IMPLEMENTATION OF A GSM BASED SMART ENERGY METER

By

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A project report submitted to the Department of Electrical and Electronic Engineering in partial fulfillment of the requirements for the degree of
Master of Engineering in Electrical & Electronic Engineering

Department of Electrical and Electronic Engineering
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Declaration

It is hereby declared that,

1. The project submitted is my original work while completing my degree at Brac University.

2. The project does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.

3. The project does not contain material that has been accepted, or submitted, for any other degree or diploma at a university or other institution.

4. I have acknowledged all main sources of help.

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Approval

Project titled "**Implementation of a GSM based smart energy meter**" submitted by Mahfuzur Rahman (19271003)

of Summer 2019 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Master of Engineering in Electrical & Electronic Engineering on 10th August 2022.

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Abstract

Traditional energy meter needs manual effort to collect the energy usage data from households and then the bill is sent to the customers at the end of the month. This process may lead to possible human errors. To increase the accuracy of the billing systems from utility providers by preventing human errors, an Arduino and GSM based automatic billing system is implemented in this project. The implemented system measures the energy usage and bill accurately and also notifies the billing information to the users via mobile phone SMS on a daily and monthly basis. The implemented system increases energy awareness and provides hassle-free service to utility customers.

Acknowledgment

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Chapter 1

Introduction

1.1 Introduction

Over the years, the energy meter has gone through rapid technological advancements, and nowadays there is a huge demand for Automatic Meter Reading (AMR) systems. Traditional meter system is not an efficient method for collecting energy use data efficiently [1]. Therefore the design of a simple low-cost wireless GSM energy meter along with a web interface including automatic billing and energy-saving features is presented in this paper. The energy provider can access the implemented meters from their office without visiting the customer's homes. The energy meter is integrated with a wireless communication module. This project allows energy providers to collect the energy data and deliver the bill slips and removes human effort. The microcontroller is used to screen the meter readings [2]. This process is safe from buyers who prompt unlawful power robbery and colossal losses. Consumer bills are sent via SMS on versatile phones [3].

1.2 Aims and Objectives

When making electricity bills, we usually see a worker writes down the meter readings. In this case, it is seen that due to his neglectful mistake, the meter reading is often wrong and compensation has to be paid to the aggrieved customer [4]. Visiting individual homes in each district's zone is the fundamental problem of the existing design. The idea of how to be more economical in using electrical energy and how to reduce the extra electricity bill due to incorrect meter readings on the customer base has led to the implementation of such a system. Users can check energy consumption and bill using cell phones through SMS [5]. This automation process leads to the removal of workforce for a meter reading. It encourages consumers to save more energy. Also, this system prevents energy theft, and wrong energy bills and monitors electricity development quickly [6]-[7].

1.3 Outline of the Project

The project report is structured as follows: **Chapter 2** presents the literature reviews. **Chapter 3** describes the methodology; **Chapter 4** provides results analysis and discussions and finally, **Chapter 5** provides the conclusion and future works.

Chapter 2
Background and Related Work

2.1 Background

Electricity is indispensable for the survival and development of humankind. Not only do we need to meet energy demand, but we also need to automate energy distribution. The traditional meter reading system is insufficient to meet the demand for future housing development [8]. The demand for automatic systems is increasing, and applications are expanding to various sectors [9]. Smart energy meter is a crucial step to reduce the cost of utility as well as services to utility providers. Rural electrification offers the implementation of advanced weighing technologies. Electromechanical gauges decay over temperature and moisture due to the analog and mechanical properties of the components. Physical meter reading is labor-intensive and time-consuming. It is an inefficient method with the possibility of wrong bill collections [10]-[12]. Electronic energy meters have replaced these traditional meters, but these problems still exist.

Therefore, a system that invoices the user's mobile phone is more appropriate in the current scenario. Here we introduce postpaid energy measurement that automatically captures the consumed energy, continuously records these readings, and displays them to the user via the LCD screen. Registered users and authorities can monitor and analyze monthly invoices from anywhere in the world [12].

Traditional meters issues are summed up as follows:

- Users need to foresee the power bill
- Manual and repetitive
- Meter readings are not precise

- Energy consumption information is inadequate and
- Lack of utility services.

2.2 Review of Existing Systems

An energy meter is a device that measures the energy consumption of an establishment. Nowadays energy meter reading takes the reading manually and then issues the bill. Manually human error is possible and does not provide a reliable meter reading. [13]. In a conventional metering system, the energy provider company hires a person who visits each house and records the reading manually to measure electricity consumption [14]-15]. Customers do not know about their daily consumption. As a result, good amount of money is to be paid at the end of the month due to the lack of knowledge of peak and off-peak consumption pattern. Sufficient work has been conducted using Arduino-based energy meter [16]. However, there is still some opportunity to work on monitoring daily energy consumption. In this project, we have analyzed the daily and monthly energy consumption bill in Taka and total load in kilowatt (kW). The analysis was done by using Arduino, LCD and GSM modules. Automatic charge information could reduce debilitating assignment and monetary wastage [17]. The modified electric meter reading system utilizes information gathered from the meter and sets up energy bills. This work proposes a meter framework in which users can screen their power utilization via their cell phones. The correspondence unit, information and arranging unit, and charging structure comprise the full AMR structure [18]. This work used plate turn instead of current to gather information and store it in a microcontroller [19].

The WiMAX handset was used for correspondence between the meter and worker ends. The gathered information from the headset will be stored in a microcontroller, and pc is used to access it. Various AMR frameworks exist in the world, and not all of them are feasible for Bangladesh [20]. Our proposed framework is designed based on Bangladesh's perspective.

