components used are • Arduino • GSM Module • 16x2 LCD • Analogue Electricity Energy Meter • Optocoupler 4n35 • Resistors • POT • Connecting wires • Bulb and holder • SIM card • Power supply • Mobile Phone.

Circuit Description

Figure 2 represents the Circuit connections for this Wireless Electricity Meter Reading Project, are shown in the diagram; we have used a Arduino UNO for processing all the things used in project. A liquid crystal display is used for displaying the status of Units and remaining balance. Data pins of LCD namely RS, EN, D4, D5, D6, D7 are connected to Arduino digital pin number 7, 6, 5, 4, 3, 2. And Rx and Tx pins of GSM module are directly connected to the Tx and Rx pins of Arduino respectively. And GSM module is powered by using a 12-volt adaptor. Relays are used for switching electricity connection which is connected at pin 11

and 12 of Arduino.

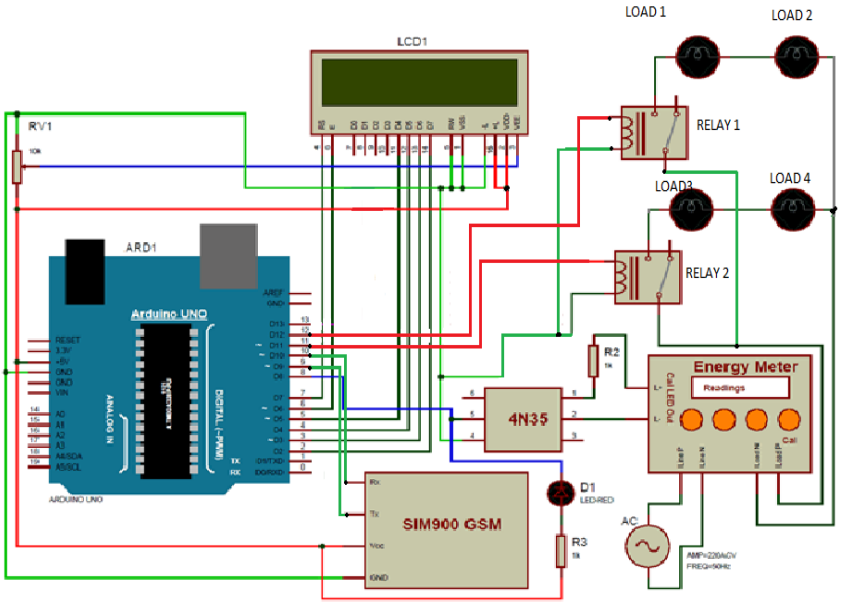


Figure.2 Circuit Diagram of the project

Connecting the Energy Meter with Arduino

Users need to buy an Analog Electricity Energy Meter. After its user needs to open it and find the Pulse LED or Cal LED's terminals (cathode and Anode). Now solder two wires at both the terminals and take it out from the energy meter and then close the energy meter and tighten the screws.

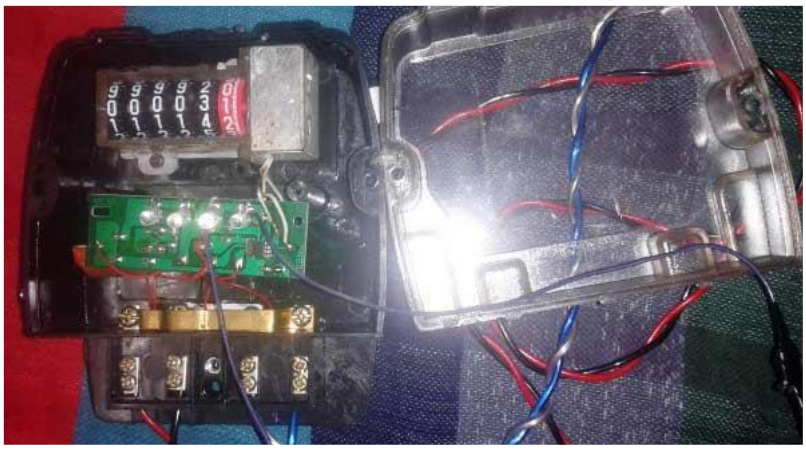


Figure.3 Connect Energy Meter with Arduino

Figure.3 shows the components present in the Electric power meter. For LED blink condition we must take connection from the first LED of Electric meter.

