AUTOMATIC POWER THEFT PROTECTION USING ARDUINO

A Project submitted in partial fulfillment of the requirements for the Award of Degree of
Bachelor of Science in Electrical and Electronic Engineering

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Saikat Basak,** Senior Lecturer**,** Department of EEE, Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree.

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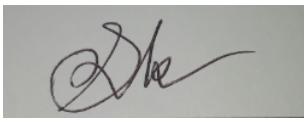

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DEDICATED

To our beloved parent……

ACKNOWLEDGEMENT

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ABSTRACT

Energy stealing is a highly general complication among countries as Bangladesh where consumers of energy are attractive consistently as the demography increment. Necessity in electricity process are ruiming the sum of produce every year remaining to energy stealing. It is perfectly unattainable to check and make up out stealing by going each customer's door to door. In this project, a new method is pursued based on Microcontroller Atmega328P to find out and monitoring the energy meter from power stealing and it by remotely disconnect and reconnecting the service line of a particular consumer. An SMS will be sent automatically to the utility central server through GSM module whenever unauthorized activities detected and a separate message will send back to the microcontroller in order to disconnect the unauthorized supply.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

BJT	Bipolar Junction Transistor
LCD	Liquid Crystal Display
LED	Light Emitting Diode
B	Battery
IC	Integrated Circuit
GSM	Global System for Mobile
EEPROM	Electrical Erasable Programmable Read Only Memory
CS	Current Sensor
PT	Potential Transformer

CHAPTER 1

INTRODUCTION

1.1 Introduction

Electricity is one of the most important blessings that science has given to mankind. But this energy used by unauthorized person cause losses to utility and also pollutes the environment. Losses in electricity energy sector can come under two sets: technical and managerial. Technical losses of electrical energy are caused due to the functional tendency of the equipment used from generating station to the distributing station. Non-Technical losses are due to lack of utility labor interference periodically.

The proposed system consists of an Arduino (microcontroller), GSM modem and current sensor. After switching power on the Arduino and the GSM modem, turn on the relay and connects the energy meter to load via relay for displaying the current data. Arduino checks the readings from PT and current sensors respectively. Relay will disconnect and reconnect the supply by the microcontroller instruction given. [1]

1.2 Conventional system

Conventional System "Energy meters displays kilowatt- hour by continuously measuring the instantaneous voltage (volts) and current (amperes) to give energy used in joules''. The primary type of electricity meter is the electromechanical induction meter and an electronic meter. In electromechanical induction meter, the total number of rotations of the aluminum disc is directly proportional to the power consumed. Electronic meters show the power consumed, power factor, the reactive power used digitally displayed on LCD or LED display, and also able to send the energy consumed readings to remote places through some

communication network. It is a single way communication. In addition to measuring energy used, electronic meters can also record other parameters of the load and supply such as instantaneous and maximum rate of usage demands, voltages, power factor and reactive power used etc. Traditionally, the electricity meters are installed on consumer's premises and the consumption information is collected by meter-readers on their fortnightly or monthly visits to the premises.

1.3 Proposed System

A smart energy meter works on communication directly with wireless data protocol, so there will be precise reading & there's no necessary for a meter reader to take energy meter reading in consumer premises. Smart energy meters can operate in divergent ways with GSM Module.

1.3.1 Merits of prepaid system (energy meter)

- User new prepaid system send precise reading on a regular interval in sequence about customer's energy usage to utility. So the bills will be proper and labor cost is reduced for taking a reading in consumer residents.
- If the consumer did not pay the energy bill within time, the utility can remotely disconnect the service line of a particular consumer and after payment the service continues to the consumer. So we can avoid sending an employee to cut off energy from the network and again to reconnect their connection.

The proposed system consists of digital energy meter (we used a display to get reading), an Arduino (microcontroller), GSM modem and negative level triggered relay. After switching power on the Arduino and the GSM modem, turn on the relay and connects the energy meter to load via relay. Then read the EEPROM and display the current data. Arduino checks the readings from voltage and current sensor i.e. PT and current sensor(CS) respectively. Also,

this Arduino helps the utility for power disconnection when the bill is not cleared by the customer. From customer point, this is a benefit to monitor their daily/monthly consumption, and get disconnected from the supply.

1.4 Project Overview

The power theft detection model proposed here is expected to detect illegal drawing of power using a microcontroller-based system that would feasibly decrease the government revenue losses over electricity theft. This project includes the modification of existing energy meters into power measuring and transmitting devices (EMTD) and checking measuring and receiving devices (CMRD) which report any abnormal inconsistency higher in power provided and consumed to the control center using a GSM modem. The energy meters are connected at individual premises. They measure the energy consumed in those premises. There are different ways in which the energy is pilfered, on most of cases of which the pilfered energy cannot be detected and accounted for. The idea of the project is to monitor a group of meters which register the energy consumed by the individual premises against a check meter, the CMRD, which is to be kept out of the reach of the individuals and keeps a continuous reading of the energy distributed from the pole of the implementation area. Every building has a number of meters and they get supply from a service drop. The CMRD will be installed at the starting point of the service drop and the individual consumers will each have an EMTD. After comparing the data of consumed power sent from the individual EMTDs of consumer premises to the CMRD with the calculated data representing the power that is passing through the check point, if there is a difference in the balance, the theft zone can be detected and an automatically message will be send to the authority.

1.5 Project Objective

To meet present day requirements of the country, the government keeps attempting at generating more power which is not enough, and also, is inefficiently costly. The generated power has to be utilized in a resourceful manner through close monitoring of power consumption and losses because illegal electricity usage may indirectly affect the economic status of a country. Also, the planning of national resources may be difficult in case of

unrecorded energy usage. But then again, following the path of many other countries which are making more modern and expensive amendments to their power transmission and distribution sector might not be financially viable for ours. All of the recent reform activities attempted by the Government in Bangladesh were in the sectors of generation and transmission of electricity. Despite the fact that the distribution system of the country, which is characterized by heavy system loss and poor collection performance, is the pressure point of the problem, it seldom got the priority in reform initiatives. Deriving fruitful results from such many initiatives is not possible while leaving the distribution system untouched. This project proposes a methodology which prioritizes in the reform of the transmission and distribution sector to make it efficient and effective with a restructured administration. Modifications offered for the existing meters would continuously check for abnormal differences between energy supplied and energy consumed by billed customers and would notify the authorities of abnormalities right away addressing the locality of theft so that tampered lines maybe fixed back to normal upon reporting. Also, with a general idea of the scene of theft, it would be possible to trace and apprehend the culprits responsible. All of this is expected to be done using locally available devices and procedures so that it is applicable in the context of a developing country with limited resources and budget. Thus, the objective of this project is to propose a way out of the issue of power theft involving methods and the usage of such apparatus, the expenditure of which would be quite reasonable for the government.

1.6 Project Outline:

Chapter 1: Introduction of the project, Conventional system, Drawbacks of regular energy the meter, proposed system, merits of prepaid system (energy meter), project overview and Project objective

Chapter 2: Circuit description, anti-theft mechanism, schematic diagram of project, overvoltage protection mechanism, software requirement, system architecture, flowchart of the overall project processing.