Chapter 3

Methodology

3.1 Block Diagram of the Implemented System

The project circuit design and system operation are described in this chapter. Fig. 3.1 shows the basic block diagram of the implemented system. The AC source is connected to the energy meter. Load is connected to the energy meter through a switch. A load pulse is generated by connecting to the Microcontroller through Opto-coupler. The output of the system will show in the display and at the same time, it will also send a message to the registered number.

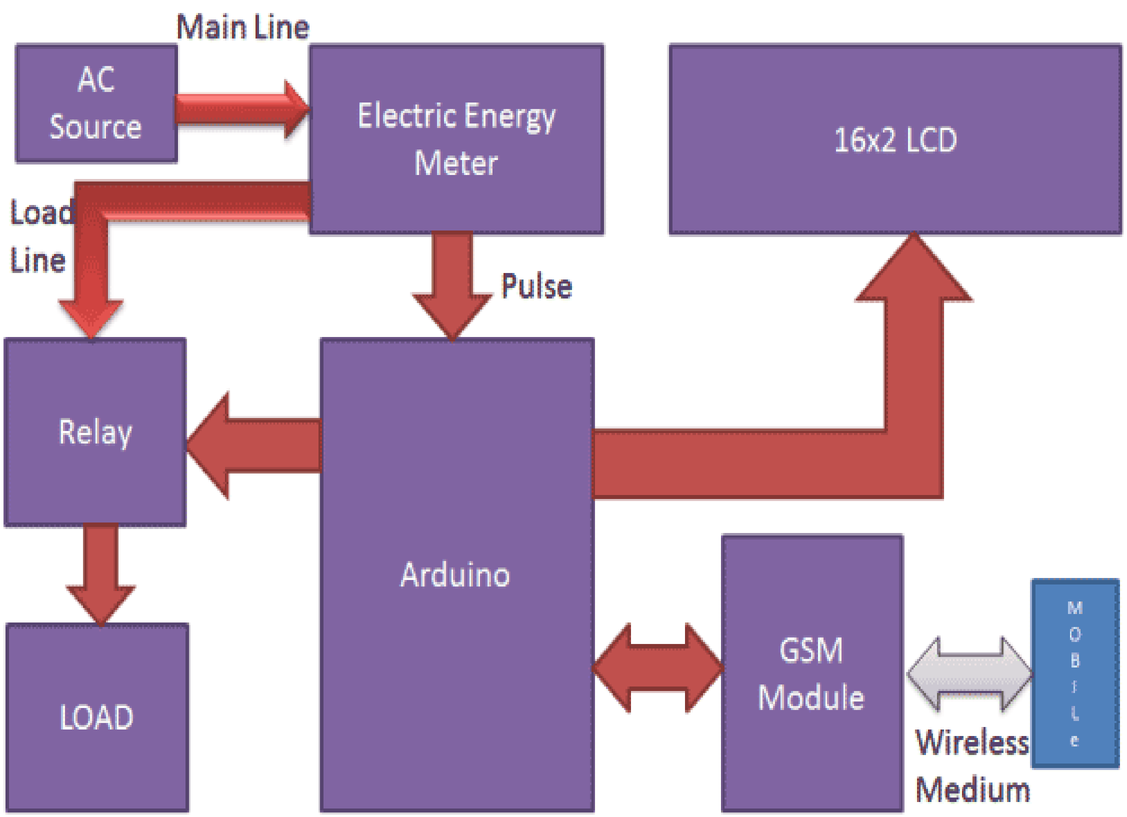

Fig. 3.1 Block diagram of the implemented system

3.2 Operation of Arduino

Fig. 3.2 shows the flowchart of the Arduino operation, which can be described as follows:

Start: This step works with the power switch on of the prototype project. If all the connections and sensors function properly, the LCD Display will show the welcome message of the project. In this process, the Arduino UNO microcontroller recognizes all the sensors connected to it.