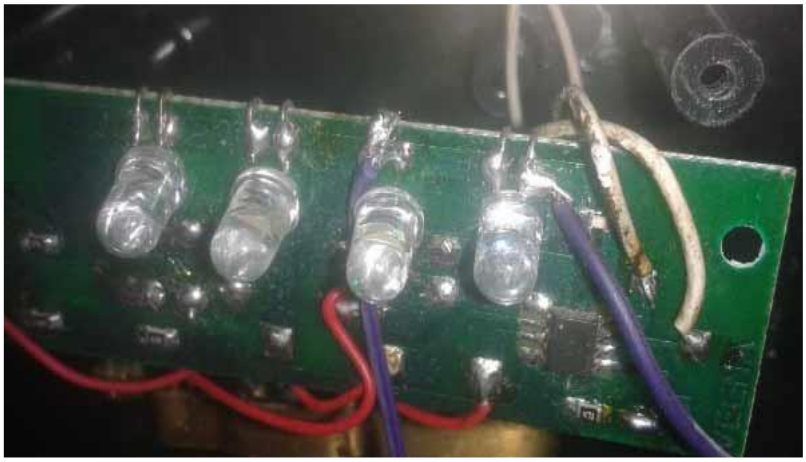


Figure.4 Connect Energy Meter with Arduino

Now user needs to connect anode terminal of LED at pin number 1 of Optocoupler and cathode terminal to pin 2 as shown in figure.4. Pin number four of Opto couper should be directly connected to ground. An LED and a Pull-up resistor are connected at pin number 5 of optocoupler. And the same terminal should go to the Arduino pin 8 too. Connection with LED, Optocoupler and Resister is shown in figure.5.

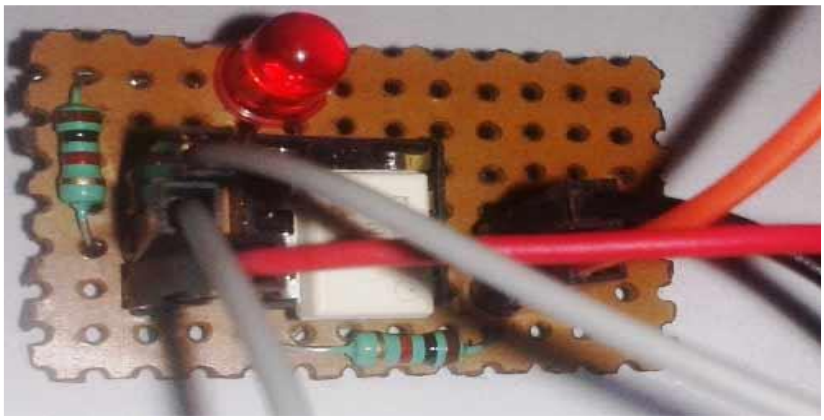


Figure.5 Connection with LED, Optocoupler and Resister

Calculation of Pulses and Units

Before proceeding for the calculations, first we must keep in mind the pulse rate of energy meter. There are two pulse rates of energy meter first is 1600 imp/kwh and second is 3200 imp/kwh. So here we are using 3200 imp/kwh pulse rate energy meter. So, first we need to calculate the Pulses for 100watt, means how many times the Pulse LED will blink in a minute, for the load of 100 watts.

Pulse= (Pluse_rate*watt*time)/ (1000*3600)

So pulses for 100 watt bulb in 60 seconds, with energy meter of 3200 imp/kwh pulse rate can be calculated as below:

Pulses=3200*100*60/1000*3600

Pulses = ~5.33 pulse per minute Now we need to calculate Power factor of a single pulse, means how much electricity

will be consumed in one pulse:

PF= watt/(hour*Pulse)

PF=100/60*5.33 PF=0.3125 watt in a single pulse Units= PF*Total pulse/1000

Total pulses in an hour is around 5.33*60=320

Units = 0.3125*320/1000

Units = 0.1 per hour If a 100 watt bulb is lighting for a day then it will consume

Units =0.1*24 Units = 2.4 Units And suppose unit rate is at your region is 3 rupees per unit then