Chapter 3: Required equipment’s and hardware, Microcontroller (ATEEGA-328), GSM MODULE (SIM-800C), general features, interface, voltage transformer, current sensor, Arduino UNO, LCD display, relay module and power supply.

Chapter 4: Result and Discussion result, practical whole working procedure, results for anti-theft mechanism and project cost.

Chapter 5: Conclusion and recommendation conclusion of the system, Limitation of the work and Recommendations for future work.

CHAPTER 2

SYSTEM DESCRIPTION

2.1 Introduction

Conventional system used in voltage transformer and current sensor of the system. Also used automatic prepaid belling system and via SMS by mobile network connection system any problem than immediately SMS by the consumer mobile and detect the fault and find out the fault and solve the some requirement follow.

2.2 Circuit Description

In the below diagram a precise and clear representation of the whole system is shown. Line voltage (220V AC) is converted into suitable DC value by using a power supply unit to operate the microcontroller, LCD, GSM module etc. The power consumed is sensed by the current sensor and potential transformer and a fraction of the total power consumed is fed to the microcontroller. There are three operating mechanisms in this system.

2.3 Anti-theft mechanism

Microcontroller compares this fraction with the predetermined reference value. The reference value is set by depending upon the maximum demand of the consumer. If the value of the power fed to the microcontroller exceeds the reference value microcontroller causes to operate GSM and relay.

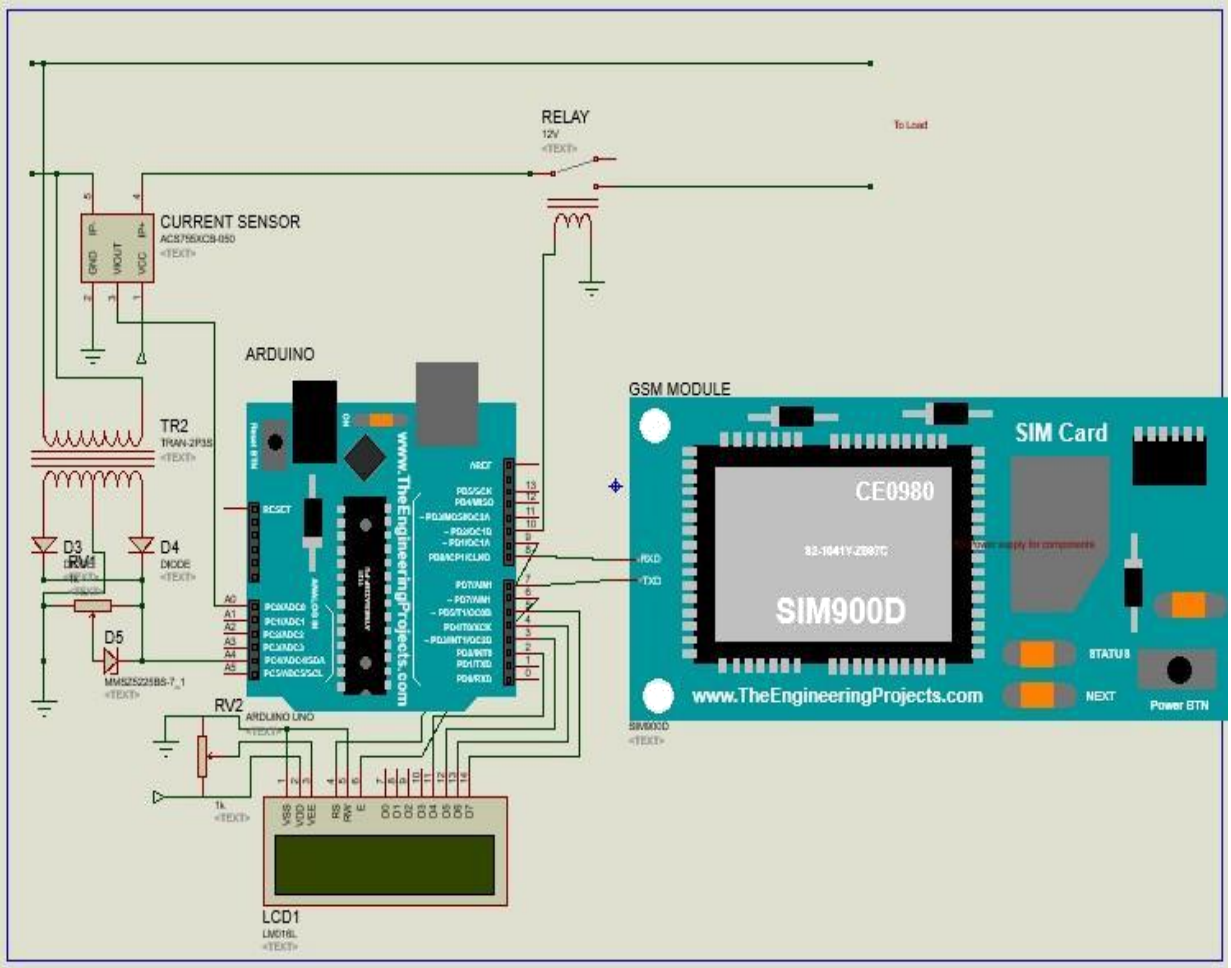

Fig 2.1: Schematic diagram of Project

In this project current sensor(CS) is connected in series with the service main which is located at the distribution pole.pin 1 is connected to 5V dc, pin 2 is grounded and pin 3 is connected to the analog input pin(A0) of the Ardunio (A0) from the Vout pin (3) of the CS.

Current sensor used in this project is able to handle up to 30 Amp(AC). The center tapped transformer(TR2) is used to sense the variation of line voltage. The output of TR2 is converted into DC and fed to pin A1 of the arduino. This DC voltage is limited up to 5V by using zener diode (D5). This is done to protect the arduino from over voltage. Microcontroller will take decision depending upon the multiplied value of pin A0 and A1 which is a fraction of the actual consumed power. Microcontroller will compare this value with the predetermined reference value. This reference is set by depending on the maximum demand of consumer. In this project the reference value is set to 60 watts. Let us examine two conditions. Assume,

A0=5A and A1=5V

A0*A1=5*5=25W

In this condition the microcontroller will take no action because 25 is less than the reference value. Again assume,

A0=7A and A1=10V

A0*A1=7*10=70W

Now the absorbed power is above the reference value. In this situation microcontroller will observe this value for 20 seconds. If the value of consumed power does not come down below the reference within 20 seconds, it will send signals to the GSM module and relay module through output pin 5 and 10. When GSM module get the signal from the microcontroller it will send a message to a cell phone which number is preloaded in the module. After getting the signal from microcontroller the relay will operate and disconnect the load from supply. The relay is mounted in the line after the protective system so as to ensure power to each element of the system even after the disconnection of the load. An LCD display is used to show the value of power, current , voltage and warning message.VSS pin of the LCD is grounded and VDD pin is connected to 5V DC. A variable voltage is supplied to

the VEE pin by using a POT in order to adjust the brightness of the display. Data pin D4 to D7 of LCD is connected to the digital pin 2 to 5 of the arduino. [7]

2.5 Over voltage protection mechanism

In this mechanism an over voltage protection is provided to the consumer's load. Microcontroller input pin A1 senses the line voltage continuously. If the line voltage exceeds the safe value microcontroller will send a trip signal to the relay and relay will disconnect the load. [7]

2.6 Software requirement

Arduino programs are used to write in any programming language with a compiler concept that produces executable binary machine code. Atmel affords an improvement of this environment for proposed system's microcontrollers. Arduino library most useful to add many readymade predefined inputs to our project. It supports C & C++ using special organize.