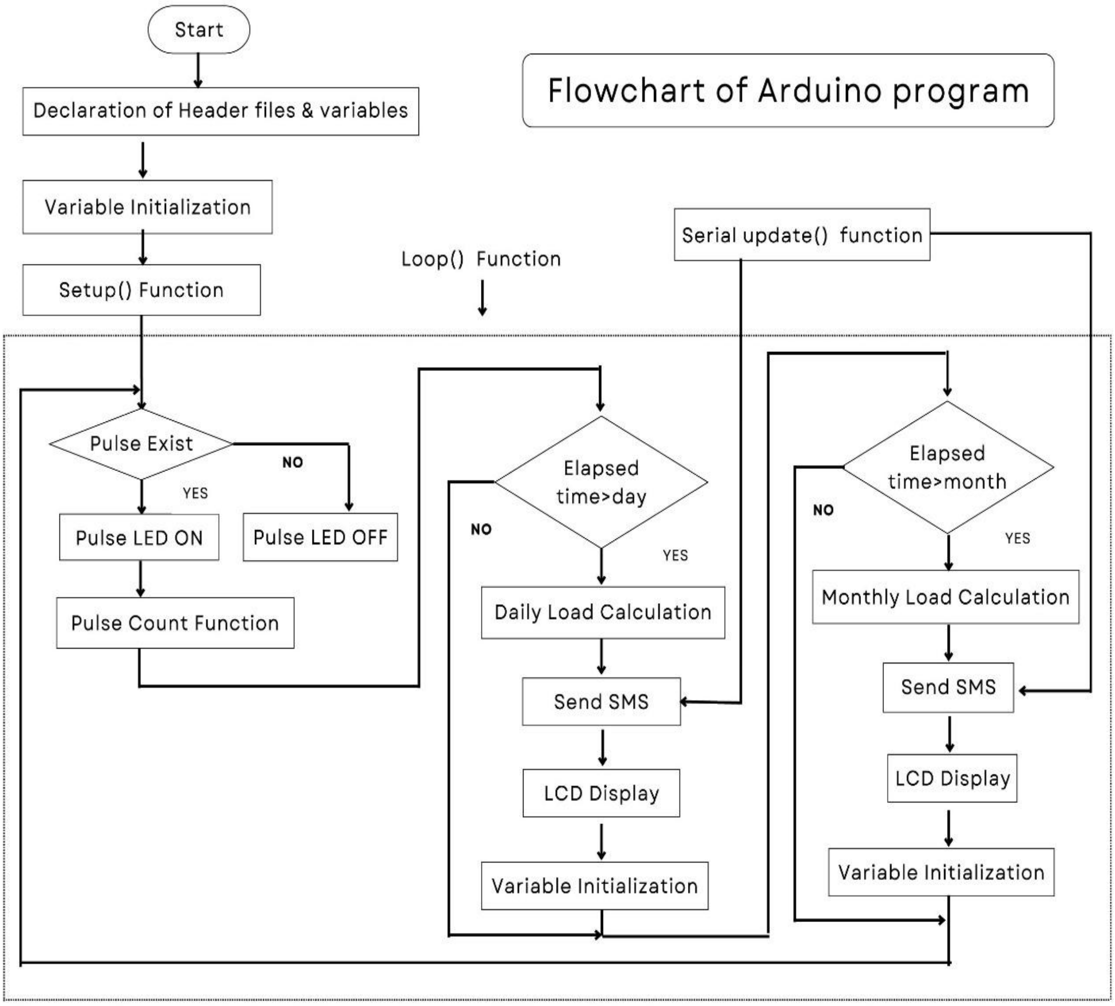

Fig. 3.2 Flowchart of Arduino operation

Declaration of header files: Arduino microcontroller needs some header files to perform different functions and commands. Also, we need some other sensor-related header files along with the Arduino regular header files.

Declaration of variables: As we used different variables in our program, we must declare those variables and their types. Also, we need to initialize some variables after declarations. Since the Arduino microcontroller follows object-oriented programming, we also derive different objects from different classes here to use in the program later.

Void Setup() function: In Void Setup() function, we declare the Arduino input and output pins. We declare the baud rate here for the Arduino microcontroller. We begin different processes like LCD objects and SMS objects here. The compiler reads this function once the system is started.

Void Loop() function: Void Loop() function always repeats. We put most of the program in this section. The pulse detector procedure in this loop detects the pulse coming from the Energy meter. If this procedure finds any pulse, it sends a signal to the Pulse indicator LED to turn it ON. If there is no pulse, then the Pulse indicator LED remains OFF. If a pulse comes, then it sends a signal to the pulse counting function. This function counts the number of pulses coming from a specific time period.

Day count timer: This function is in the loop() function to check the elapsed time. If the elapsed time exceeds the day, then the daily load and bill calculation start. Then comes the daily load calculation process.

After the load and bill calculation, the result goes to the SMS and LCD process. Send SMS also invokes the serial update() function. LCD function shows the data on the LCD screen. Then all the variables are initialized. On the other hand, if the elapsed time is shorter than the day, the system skips the Day count timer process and goes to the next step.

Month count timer: This function is in the loop() function to check the elapsed time. If the elapsed time exceeds the month, then the monthly load and bill calculation starts. Then comes the monthly load calculation process. After the load and bill calculation, the result goes to the

SMS and LCD process. Send SMS also invokes the serial update() function. The SMS function sends the monthly customer load consumptions and bill information to the customer's mobile. Then the system goes to the LCD function, which shows the data in the LCD screen as monthly bill and load consumption. Then all the variables are initialized. On the other hand, if the elapsed time is shorter than the month, the system skips the month count timer process and goes to the beginning of the Void Loop() function.

Void Loop() function repeats continuously and the system goes on further to show the required result of the customer.

Serial update() function: This function is outside the void loop() part and is invoked by the daily timer function and monthly timer function whenever necessary from the void loop() function.

3.3 Overall Working Principle

Fig. 3.3 shows the circuit diagram of the overall system. 220V AC is supplied through a plug to the energy meter. The led indicator is added if there is a wrong connection. Load is connected to the neutral wire and the live wire is connected to control the loads. Optocoupler LN35 pins 1 and 2 are connected to the live and neutral wire, respectively.

The 5V source is connected to Pin 5 of the optocoupler using a 1 kilo-ohm resistor. The Arduino A1 pin is connected to pin 5 and pin 6 no is connected to the ground. Arduino is powered by a 12V dc using an adapter. ICSP pins 1 and 3 are connected to 5V and ground, respectively.

The Arduino 5V and ground pins are connected to the LCD display 5V and ground pin, respectively. Microcontroller's A4 and A5 are connected to the LCD display's data and the clock signal respectively. Arduino's pins 2 and 3 are connected to the T_x and R_x port of the GSM model, respectively. Vcc is connected to the power port module for high chip-set enabled. An LED indicates the pulse with Arduino.