You must pay for 2.4 Units Rs: Rupees= 2.4*3 = 7.2 rupees

Programing Explanation

First of all, we include required library and Define pins & variables that are required in our project. This can be seen in the first few lines of our program code below. After it we initialize the LCD, serial communication, GSM and display some messages. After this loop function we read serial received data if any. And reads pulse from energy meter and show units and balance on LCD.

```
void setup()
{
lcd.begin(16,2);
Serial.begin(9600);
pinMode(led, OUTPUT);
.. ...
... ....
lcd.print("AKNV");
lcd.setCursor(0,1);
delay(2000);
```

After this in loop function we read serial received data if any. And reads pulse from energy meter and show units and balance on LCD.

```
void loop()
{
serialEvent();
rupees=EEPROM.read(1);
units=rupees/3.0;
lcd.setCursor(0,0);
lcd.print("Units:");
```

void init_sms(), void send_data(String message), and void send_sms() functions have been used to send SMS.

```
void check_status()
{
if(rupees>15)
{
digitalWrite(relay1, HIGH);
digitalWrite(relay2, HIGH);
flag1=0;
flag1=0;
```

send_confirmaiton_sms() function is used for sending confirmation message to the user if recharge has been done and it also update the balance in the system. decode_message() function is used for decoding the amount figure from the SMS message, by using the # and * as starting and ending character. read_pulse() function is used for reading pulse from the Energy meter through optocoupler IC. And update the unit and balance.

Experimental setup

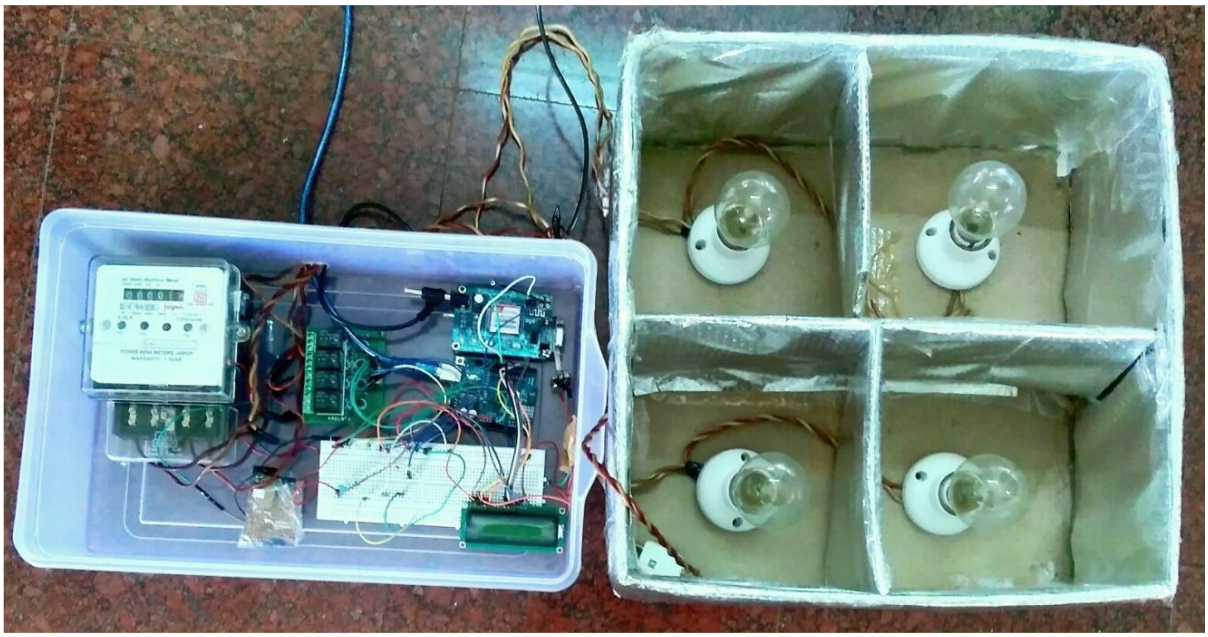


Figure.6 Experimental setup

The figure.6 is the Experimental Setup of complete project. Which contains all connection as shown in circuit diagram as well as Block diagram.

