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A Basic Overview of Prepaid Energy Meter

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***Abstract*: The aim of this project is to minimize the queue at the electricity billing counters and to restrict the usage of electricity automatically, if the bill is not paid. The project also aims at proposing a system that will reduce the loss of power and revenue due to power thefts and other illegal activities. The work system adopts a totally new concept of "Prepaid Electricity". The GSM technology is used so that the consumer would receive messages about the consumption of power (in watts) and if it reaches the minimum amount, it would automatically alert the consumer to recharge. This technology holds good for all electricity distribution companies, private communities, IT parks and self-containing housing projects. The implementation of this project will help in better energy management, conservation of energy and also in doing away with the unnecessary hassles over incorrect billing. The automated billing system will keep track of the real time consumption and will leave little scope for disagreement on consumption and billing.**

***Keywords*: Arduino, Energy meter, GPRS, Potentiometer, Relay.**

1. Introduction

Now a days it is very hectic job for everybody to pay electricity bills on time. If you don't pay those bills on time then you must need to pay some amount of fine. Sometimes people go out of their houses for few weeks or for few months but still they need to pay their electricity bills without using any kind of it. GSM technology is used so that the consumer would receive messages about the consumption of power (in watts) and if it reaches the minimum amount, it would automatically alert the consumer to recharge. This technology holds good for all electricity distribution companies, private communities, IT parks and self-containing housing projects. The development of GSM infrastructure in past two decades made meter reading system wireless. The GSM infrastructure, which has national wide coverage, can be used to request and retrieve power consumption notification over individual houses and flats. Apart from making readings using GSM communication, billing system is needed to be made prepaid to avoid unnecessary usage of power. It replaces traditional meter reading methods and enables remote access of existing energy meter by the energy provider. Also they can monitor the meter readings regularly without the person visiting each house.

2. Hardware requirement

A. Energy Meter (Analog)

Analog meters also known as electromechanical are the most common, the simple meter spins forward when your using electricity. If the analog meter is bidirectional it will spin backwards when your solar electric system is pushing extra electricity back into the grid. The number of times the disc spins forward or backwards determines how much electricity you are using or contributing to the electric grid. The utility company must dispatch a meter reader every month to figure out how much energy your building is using.

Energy= Watt * Time

Fig. 1. Analog energy meter

B. Arduino Uno

It is Arduino is an open source microcontroller which can be easily programmed, erased and reprogrammed at any instant of time. Introduced in 2005 the Arduino platform was designed to provide an inexpensive and easy way for hobbyists, students and professionals to create devices that interact with their environment using sensors and actuators. Based on simple microcontroller boards, it is an open source computing platform that is used for constructing and programming electronic devices. It is also capable of acting as a mini computer just like other microcontrollers by taking inputs and controlling the outputs for a variety of electronics devices. It is also capable of receiving and sending information over the internet with the help of various Arduino shields, which are discussed in this paper. Arduino uses a hardware known as the Arduino development board and software for developing the code

known as the Arduino IDE (Integrated Development Environment). Built up with the 8-bit Atmel AVR microcontroller's that are manufactured by Atmel or a 32-bit Atmel ARM, these microcontrollers can be programmed easily using the C or C++ language in the Arduino IDE. Unlike the other microcontroller boards in India, the Arduino boards entered the electronic market only a couple of years ago, and were restricted to small scale projects only.

Fig. 2. Arduino Uno

C. 16 X 2 LCD Module

LCD module is used to observe the total output energy from the energy meter in an accurate digital numeric value.

Fig. 3. 16 X 2 LCD Module

D. GSM Module

GSM/GPRS module is used to establish communication between a computer and a GSM-GPRS system. Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. Global Packet Radio Service (GPRS) is an extension of GSM that enables higher data transmission rate. GSM/GPRS module consists of a GSM/GPRS modem assembled together with power supply circuit and communication interfaces (like RS-232, USB, etc.) for computer. GSM/GPRS MODEM is a class of wireless MODEM devices that are designed for communication of a computer with the GSM and GPRS network. It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. Also they have IMEI (International Mobile Equipment Identity) number similar to mobile phones for their identification. A GSM/GPRS MODEM can perform the following operations:

1. Receive, send or delete SMS messages in a SIM.
2. Read, add, search phonebook entries of the SIM.
3. Make, Receive, or reject a voice call.

Fig. 4. GSM module

E. Potentiometer

It is used to vary the resistance value very easily. The Potentiometer rating is 10K.