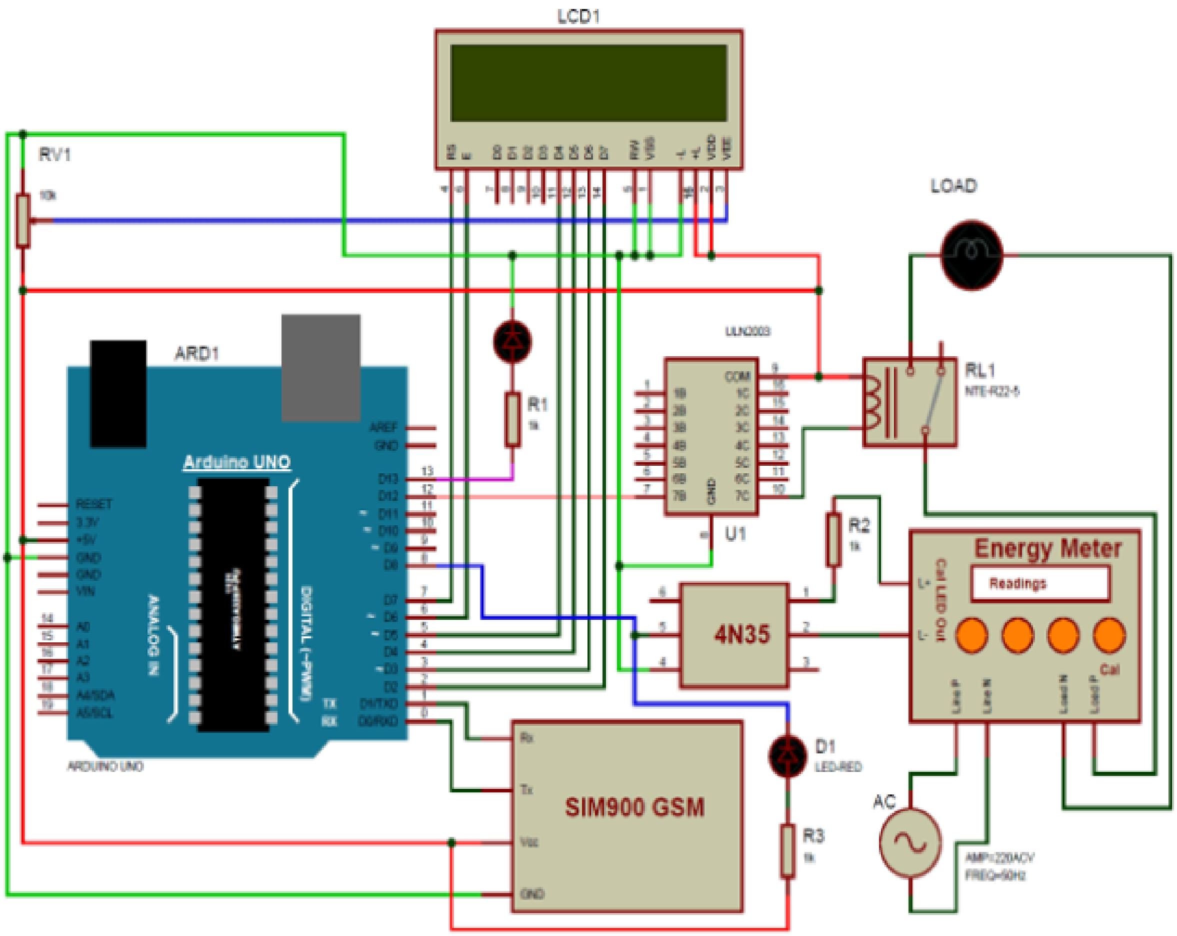

Fig. 3.3 Circuit diagram of the implemented system

In case of an error, the system will shut down automatically from the power supply. GSM module, Arduino control, and networking can safeguard the system from any irregularities at the AC supply. The GSM module is a communicator which can be used to turn on and off the device via mobile phone.

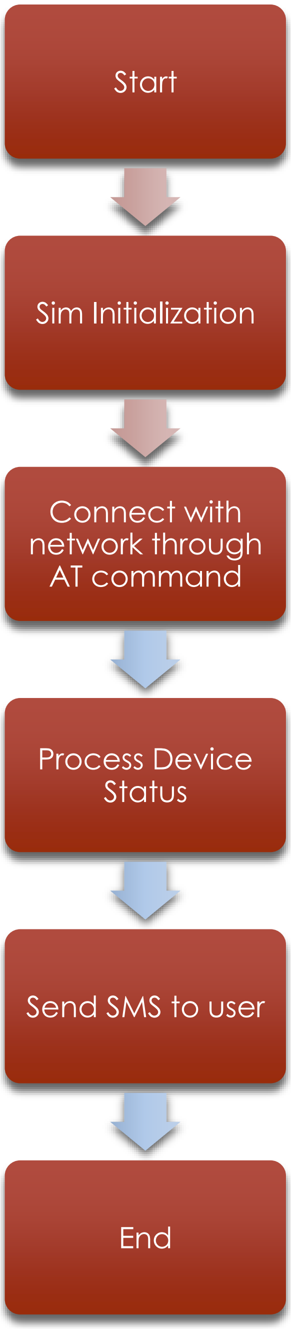

Fig. 3.4 GSM workflow

When the system is on, the device sends a ‘Device ON’ notification to the user. After the device is on, it starts to calculate the current and voltage of the load connected to the device and starts to calculate the power. Hence, it will show the total load connected in kW to the device and calculate the bill in taka as per unit price. The calculated power and bill will be sent to the user through GSM Module via SIM. As a result, the customer will be able to see the real-time data of its premises.