FLOW CHART

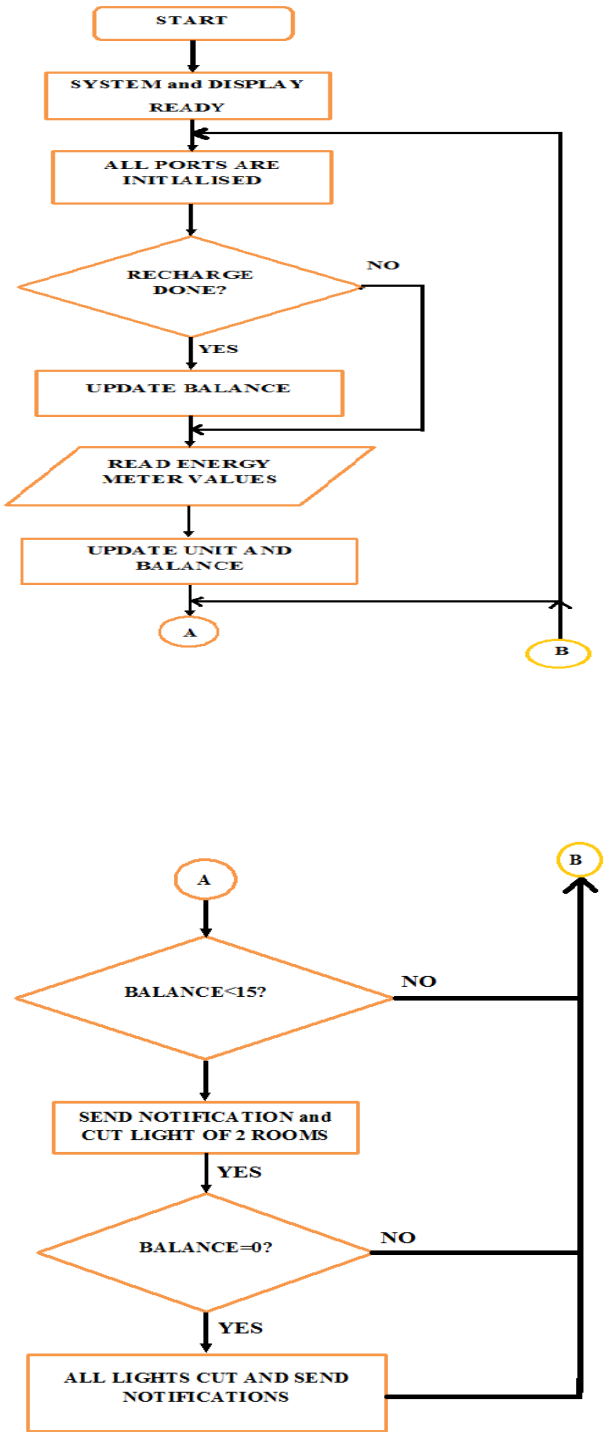


Figure.7 Flow Chart of the project

Figure.7 represents the flow chart of the project indicating in step by step.

Hardware and software specification

Technical Specification of Arduino UNO

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz

Table 1 Arduino UNO Specification

Specification of android studio

Version 2.x

Criterion	Description
OS version	Windows 7 or later Mac OS X 10.9.5 or later GNOME or KDE desktop
RAM	3 GB RAM minimum, 8 GB RAM recommended; plus 1 GB for the Android Emulator
Disk space	500 MB disk space for Android Studio, at least 1.5 GB for Android SDK, emulator system images, and caches
Java version	Java Development Kit (JDK) 8
Screen resolution	1280x800 minimum screen resolution

Table.2 Specification of Andriod Studio

Version 2.x

Criterion	Description
OS version	Windows 7 or later Mac OS X 10.9.5 or later GNOME or KDE desktop
RAM	3 GB RAM minimum, 8 GB RAM recommended; plus 1 GB for the Android Emulator
Disk space	500 MB disk space for Android Studio, at least 1.5 GB for Android SDK, emulator system images, and caches
Java version	Java Development Kit (JDK) 8
Screen resolution	1280x800 minimum screen resolution

Table.3 Description of Android Studio with JDK

Result analysis

The code is compiled in ARDUINO IDE software and Result of working is displayed in 16*2 LCD display all were shown here.

Figure.8 Heading of project is displayed

Figure.9 Group name is displayed.