2.7 System Architecture

The system architecture of Arduino and GSM based smart energy meter (we used a display) is below. The energy consumption is being calculated using the energy meter IC and Arduino. In order to prevent a power theft, detection program is present in the Arduino. Arduino and GSM based smart energy meter can be divided into several parts as Arduino, GSM modem, Relay, Opto-coupler, Display Unit and Power Supply Unit etc.

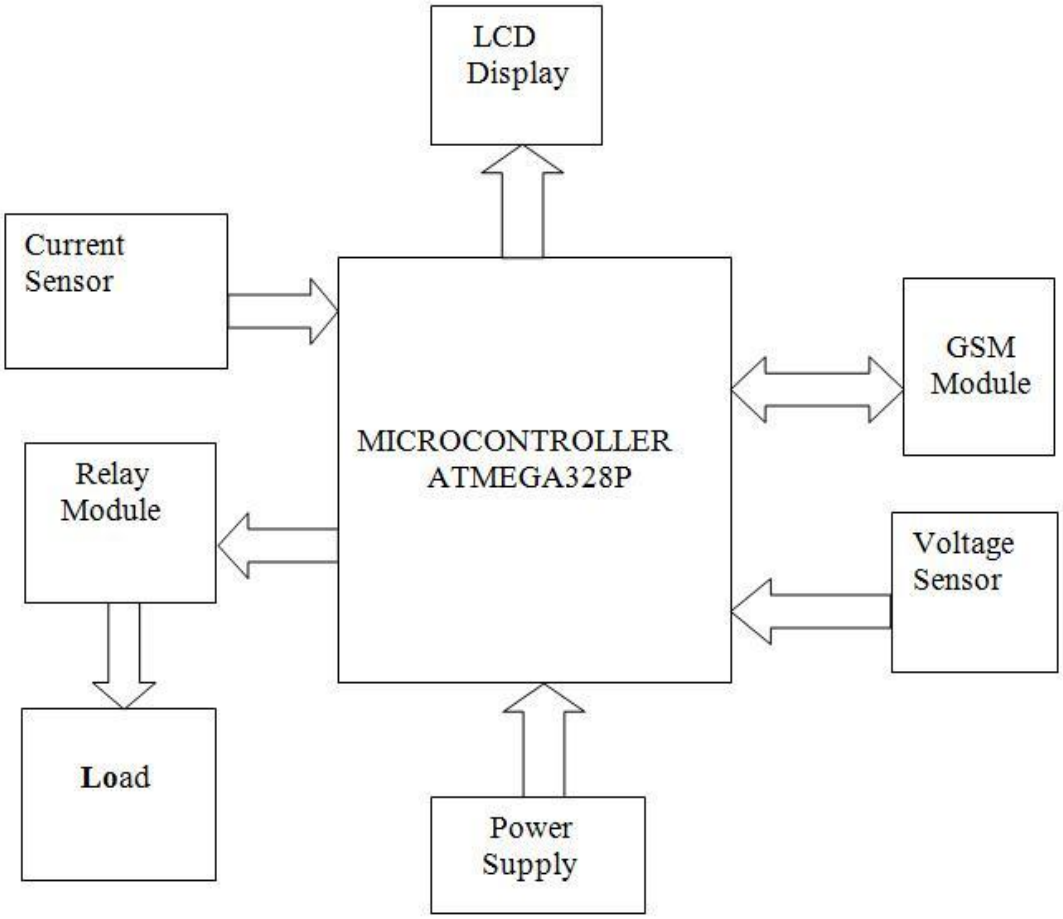

Fig 2.2: System architecture

In the above block diagram, a precise and clear representation of the whole system is shown. Line voltage (220V AC) is converted into suitable DC value by using a power supply unit to operate the microcontroller, LCD, GSM module etc. The power consumed is sensed by the current sensor and potential transformer and a fraction of the total power consumed is fed to the microcontroller. Microcontroller compares this fraction with the predetermined reference value. The reference value is set by depending upon the maximum demand of the consumer. If the value of the power fed to the microcontroller exceeds the reference value microcontroller causes to operate GSM and relay.