Fig. 3.5 Device ON notification

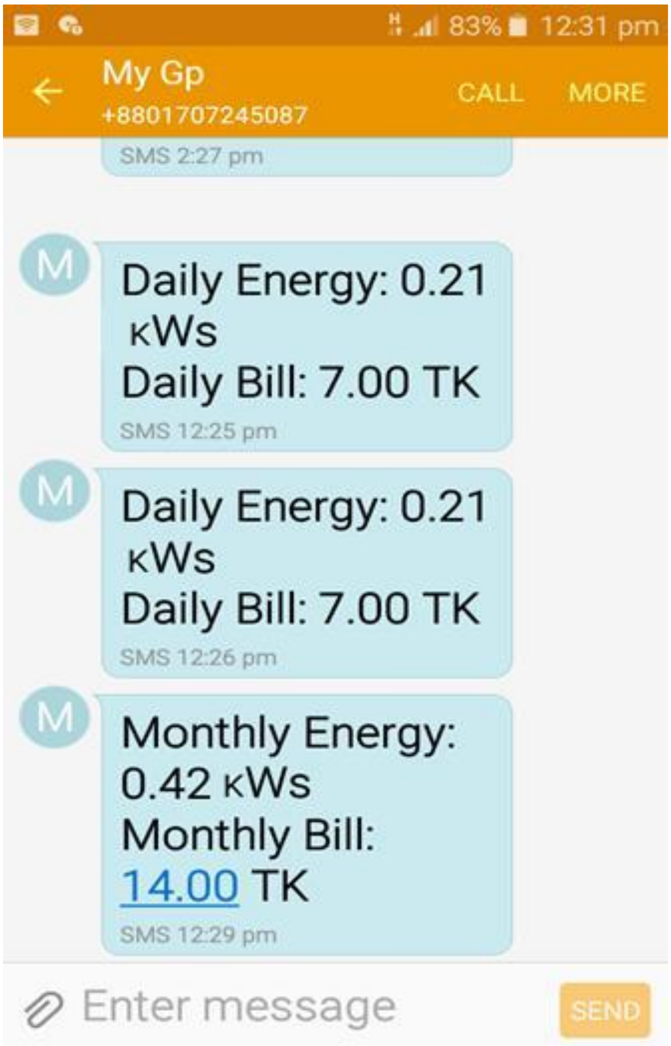

Fig. 3.6 Real time data analysis at user end

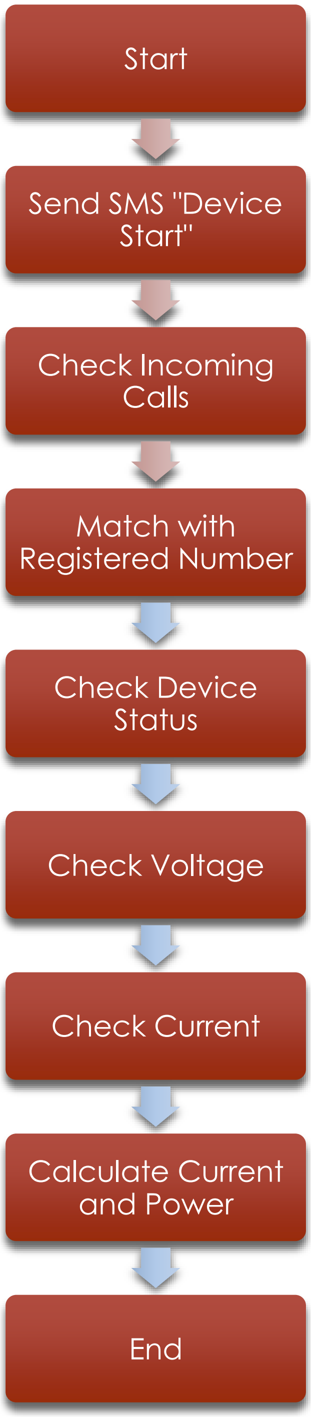

Fig. 3.7 Arduino workflow

After being given proper instructions, Arduino continues its function in the system. This device automatically runs the whole system. However, this device operates the system which is shown in the workflow. After starting its operation, it sends an SMS device start, checks incoming calls and matches with the registered number. After measuring voltage and current, it calculates current and power which will show the LCD and simultaneously sends an SMS to the registered number.

Chapter 4

Results and Discussion

4.1 Introduction

The system result and related discussions are discussed in this chapter. The results obtained by properly designing the system prove that the system is realistic and up-to-date. The real impact of this system is to increase awareness about the daily use of electricity. As a result of the implementation of the system, the customer will be able to know the amount of his monthly and daily power consumption and their bill. The customer will be more economical in using electricity than ever before.

4.2 Results

The results of the experiment are presented in the following Table. Calculations are given in Appendix B.

Table 4.1. Daily and monthly assumed energy consumption and bill

Energy consumption	Day 1	Day 2	Monthly
Unit (kWs)	0.21	0.21	0.42
Cost (TK)	7.00	7.00	14.00

Traditionally the electricity bill is calculated at the end of the month. This project gives daily energy usage notifications to the customer for awareness and less energy use.

4.3 Discussion

Higher energy use means a higher energy bill. The electricity usage of different customers is different. Two 100W bulbs were used as a load in this project for demonstration purpose. This load assumption gives 0.42 kWs energy usage and 14 TK of electricity bill per month. Different loads give different results in energy usage and bills.

Chapter 5

Conclusion and Future Work

5.1 Conclusion

A smart energy meter is proposed in this paper using Arduino and GSM modules where the consumers can see their energy consumption and bill at any time from their cell phones. This system removes workforce to collect energy data and increases the efficiency of the energy providers as well. It also encourages consumers to save energy and prevents the possibility of meter reading errors. Through this, utility service providers would be able to collect all kinds of data and provide better service to the consumers.