Figure.10 When System is ready SYSTEM READY is displayed

Figure.11 Current Unit is 10 and Balance is 30

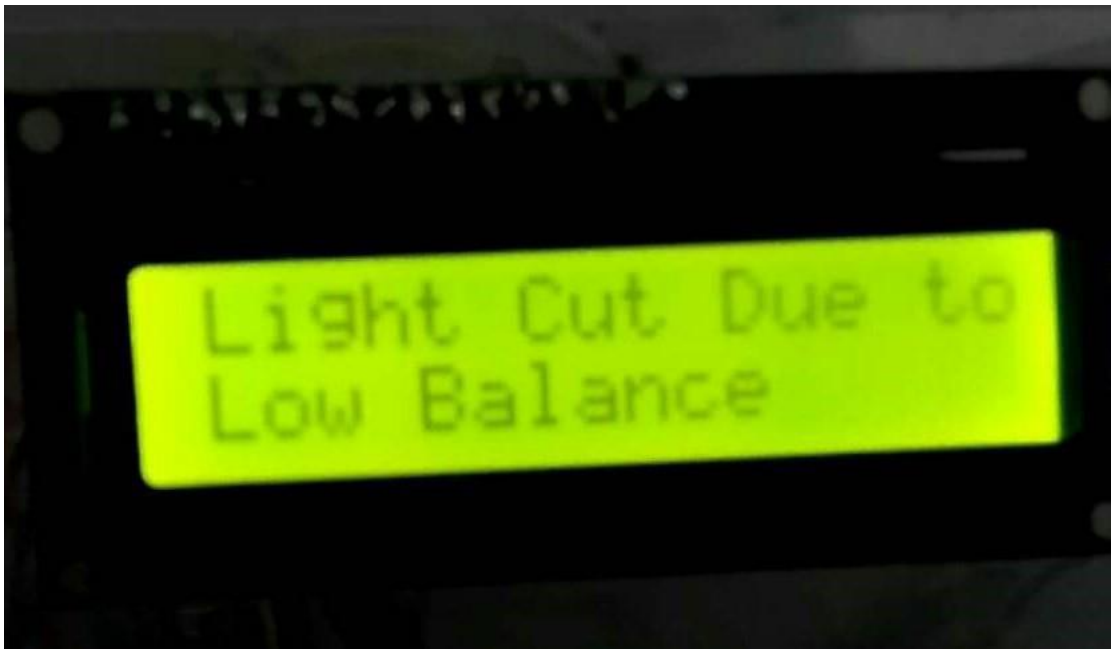


Figure.12 Light is cut when balance is below 15 Rupees

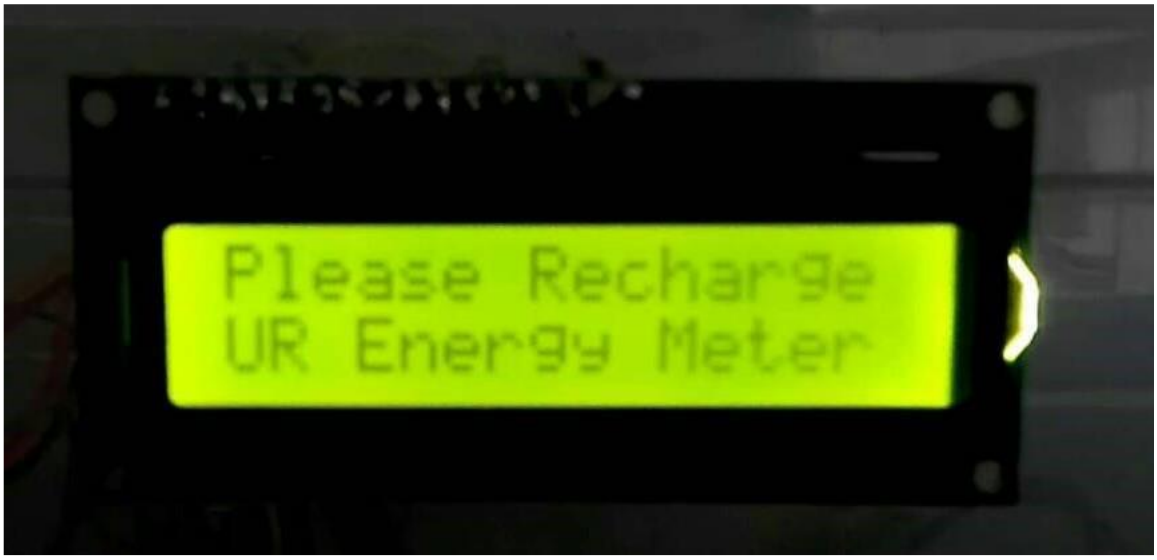


Figure.13 Recharging indication

Figure.14 When Units and Balance is Zero

Figure.15 Recharge Received

Figure.16 Energy meter Recharged by 30 rupees.