Fig. 5. Potentiometer

F. Opto-coupler (4N35)

It contains LED on one side and a photo transistor is present on the other side. It is a protection device from high voltage.

Fig. 6. Opto-coupler

G. Relay

It is used to make or break the circuit.

Fig. 7. Relay

H. ULN 2003(16-pin IC)

It is used to drive the relay properly.

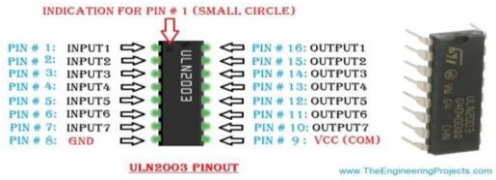

Fig. 8. ULN 2003

I. Power Supply (12 Volt)

It is used to provide constant output voltage.

Fig. 9. 12 Volt power supply

3. Software requirement

As per it is an Arduino based project here we used an Arduino UNO R3 developing board for creating our software base for our prepaid energy meter. So here we are explaining step by

step details to use our software.

Step-1: Here Arduino UNO software has been used.

Fig. 10. Arduino 1.6.4 software interface

Step-2: First we need to select the Board type and Port type from the tools.

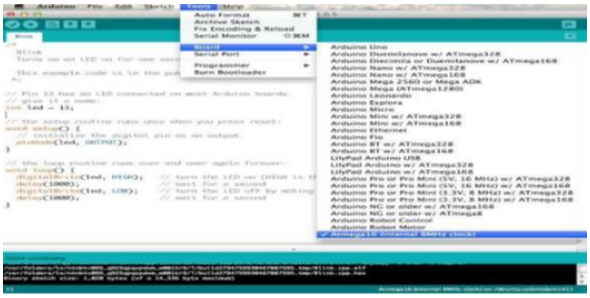

Fig. 11. Tools setting window of Arduino 1.6.4 software

Step-3: Now check all your required specifications on the programming panel.

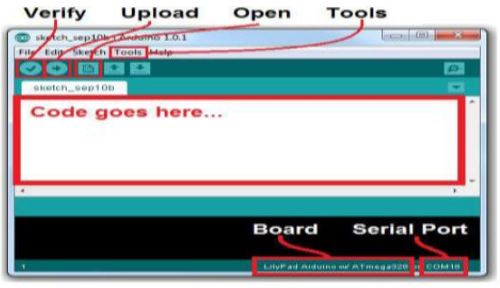

Fig. 12. Specification checking window of Arduino 1.6.4 software

Step-4: Now put your required program and upload it on your Arduino Board.

Fig. 13. Programming window of Arduino 1.6.4 software

4. Pseudo code of Arduino programme

```
#include<EEPROM.h>
#include <LiquidCrystal.h>
  LiquidCrystallcd(7,6,5,4,3,2);
  int led=13;
  #define pulsein 8
  #define relay 12
  unsignedintpusle_count=0;
  float units=0;
  unsignedint rupees=0;
  floatwatt_factor=0.3125;
  unsignedint temp=0,i=0,x=0,k=0;
  charstr[70],flag1=0,flag2=0;
  String bal="";
  void setup()
  {
  lcd.begin(16,2);
  Serial.begin(9600);
  pinMode(led, OUTPUT);
  pinMode(pulsein, INPUT);
  pinMode(relay, OUTPUT);
  digitalWrite(pulsein, HIGH);
  lcd.setCursor(0,0);
  lcd.print("Prepaid Energy");
  lcd.setCursor(0,1);
  lcd.print(" Meter ");
  delay(2000);
  lcd.clear();
  lcd.print("EE-A Batch-1");
  delay(2000);
  lcd.clear();
  lcd.print("GSM Initilizing...");
  gsm_init();
  lcd.clear();
  lcd.print("System Ready");
  Serial.println("AT+CNMI=2,2,0,0,0");
  init_sms();
  send_data("System Ready");
  send_sms();
  delay(1000);
  digitalWrite(led, LOW);
  lcd.clear();
  // EEPROM.write(1,0);
  // rupees=EEPROM.read(1);
  }
  void loop()
  serialEvent();
  rupees=EEPROM.read(1);
  units=rupees/5.0;
  lcd.setCursor(0,0);
  lcd.print("Units:");
  lcd.print(units);
  lcd.print("");
  lcd.setCursor(0,1);
```

```
if(rupees<15)
lcd.print("LOW Balance:");
else
lcd.print("Balance:");
lcd.print(rupees);
lcd.print("");
read_pulse();
check_status();
if(temp==1)
{
decode_message();
send_confirmation_sms();
```