5.2 Future Work

Electrical energy meters are more accurate than conventional meters. The project may increase the transparency between distributors and consumers. Since the world is moving fast with better communication platforms, these devices will be able to deliver real-time data for any time at any place. In the future, this device could be a new gateway to smart grid technology. Also, the future system would be designed for a three-phase system along with protection. To make the device more reliable, an app could be developed. Through the app, the user can easily get all the data and the admin could access the meters.

References

[1] Landi, Carmine, Pietro Merola, and Giacomo Ianniello. "ARM-based energy management system using smart meter and Web server." In *2011 IEEE International Instrumentation and Measurement Technology Conference*, pp. 1-5. IEEE, 2011.

[2] Sehgal, Vivek Kumar, Nitesh Panda, Nipun Rai Handa, Shubhrangshu Naval, and Vipul Goel. "Electronic Energy Meter with instant billing." In *2010 Fourth UKSim European Symposium on Computer Modeling and Simulation*, pp. 27-31. IEEE, 2010.

[3] Wasi-ur-Rahman, Md, Mohammad Tanvir Rahman, Tareq Hasan Khan, and SM Lutful Kabir. "Design of an intelligent SMS based remote metering system." In *2009 International Conference on Information and Automation*, pp. 1040-1043. IEEE, 2009.

[4] Alam, Md Abrarul, and Mohammad Zeyad. "Smart cities and buildings: GSM based smart electric energy meter billing system." In *2019 IEEE International Conference on Power, Electrical, and Electronics and Industrial Applications (PEEIACON)*, pp. 1-4. IEEE, 2019.

[5] Abdollahi, Ali, Marjan Dehghani, and Negar Zamanzadeh. "SMS-based reconfigurable automatic meter reading system." In *2007 IEEE International Conference on Control Applications*, pp. 1103-1107. IEEE, 2007.

[6] Kanovskyi, Andrii, Oleksandr Osolinskyi, Hrystyna Lipyanina-Goncharenko, and Anatoliy Sachenko. "A Concept of Microprocessor-Based Electrical Load Control System with Extended Functionality." In *2021 IEEE 4th International Conference on Advanced Information and Communication Technologies (AICT)*, pp. 112-117. IEEE, 2021.

[7] Ajeeba, A. A., Anna Thomas, and Risa Rasheed. "IoT Based Energy Meter Reading, Theft Detection and Disconnection." *International Research Journal of Engineering and Technology* (2017).

[8] Sehgal, Vivek Kumar, Nitesh Panda, Nipun Rai Handa, Shubhrangshu Naval, and Vipul Goel. "Electronic Energy Meter with instant billing." In *2010 Fourth UKSim European Symposium on Computer Modeling and Simulation*, pp. 27-31. IEEE, 2010.

[9] Shahidi, Sarwar, Md Abdul Gaffar, and Khosru M. Salim. "Design and implementation of digital energy meter with data sending capability using GSM network." In *2013 2nd International Conference on Advances in Electrical Engineering (ICAEE)*, pp. 203-206. IEEE, 2013.

[10] Malik, Qasim, Aamir Zia, Rehan Ahmad, Muhammad Asim Butt, and Zain Ahmad Javed. "Design and Operation of Smart Energy Meter for Effective Energy Utilization in Smart Cities." In *2019 IEEE Conference on Sustainable Utilization and Development in Engineering and Technologies (CSUDET)*, pp. 219-223. IEEE, 2019.

[11] Sureshkumar, R. "Automated electrical distribution network using Arduino and GSM." In *2021 International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA)*, pp. 1-4. IEEE, 2021.

[12] Patel, Himanshu K., Tanish Mody, and Anshul Goyal. "Arduino based smart energy meter using GSM." In *2019 4th International Conference on Internet of Things: Smart Innovation and Usages (IoT-SIU)*, pp. 1-6. IEEE, 2019.

[13] Arif, Anmar, Muhannad Al-Hussain, Nawaf Al-Mutairi, Essam Al-Ammar, Yasin Khan, and Nazar Malik. "Experimental study and design of smart energy meter for the smart grid." In *2013 international renewable and sustainable energy conference (IRSEC)*, pp. 515-520. IEEE, 2013.

[14] Ashna, K., and Sudhish N. George. "GSM based automatic energy meter reading system with instant billing." In *2013 International Mutli-Conference on Automation, Computing, Communication, Control and Compressed Sensing (iMac4s)*, pp. 65-72. IEEE, 2013.

[15] Chandler, Terry. "The technology development of automatic metering and monitoring systems." In *2005 International Power Engineering Conference*, pp. 1-147. IEEE, 2005.

[16] Khalifa, Tarek, Kshirasagar Naik, and Amiya Nayak. "A survey of communication protocols for automatic meter reading applications." *IEEE communications surveys & tutorials* 13, no. 2 (2010): 168-182.

[17] Maitra, Subhashis. "Embedded Energy Meter-A new concept to measure the energy consumed by a consumer and to pay the bill." In *2008 Joint International Conference on Power System Technology and IEEE Power India Conference*, pp. 1-8. IEEE, 2008.

[18] Kurde, Arati, and V. Kulkarni. "IOT based smart power metering." *International Journal of Scientific and Research Publications* 6, no. 9 (2016): 411-415.

[19] Tan, HG Rodney, C. H. Lee, and V. H. Mok. "Automatic power meter reading system using GSM network." In *2007 International Power Engineering Conference (IPEC 2007)*, pp. 465-469. IEEE, 2007.