2.8 Flowchart of the overall project processing

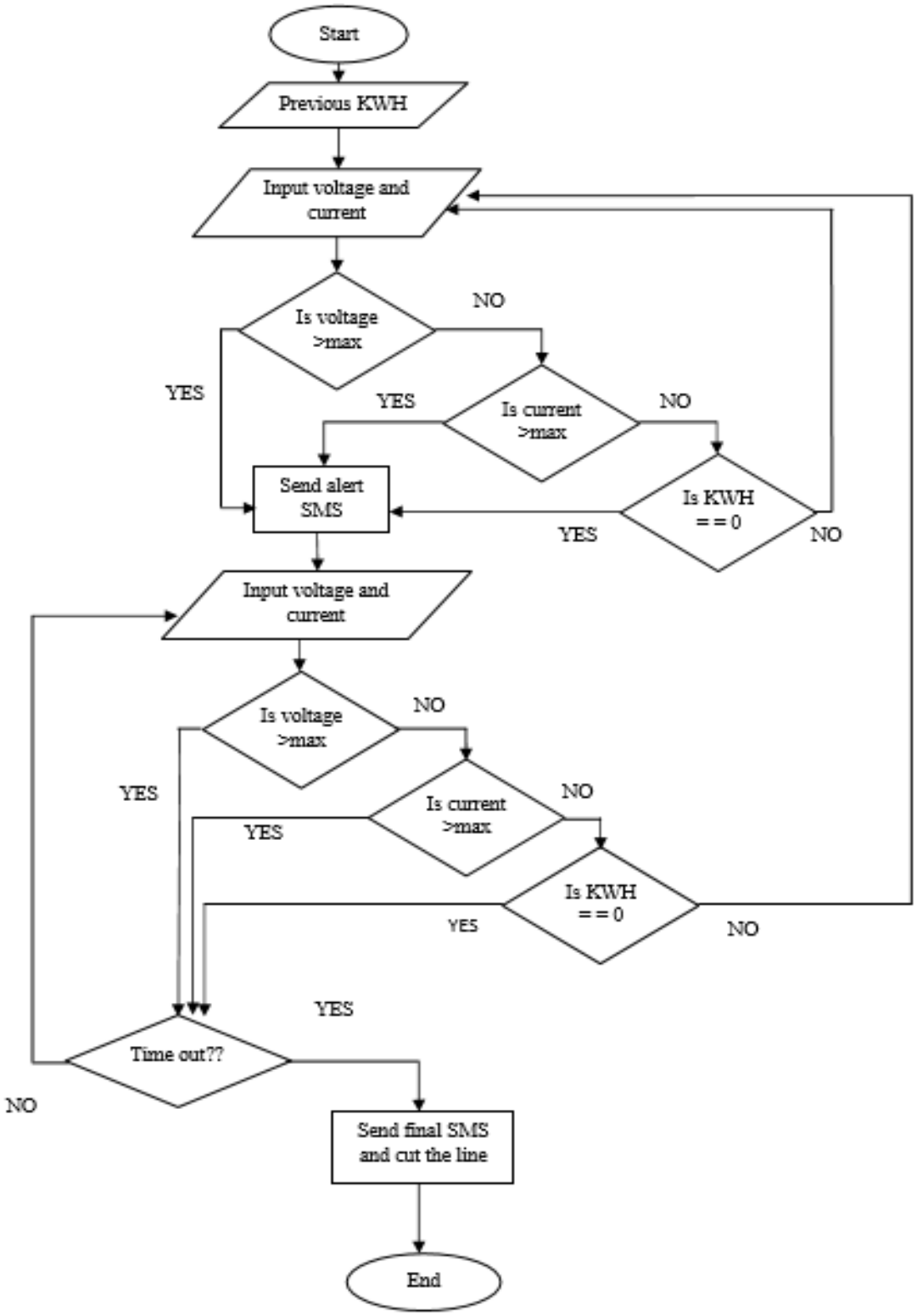

Fig 2.3: Flow chart

2.9 Summary

This chapter we discuss our project related circuit discussion, Schematic diagram of Project, anti-theft mechanism, overall voltage protection mechanism, system architecture and flowchart of the overall voltage protection. Also we discuss working principle different kind of mechanism and diagram.

CHAPTER 3

HARDWARE IMPLEMENTATION

3.1 Required Equipment's

In this chapter, we have provided a brief description of the devices and components that were used for the project. An attempt at explaining the general working mechanisms, features, applications and advantages of the system apparatus was made since without having a common idea of all the main components, it would be quite hard for a reader to understand the application and contribution of the individual components in the procedure followed in the project. The major system components being –

i. Microcontroller (ATMEGA-328)
ii. GSM (sim-800C) module
iii. Current sensor (ACS-712)
iv. LCD-16×2
v. Relay module (5V)
vi. Power supply (5V DC)
vii. Arduino UNO
viii. Voltage Transformer (220V to 12V)

3.2 Microcontroller (ATMEGA-328)

The ATmega328 is a single-chip microcontroller created by Atmel in the mega AVR family. [4]

Table 3.1: Key parameters of ATMEGA-328

Parameter	Value
CPU type	20 MIPS at 20 MHz
Flash memory	32 kB
SRAM	2 kB
EEPROM	1 kB
Pin count	28-pin PDIP, MLF, 32-pin TQFP, MLF
Maximum operating frequency	20 MHz
Number of touch channels	16
Hardware Touch Acquisition	No
Maximum I/O pins	23
External interrupts	2
USB Interface	No
USB Speed	

3.3 Parallel program mode

Table 3.2: parallel program mode

Programming signal	Pin Name	I/O	Function
RDY/BSY	PD1	O	High means the MCU is ready for a new command,
OE	PD2	I	Output Enable (Active low)
WR	PD3	I	Write Pulse (Active low)
BS1	PD4	I	Byte Select 1 (“0” = Low byte, “1” = High byte)
XA0	PD5	I	XTAL Action bit 0
XA1	PD6	I	XTAL Action bit 1
PAGEL	PD7	I	Program memory and EEPROM Data Page Load
BS2	PC2	I	Byte Select 2 (“0” = Low byte, “1” = 2nd High byte)
DATA	PC[1:0]:PB[5:0]	I/O	Bi-directional data bus (Output when OE is low)

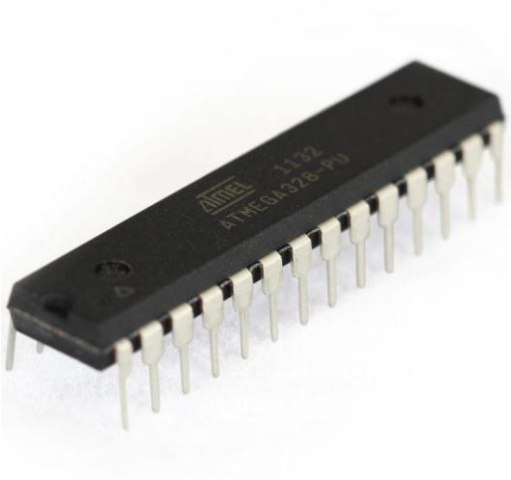

Fig 3.1: ATMEGA 328

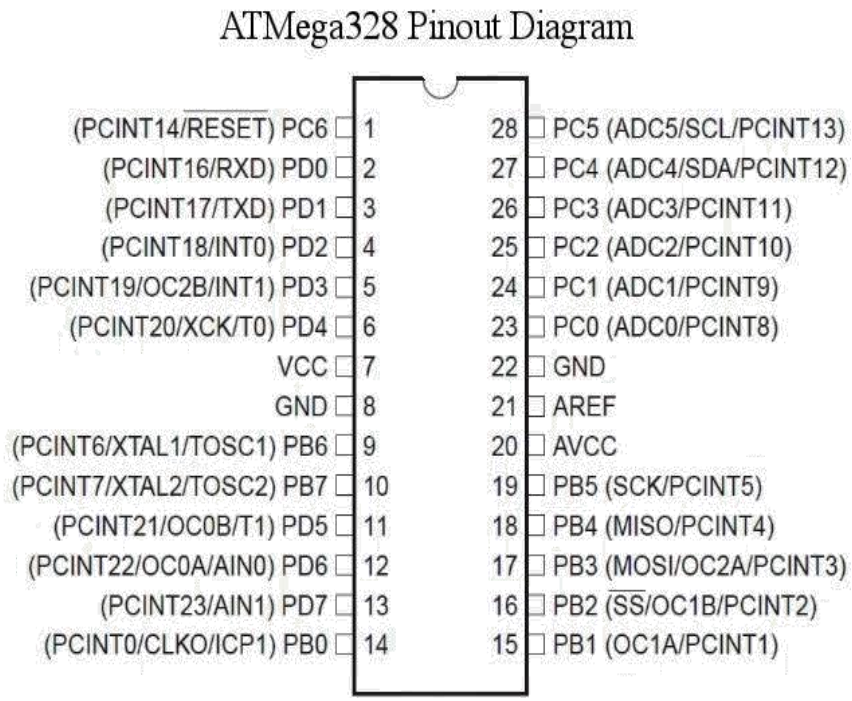

Fig 3.2: Pin Diagram

3.4 GSM Module (sim-800C)

Fig 3.3: Typical GSM module

A GSM Modem is operating on same principal of mobile phone. It is a type of modem which receives a sim card and operates over contribution to a mobile operator, as like a mobile phone from the mobile operator perspective. The GSM is interface with the arduino and it is used to send the information to the consumer about the faulty condition of the system through the SMS. [2] [5]

3.4.1 General features

- Quad-band 850/900/1800/1900MHz
- Control via AT commands (3GPP TS 27.007, 27.005 and SIMCom enhanced AT Commands)
- Supply voltage range 3.4 ~ 4.4V
- Low power consumption

3.4.2 Specifications for SMS via GSM/GPRS

- Point to point MO and MT
- SMS cell broadcast
- Text and PDU mode

3.4.3 Interfaces

- Analog audio interface
- USB interface
- Serial interface
- Interface to external SIM 3V/1.8V
- GSM Antenna pad
- Bluetooth Antenna pad

3.4.4 Compatibility

- At cellular command interface

3.5 Voltage Transformer

Voltage Transformer is fundamentally step-down transformers very accurate turn's ratio. A standard measuring device used to measure the change in high magnitude to lower voltage for step down transformer. It works in technique with more number of primary turns and less number of secondary turns. Uper value voltage and current cannot be measured directly.