Figure.17 Recharge when Balance is above 15.

Figure.18 After Recharging 15 Rupees, Balance is 48

Alert messages in Mobile phones

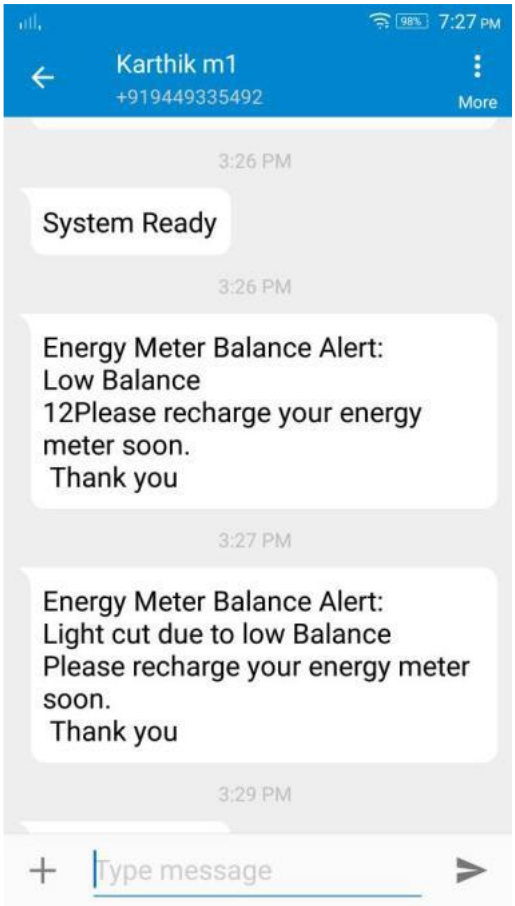


Figure.19 SMS Alerts on Mobile phone

Recharging in Android app

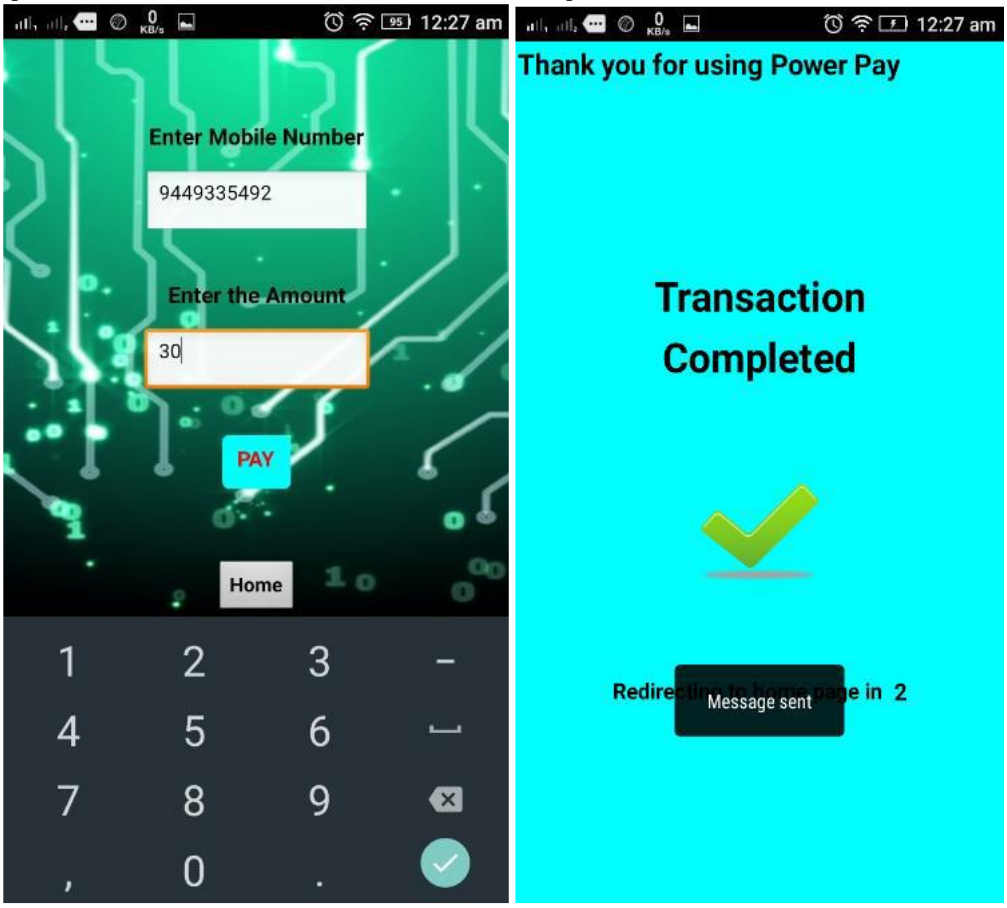
Step 1

Android app first window

Step 2

Second Window

Step 3 Step 4



Entering mobile number and Amount Message sent

Figure.20 Android App layout and Working

Applications and advantages

Applications

• The power providing company can easily access house electric bills remotely from their office.
• The electric bills are sent to their respective house owner by sending message to their mobile number every month.
• If the subscriber fails to pay the bill in time, then power to the house will be cut remotely from the office.
• Using this technology electric office can handle electric bills of many houses from an office.
• The subscriber gets updated electric bills by message in their mobile every month the owner is present in the home or not.

Advantages

• The subscriber gets electric bills update every month.
• The subscriber can pay their bill amount by using their valid bank account number from any place by sending message.
• The power to the house will be cut off from office in case of failure of paying the bills.
• As soon as the bills are paid power to the house will be given without any delay.
• The subscriber will get the detailed bill of the house like meter reading as well as the amount to be paid.

Future Scope and Conclusion

Future Scope

In the present time of 21st century we have no space for errors or faults either in any technical system or in general applications. Prepaid energy meter is an advantages concept for the further. It's facilitating the exemption from electricity bills. Electricity coupons will be available at nearby shops. The word prepaid means "pay before use" one of the advantageous features of this concept prepaid energy meter is used to prepay the ongoing supply of electricity to homes, offices etc.

Conclusion

Using this GSM based community electric module, we can monitor many energies meter in a colony and keep a tab of their reading and consumption.