[20] Zeyad, Mohammad, Prodip Biswas, Md Zakaria Iqbal, Susmita Ghosh, and Pronab Biswas. "Designing of microcontroller based home appliances governor circuits." *International Journal of Computer and Electrical Engineering (IJCEE)* 10, no. 2 (2018): 94-105.

Appendix

Appendix A. Circuit Components

- Electrical energy meter
- Arduino microcontroller
- Optocoupler
- GSM SIM 808/900A
- Capacitor
- Resistors
- LCD Display
- Potentiometer
- Bridge Rectifier
- BJT 547
- AC to DC converter(12V-6V)

Fig. A.1 Electrical energy meter.

The energy meter is a device used to measure consumed energy in household, commercial or industrial buildings. Energy meter has. 2 connection sides. One side is the input side which is connected to the AC power line and the output side is connected to the optocoupler to measure the unit.

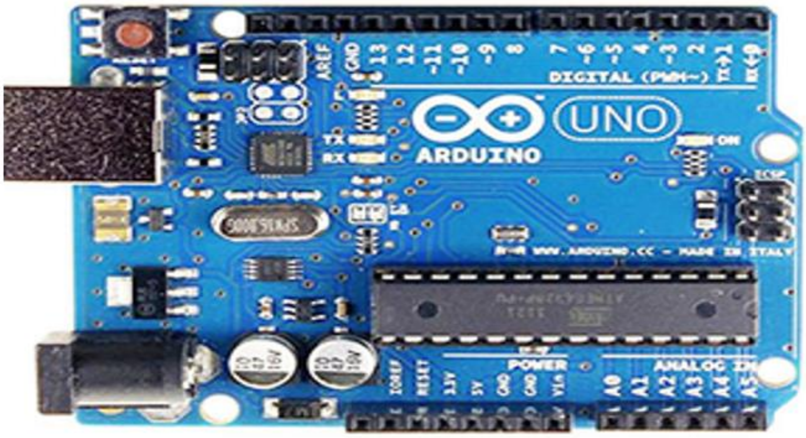

Fig. A.2 Arduino Microcontroller AT MEGA 328P

Arduino is a microcontroller-based project that can be programmed to control physical devices. The device has an 8-, 16- or 32-bit Atmel microcontroller that can be programmed using C and C++ programming languages. Arduino Uno with 14 I/O pins was used for our project. Arduino was used in our project to control the circuit, measure voltage, tripping time, and provide notifications to the users. The Arduino Uno library is vast, easy to use, and cheaper than other products.

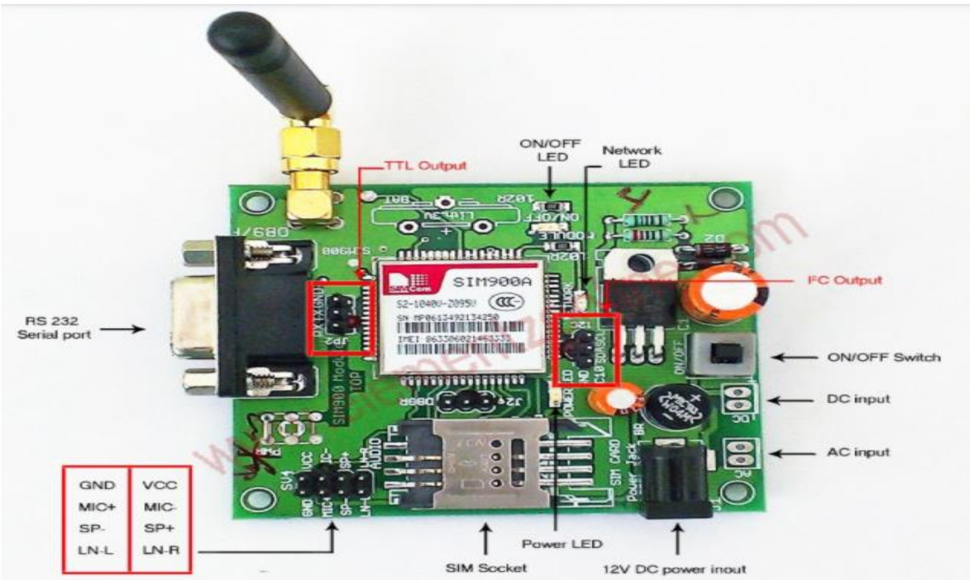

Fig. A.3 GSM Modem

GSM A6 is a device that connects cell phones to deliver the notifications using the SIM card. The GSM modem holds dc input, ac input on/off switch and RS 232 serial port, etc. Quadband GSM/GPRS module to connect GPS with satellite route was used which is known as SIM808 module. SIM808 modules transmitter and receiver port are connected Arduino’s pin 2 and 3 no, respectively.

Fig. A.4 LCD display

A 2×16 line LCD display was used for this project which operates on 5V dc. Its Data and Clock port are connected to Arduino A4 and A5 pins respectively. LCD showed the daily and monthly billing with cost.

Optocouplers are also known as optical isolators, consist of LED and transistors. 4N35 Optocoupler is used in the project switch consisting of 6 pins. Arduino A1 pin was connected to optocouplers pin 5. Optocoupler 5 no pin was connected to 1kΩ resistor in the project. The entire circuit was implemented on the breadboard. Jumper wires were used to connect all the circuit components.

A 12V DC power supply was used to turn on the Arduino and GSM module. Two indicate pulse, a led was used for Arduino's pin no 13 and Ground. A potentiometer is a voltage divider three-terminal register which is used to control circuits. A potentiometer was used to convert 6V to 5V in the project. BJT is a switching device, and BJT547 was used for this project.