Transformer has 240 V primary windings and center tapped secondary winding. The transformer has flying colored insulated connecting leads (Approx. 100 mm long). The Transformer act as step down transformer reducing 240V AC to 12V AC.

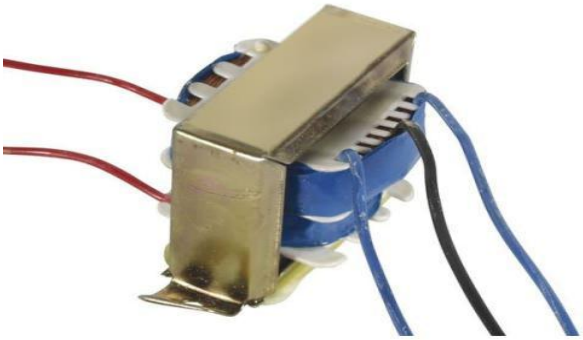

Fig 3.4: Typical Voltage Transformer (Center tapped)

3.6 Current Sensor (ACS-712)

The Allegro ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switched-mode power supplies, and over current fault protection. The device is not intended for automotive applications. The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized Bi-CMOS Hall IC, which is programmed for accuracy after packaging.

Fig 3.5: Current sensor

3.7 Features and Benefits

- Low-noise analog signal path
- Device bandwidth is set via the new filter pin
- 5 µs output rise time in response to step input current
- 80 Hz bandwidth
- Total output error 1.5% at T_A = 25°C
- Small footprint, low-profile SOIC8 package
- 1.2 m Ω internal conductor resistance
- 2.1 kV $_{RMS}$ minimum isolation voltage from pins 1-4 to pins 5-8
- 5.0V, single supply operation
- 66 o 185 mV/A output sensitivity
- Output voltage proportional to AC or DC currents
- Factory-trimmed for accuracy
- Extremely stable output offset voltage
- Nearly zero magnetic hysteresis
- Ratio-metric output from supply voltage

3.8 Arduino UNO

Arduino is open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments.

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators.

The microcontroller on the board is programmed using the Arduino programming language and the Arduino development environment. Arduino projects can be stand-alone or they can communicate with software running on a computer (e.g. Flash, Processing, Max/MSP).

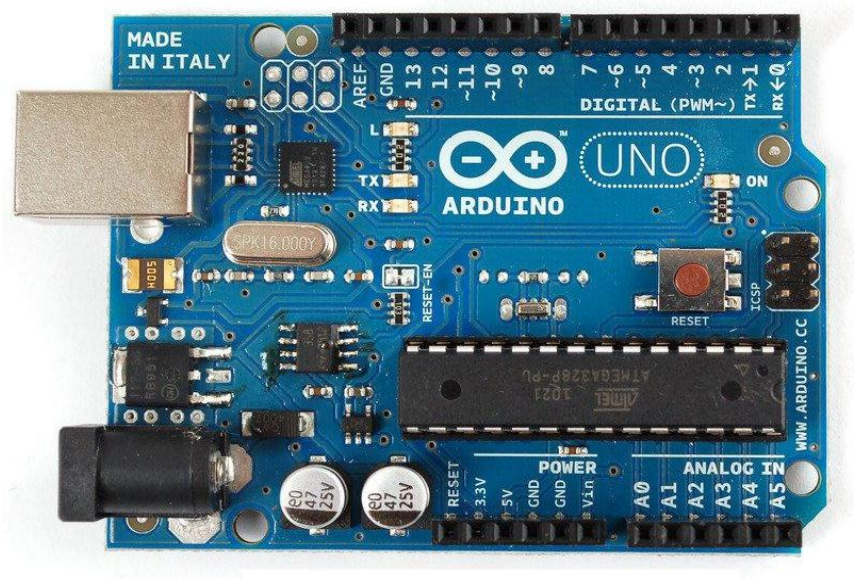

Fig 3.6: Arduino UNO

Table 3.3: Technical details

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

3.9 LCD Display (16×2)

With a wide range of applications, the 16x2 LCD (Liquid Crystal Display) display screen used here is a basic electronic display module and is very commonly used in various devices and circuits. This module was better suited to serve our purpose and is generally more preferred over seven segments and other multi segment LEDs because LCDs are economical, easily programmable, have no limitation of displaying special & even custom characters

(unlike in seven segments), animations and so on. Using an LCD display is essential for us for displaying the energy usage of and to the providers and users.

We come across LCD displays everywhere around us. Computers, calculators, television sets, mobile phones, digital watches use some kind of display to display the time. An LCD is an electronic display module which uses liquid crystal to produce a visible image. The 16×2 LCD display is a very basic module commonly used in DIYs and circuits. The 16×2 translates to a display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5×7-pixel matrix. LCD is used to show all result on screen. In this project 16pin (LMB162AFC) LCD is used to display the parameters of transformer such as voltage, current and temperature.

With a standard HD44780 chipset, these 16 characters by 2-line display works great with any microcontroller and is very easy to interface. It is possible to use all 8 bits plus 3 control signals or 4 bits plus the control signals of the 8-bit parallel interface of this LCD.