- Accessing of electric bills will become much easier with much more added features.
- The use of GSM based billing machine is going to revolutionize in near future to.
- The only disadvantage in this concept is the meter used in houses should be digital and network problem of GSM technology.

With the available resource, we are able to demonstrate the working of GSM module successfully.

REFERENCES

[1]. Pradko, “Programming and Customizing the 8051 Microcontroller “, TMH Publications, 2008.

[2]. Designing Embedded Hardware By John Catsoulis, Publisher: O'Reilly Pub Date: May 2005 ISBN: 0-596-00755-8 Pages: 400.

[3]. Kumarsagar M.Dange et al. “Prepaid Energy Meter using GSM Module” International Journal of Engineering Science Invention ISSN (Online): 2319 6734, ISSN (Print): 2319 – 672 ||Volume 6 Issue 2|| February 2017 || PP. 80-85www.ijesi.org.

[4]. Dipta Paul, et.al “Design and Implementation of an Efficient Smart Digital Energy Meter” International Journal of Soft Computing and Engineering (IJSCE)ISSN: 2231-2307 (Online), Volume-13 Issue-1, March 2023.

[5]. H. Manoj T. Gadiyar, et al. “DETECTING ANOMALOUS ACTIVITIES IN SPATIO-TEMPORAL REGION” in International Journal of Engineering Applied Sciences and Technology(IJEAST), Vol. 6, Issue 1, ISSN No. 2455-2143, Pages 441-444, Published Online during May 2021.

[6]. R. Mohan Naik and S. V. Sathyanarayana, “Key management infrastructure in cloud computing environment-a survey,”ACCENTS Transactions on Information Security, vol. 2, no. 7,pp. 52–61, 2017.

[7]. Shalini, I. S., R. Mohan Naik, and S. V. Dr. "Sathyanarayana “A Comparative Analysis of Secret Sharing Schemes with Special Reference to e-Commerce Applications,”." International Conference on Emerging Research in Electronics, Computer Science and Technology (IEEE). 2015.

[8]. R., M.N., Gadiyar, H.M.T., M., S.S., Bharathrajkumar, M. and K., S.T. (2022), "Enhanced cipher text-policy attribute-based encryption and serialization on media cloud data", International Journal of Pervasive Computing and Communications, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/IJPCC-06-2022-0223