Appendix B. Calculation

The energy meter provides 1600 imp/kWh.

1 imp = $\frac{1}{1600} \times 60 \times 60 \times 1000$ kWh =2250 Ws

To make calculation easy, 1 Month = 2 Days and 1 unit=3.5 BDT was assumed.

Pulse count:

For 200W load,

Pulse interval time = 11s

Daily energy consumed = (2250 / pulse interval time)

= (2250/11) Watt-second (Ws)

=204.545 Ws

=0.21 kWs

= (0.21/0.105) [Let 0.105 kWs = 1 unit]

= 2 unit

Let per unit cost = 3.5 TK

First day Bill (TK) = no of unit × per unit cost

= 2×3.5

= 7.00

Second day, daily energy consumed =0.21 kWs

Second day Bill (TK) = no of unit × per unit cost

= 2×3.5 =7.00

Let, 1 month = 2 days

Monthly energy consumed = (0.21+0.21) kWs

= 0.42 kWs

No of unit = (0.42/0.105) [Let 0.105 kWs = 1 unit]

= 4 unit

Monthly Bill (TK) = no of unit × per unit cost

= 4 × 3.5 = 14.00

Appendix C. Programming Code

```
#include<SoftwareSerial.h>
SoftwareSerialmySerial(2, 3); //A6 Tx & Rx is connected to Arduino #3 & #2
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE); //27,3F,3C
intpulseCount=0;
long previousMillis = 0;
long interval = 46000;
long previousMillis2 = 0;
long interval2 = 99200;
unsigned long startTime;
unsigned long stopTime;
intpulseTime;
float dEnergy=0.00;
float dBill=0.00;
float mEnergy=0.00;
float mBill=0.00;
void setup()
{
  Serial.begin(9600);
  mySerial.begin(9600);
  delay(500);
  lcd.begin(16,2);
  lcd.backlight();
  pinMode(A1,INPUT);
  pinMode(13,OUTPUT);
  lcd.setCursor(0,0);
  lcd.print("Energy Meter Bills");
  lcd.setCursor(0,1);
  lcd.print("Initializing....");
  delay(1000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("D.Energy:"+String(dEnergy/1000,2)+" kWs");
  lcd.setCursor(0, 1);
  lcd.print("D.Bill:"+String(dBill,2)+" TK");
  delay(100);
}
void loop()
{
    if(analogRead(A1)<900){
      digitalWrite(13,1);
      pulseCount++;
      if(pulseCount==1){
         startTime = millis()/1000;

}
      if(pulseCount==2)
```

```
{
        stopTime = millis()/1000;
        pulseTime = stopTime-startTime;
      }
      delay(500);
    }else{
      digitalWrite(13,0);
      }
    unsigned long  currentMillis = millis();
    if(currentMillis - previousMillis> interval){
       previousMillis = currentMillis;
       if(pulseCount==1){
        pulseCount=2;
        pulseTime=22;
        }
       if(pulseCount==3 || pulseCount==5){
        pulseCount=4;
        pulseTime=11;
        }
       dEnergy=(2250/pulseTime)*pulseCount;
       dBill= pulseCount*3.5;
      //for SMS.....
      //mySerial.println("AT");
      //updateSerial();
      mySerial.println("AT+CMGF=1");
      //updateSerial();
      delay(1000);
      mySerial.println("AT+CMGS=\"+8801676123462\""); // change ZZ with country code and
xxxxxxxxxxx with phone number to sms
      //updateSerial();
      delay(2000);
      mySerial.println("Daily Energy:"+String(dEnergy/1000,2)+" kWs");   // text content
      mySerial.println("Daily Bill:"+String(dBill,2)+" TK");
      //updateSerial();
      delay(500);
      mySerial.write(26);
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("D.Energy:"+String(dEnergy/1000,2)+" kWs");
      lcd.setCursor(0, 1);
      lcd.print("D.Bill:"+String(dBill,2)+" TK");
      mEnergy= mEnergy + dEnergy;
      mBill= mBill + dBill;
      previousMillis = currentMillis;
      pulseCount=0;
      pulseTime=0;
      dLoad=0.00;

dBill=0.00;
      delay(100);
      }
```

```
 unsigned long currentMillis2 =millis();
    if(currentMillis2 - previousMillis2 > interval2){
     previousMillis2 = currentMillis2;
     //for SMS.....
     //mySerial.println("AT");
     //updateSerial();
     mySerial.println("AT+CMGF=1");
     //updateSerial();
     delay(1000);
     mySerial.println("AT+CMGS=\"+8801676123462\""); // change ZZ with country code and
xxxxxxxxxxx with phone number to sms
     //updateSerial();
     delay(2000);
     mySerial.println("Monthly Energy:"+String(mEnergy/1000,2)+" kWs");   // text content
     mySerial.println("Monthly Bill:"+String(mBill,2)+" TK");   // text content
     //updateSerial();
     delay(500);
     mySerial.write(26);
     lcd.clear();
     lcd.setCursor(0, 0);
     lcd.print("M.Energy:"+String(mEnergy/1000,2)+" kWs");
     lcd.setCursor(0, 1);
     lcd.print("M.Bill:"+String(mBill,2)+" TK");
     mLoad= 0.00;
     mBill= 0.00;
     delay(100);
    }
}
void updateSerial()
{
  delay(500);
  while (Serial.available())
  {
    mySerial.write(Serial.read()); // Forward what Serial received to Software Serial Port
  }
  while(mySerial.available())
  {
    Serial.write(mySerial.read()); // Forward what Software Serial received to Serial Port
  }
}
```