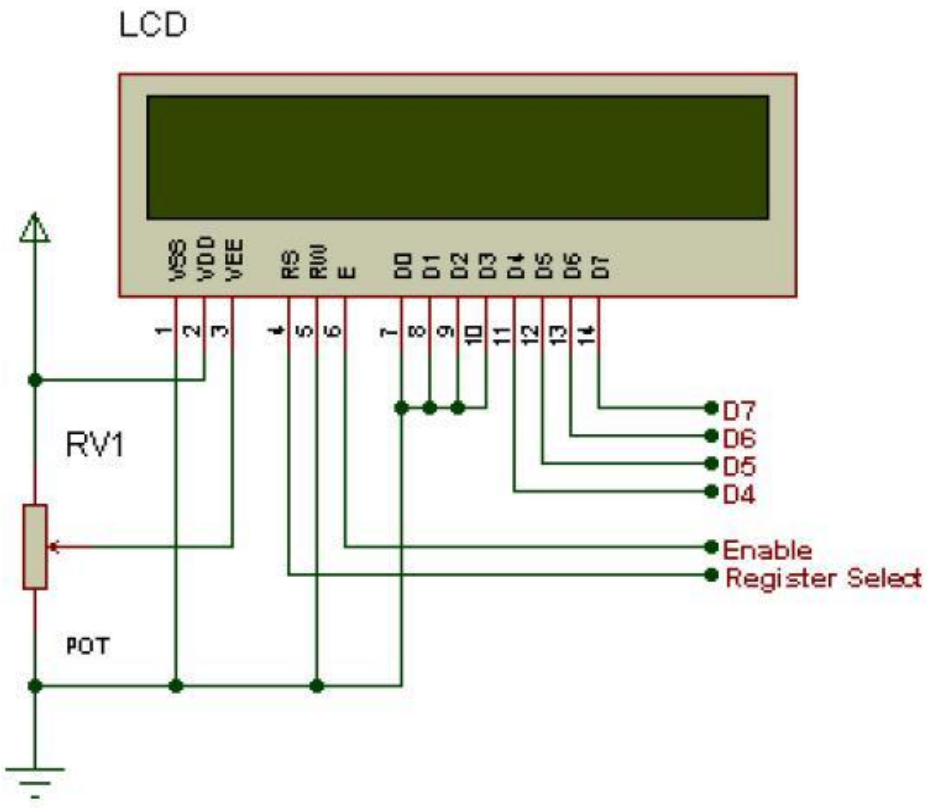

Fig 3.7: Connection diagram of LCD

3.9.1 The pin diagram of the 16x2 LCD display is shown below

Table 3.4: The pin diagram of the 16x2 LCD

Pin No	Name	Description
1	VSS	Power supply(GROUND)
2	VCC	Power supply(+5V)
3	VEE	Contrast adjust
4	RS	0-Instruction input 1-Data input
5	R/W	0-Write to LCD module 1-Read from LCD module
6	EN	Enable signal
7	D0	Data bus line 0 (LSB)
8	D1	Data bus line 1
9	D2	Data bus line 2
10	D3	Data bus line 3
11	D4	Data bus line 4
12	D5	Data bus line 5
13	D6	Data bus line 6
14	D7	Data bus line 7 (MSB)

3.10 Relay Module (5v, One-Channel)

It is widely adopted in devices of power protection, automation technology, sport, remote control, reconnaissance and communication, as well as in devices of electro-mechanics and power electronics. Generally speaking, a relay contains an induction part which can reflect input variable like current, voltage, power, resistance, frequency, temperature, pressure, speed and light etc. It also contains an actuator module (output) which can energize or de-

energize the connection of controlled circuit. The function of relay is to disconnect the supply when the abnormal condition is happened. The relay circuit is connected to Arduino board with using of opto-coupler (pc817). Opto-coupler is used for protects the microcontroller from high voltage spikes and the isolation purpose. The transistor is used in relay circuit to operate the relay. The output of Arduino become high, the relay circuit will operate and trips the load.

Fig 3.8: Relay Module

3.11 Power supply (5V, 9v DC)

We can get our desired voltage using IC 7805. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage. 7805 provides +5V regulated power supply.

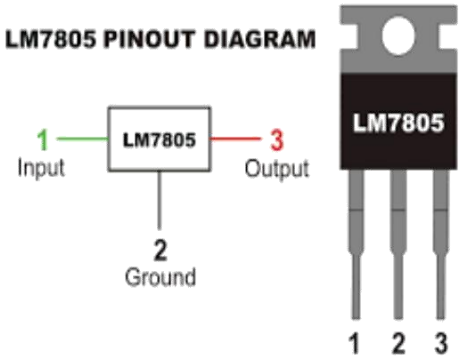

Fig 3.9: LM7805 voltage regulator IC

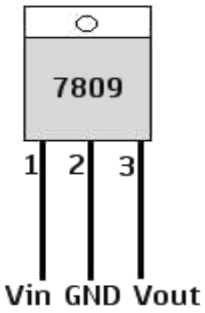

Fig 3.10: LM7809 voltage regulator IC

3.11.1 Pin Description:

Table 3.5: Pin description

Pin No	Function	Name
1	Input voltage (5v-18v)	Input
2	Ground (0v)	Ground
3	Regulated output 5V(4.8V-5.2V)	Output

3.12 Summary:

This chapter we discuss our project related various kind of instrument. This chapter we discuss different kind of instruments theory. Such as, Microcontroller (ATMEGA-328), GSM (sim-800C) module, Current sensor (ACS-712), LCD-16×2, Relay module (5V), Power supply (5V DC) , Voltage Transformer (220V to 12V), Arduino UNO, transistor, resistor, capacitor, relay, diode, etc. We also discuss classification of different kind of instrument.

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Results for prepaid billing

In the figure4.1 below, no bulb is on and power consumed is 7.3watt successive energy consumption is shown.

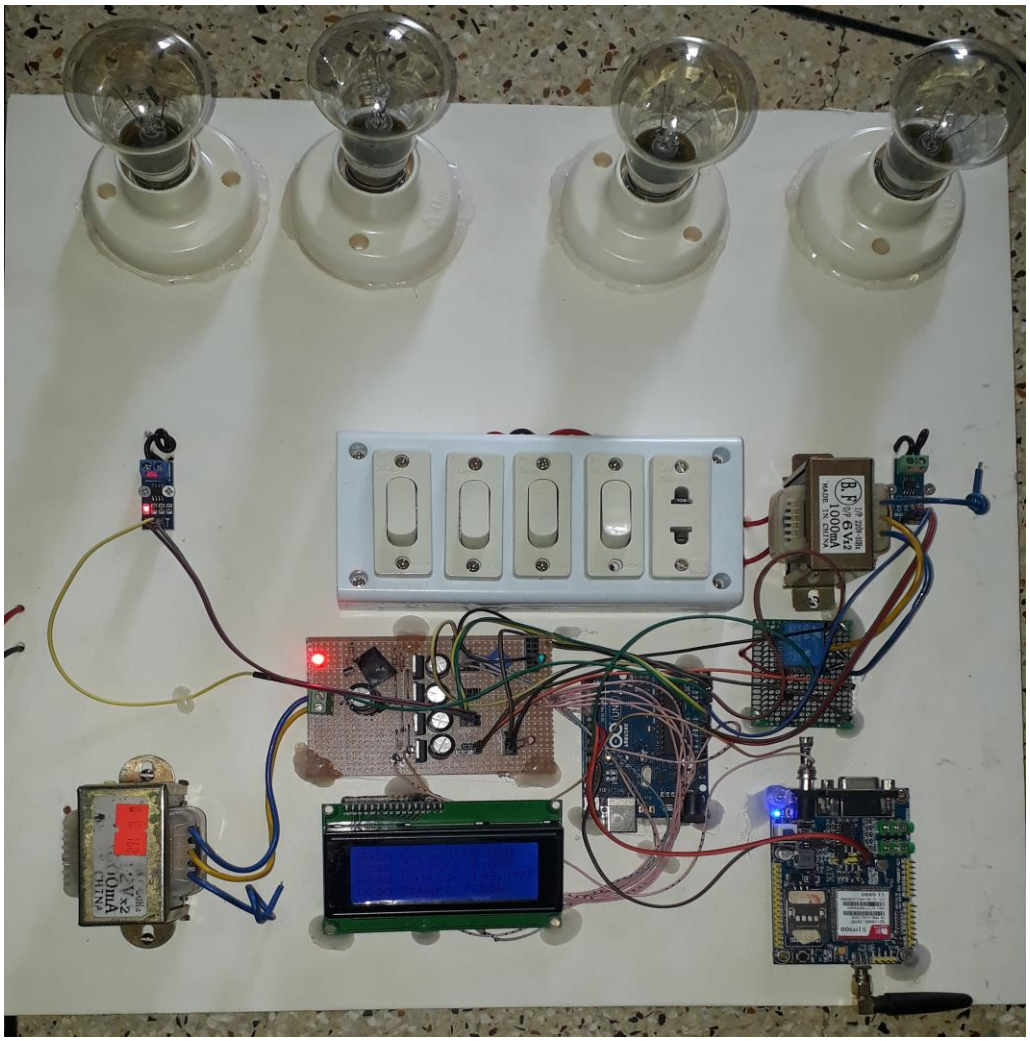

Figure 4.1: All load off

In figure 4.2 below, one bulb is on and power consumed is 55 watts. The maximum demand is 120 watts. It does not cross the maximum demand so hence the system is working in the normal condition.