5. Block diagram

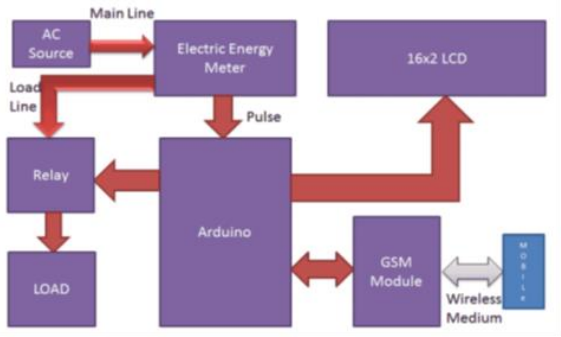

Fig. 14. Block diagram

6. Circuit diagram

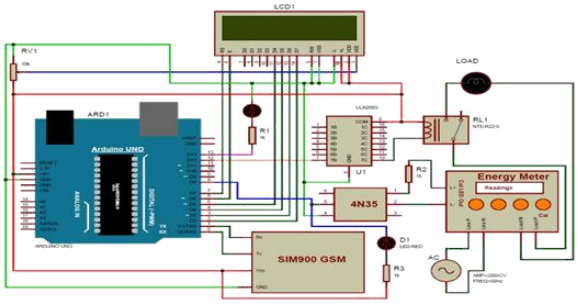

Fig. 15. Circuit diagram

7. Operating principle

The proposed model has the Arduino UNO as Central Processing Unit. The whole system is interfaced with Arduino UNO. The GSM modem is serially connected with the Arduino which is the major communication module between User and provider. The GSM uses its own network for the transfer of information. Special coding in Arduino 1.8.7 Desktop version is used for programming Arduino UNO. The relay acts as switching device to cut off and restore power supply. The LCD is interfaced to Arduino using parallel port connection. In this project the Arduino 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. The Arduino pulls the SMS received by phone, decodes it, recognizes the Mobile no. and then switches on the relays attached to its port to control the appliances. After successful operation, Arduino sends back the acknowledgement to the user's mobile through SMS. The coding emphasis the fact that it reduces human labor but increases the efficiency in calculation of bills for used electricity. The user will have an universal number and they can recharge outlets of electricity board. The acknowledgement of recharged coupon detail will come to notice of the consumer and also will get displayed in LCD module. So this process will bring a solution of creating awareness on unnecessary wastage of power and will tend to reduce wastage of power. This module will reduce the burden of energy providing by establishing the connection easily and no theft of power will take place. The LCD display will display the used amount and balance amount that can be used.

8. Unit consumption calculation

Before proceeding for the calculations, first we have to 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 have used 3200 imp/kwh pulse rate energy meter. Meaning of 3200 imp/kwh(impulse per kilo-watt-hour) is that if the LED of the energy meter blinks 3200 times then 1kWh unit is consumed. This is called as meter constant which is actually used to calculate meter's accuracy during manufacturing as per class of meter. So first we need to calculate the pulses for 200-watt load demand that load will be turned on for 30 seconds.

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

So pulses for 200-watt bulb in 30 seconds, with energy meter of 3200 imp/kwh pulse rate can be calculated as below:

Pulses=3200*200*30/1000*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=200/30*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

9. Application

This device aims for reducing various human efforts and a smarter future. It can reduce human efforts, pocket friendly, reduce the wastage of electricity. We can control the usage as per our requirement, we can control the device with our mobile phones from anywhere, low maintenance charge.

10. Conclusion

The design of Smart Energy meter using GSM technology can make the users to pay for the electricity before its consumption. In this way, consumers hold credit and then use the electricity until the credit is exhausted. If the available credit is exhausted then the electricity supply is cut-off by a relay. This reduces human labor and at the same time increases the efficiency in calculation of bills for used electricity. Smart energy meters will bring a solution of creating awareness on unnecessary wastage of power and will tend to reduce wastage of power. This module will reduce the burden of energy providing by establishing the connection easily and no theft of power will take place. This paper work exposes the purpose of energy monitoring and controlling by implementing prepaid system. It is hoped that this work helps the consumers for better energy management and its utility in the distribution system for economic liability of the Electrical Boards.

11. Future scope

It is a very advanced technology that we have used in our project to create a smarter & better future. In this system we can control this device from anywhere in the world with proper mobile signal connection to our mobile. This device will inform us when our money for consumption has come to an end. Then our device will send us a text message that our balance is low and we need to recharge it immediately. So, we can recharge it from anywhere through our mobiles.

References

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