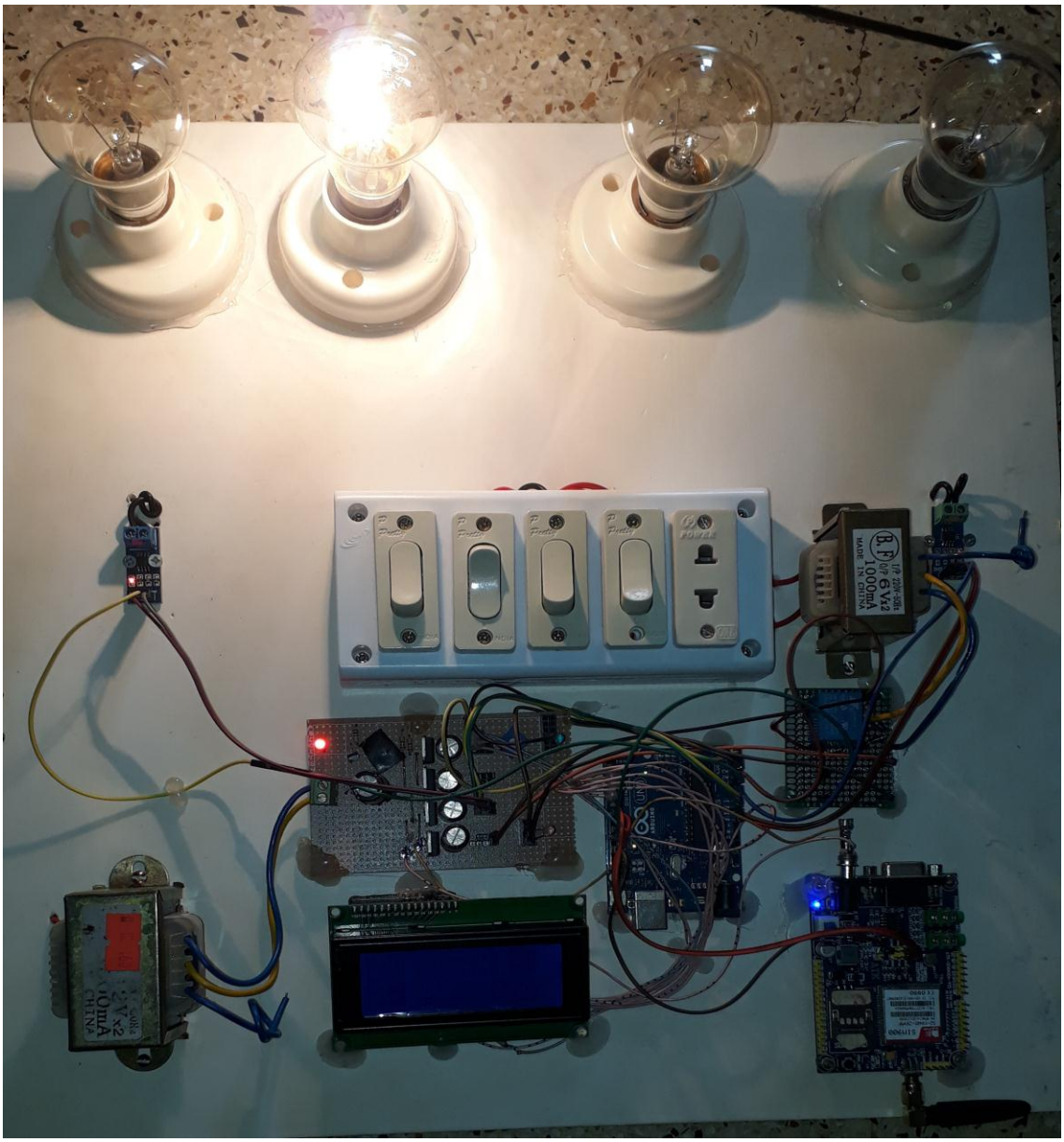

Figure 4.2: One load ON

In figure 4.3 below, two bulbs are on and power consumed is 95 watts. The maximum demand 120 watts. It does not cross the maximum demand so hence the system is working in the normal condition.

Figure 4.3: Two load ON

In figure 4.4 below, three bulbs are ON and consumed power is 135 watts. In this condition consumed power crosses, the maximum demand. The system is now continuously checking the power, if it is coming back below the maximum demand. The system will observe the

power for 20 seconds. If the consumed power does not come back below the maximum demand within this time load will be tripped and text message will be sent to consumer and supply company.

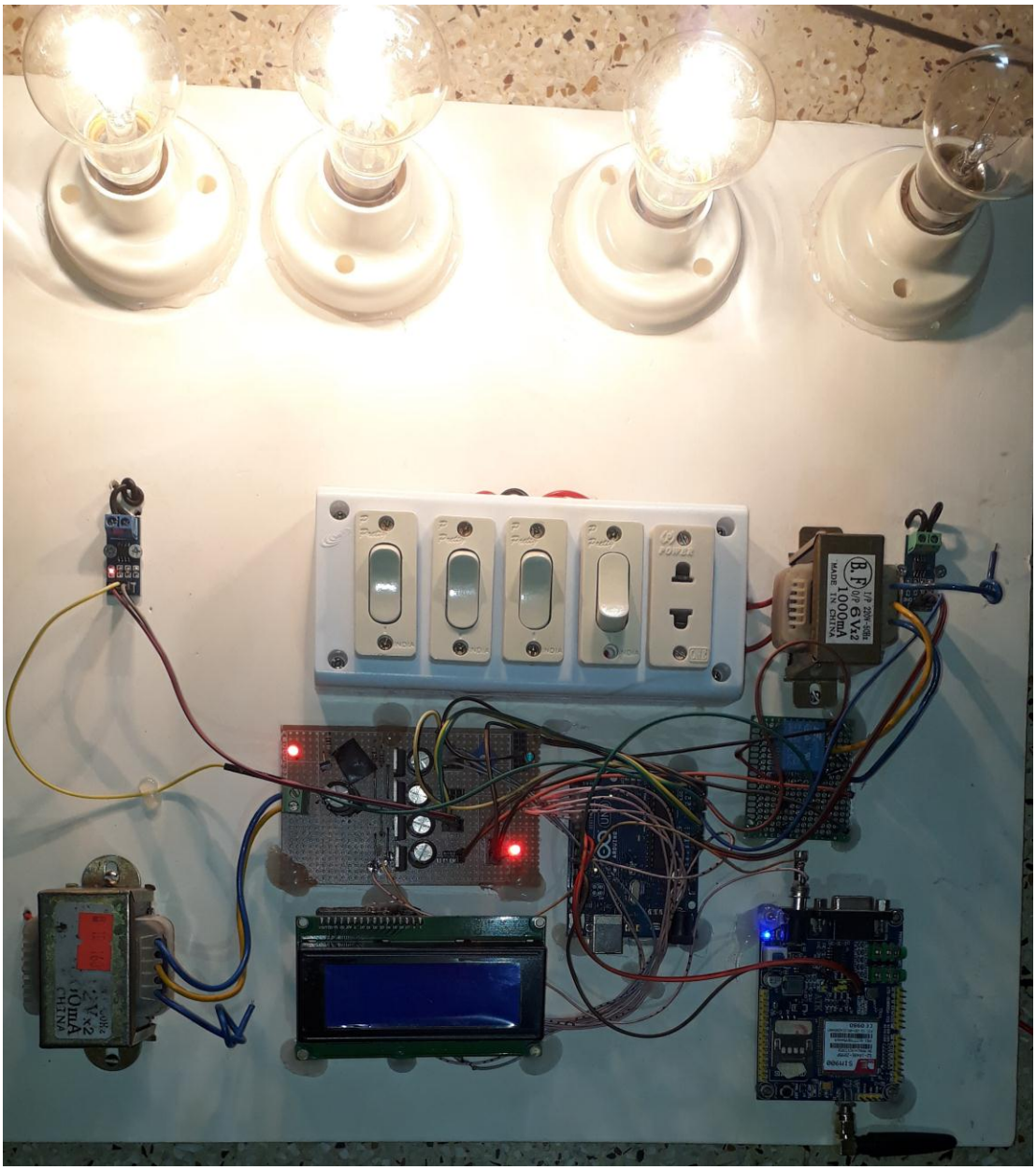

Figure 4.4: Overload Condition

4.2 Results for anti-theft mechanism:

In figure 4.2 one bulb is on and power consumed is 55 watts. The maximum demand is 120 watts It does not crosses the maximum demand. Hence the system is working in the normal condition.

In figure 4.3 two bulbs are ON and power consumed is 95 watts. It does not cross the maximum demand and hence the system is working in the normal condition.
In figure 4.4 three bulbs are ON and consumed power is 135 watts. In this condition consumed power crosses, the maximum demand. The system is now continuously checking the power, if it is coming back below the maximum demand. The system will observe the power for 10 seconds. If the consumed power does not come back below the maximum demand within this time load will be tripped and text message will be sent to consumer and supply company.

In figure 4.4 three bulbs are cut out due to the action of tripping mechanism. This mechanism is activated by the microcontroller signal which is sent after the observation of 10 seconds.
The message in figure 4.5 is sent to the supply company during shutting down. A unique customer ID is added in this message. Supply company can detect the place of pilferage with the help of this customer ID.

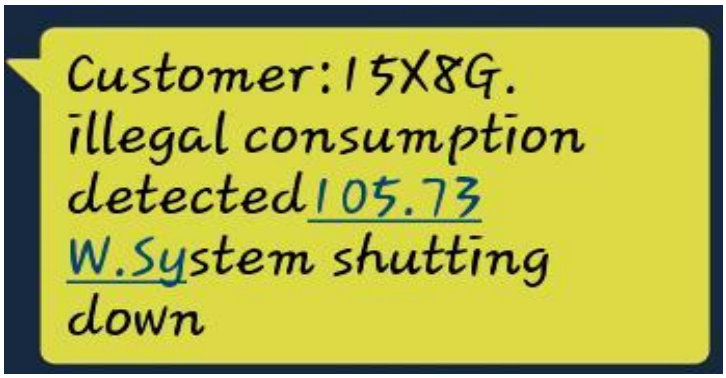

Figure 4.5: Messaging when overload occur

4.3 Discussion:

The main destination of the project is power theft protection. In the proposed model, every consumer is provided with an automated meter reader with inbuilt microcontroller the data consumed at regular intervals, the PIC microcontroller can be employed at consumers. PIC microcontroller sends data continuously and processes data, it already has the record of amount of power sent to each line and it compares this to received feedback, if the difference between these two values exceeds the prescriber limits then the microcontroller understands that power theft was happened and raises an alarm, also sends this information to local authorities via GSM modem. There is a prescribed limit because, we have to keep track of all general power losses other than theft and microcontroller was employed at consumer's end. Overall this system saves the power for the consumer, so this system is very effective.

4.4 Project Table Cost:

4.1: Project cost list

Name	Model / Value	Quantity	Cost
Arduino	UNO	1	380/=
Voltage regulator	7805 ,7812 (PNP)	4	20/=
Capacitor	220uf,10uf	5	60/=
Transformer	12v ,6v	1	250/=
Current sensor	-	2	100/=
Resistor	10k,1k 100k, 4.7k,1 ohm	15	20/=
Diode	1N4007	12	30/=
Switch & socket	-	5	100/=
Relay	Dc	1	20/=
Light	60watts, 40 watts	4	120/=
Project Board	-	1	60/=
Buzzer	5v	1	5/=
Led	2.5v	4	10/=
Variable resistor	103k	2	10/=
GSM (sim-800C) module	-	1	400/=
Batten holder	-	4	100/=
Others	-	-	350/=
Total			**=2035/-**

4.5 Summary:

This chapter we discuss our ProJet practical working procedure. This chapter we show that three condition, Firstly, we show that load is off condition, Secondly, we show that load is on condition and Finally, we show that overload condition than whole circuit will be trip. Also, we discuss result, discussion and overall whole project cost.

CHAPTER 5

CONCLUSIONS

5.1 Conclusion

Direct connections to the power system, through tapping the power line is one of the methods widely used in our country for electricity theft, a common form of commercial losses. Owing to the lack of information on both commercial and the legal loads in the system, commercial losses are nearly impossible to measure using traditional power system analysis tools. The results of commercial losses measurements in our country are often inaccurate. Whatever losses measured, are billed on the legal consumers also with the added disadvantageous condition of load-shedding during power failure. The progress in technology about electrical distribution network is a non-stop process. New things and new technology are being invented. Design of future electricity markets is aimed at providing consumers with highly reliable, flexible, readily accessible, and cost-effective energy services by exploiting advantages of both large centralized generators, as well as small distributed power generation devices. While, we may not be able to apply the latest of technologies to eradicate the problem of transmission and distribution(T&D) losses in our power theft owing to insufficient funding, we may still use the limited resources in our hands to develop an economic, yet satisfactorily effective modification of the current T&D system to improve the situation. The proposed system, although might seem to be little bit complex as far as distribution network is concerned, but it's an automated system of theft detection that saves time as well as help maximize profit margin for utility company working in electrical distribution network. Utility company can keep a constant eye on its costumer at an affordable cost of this new system.

This project is the combined hardware advantage for both utility and the customer. Arduino, relay, and GSM stationed, power theft detection, and voltage variation is built which is able to read and send data via GSM modem, capable of managing and controlling the supply to that meter through relay. Due to the power theft protection system defaulter meter line cutting/joining labor system is reduced. Power consumption, power quality, and its accuracy can be monitored by the consumers directly in their mobile. This process will reduce the labor work and human error in the distribution system and also protect the consumer equipment.

This project is aimed at reducing the heavy power and revenue losses that occur due to power theft by the customers, at the same time, finding the right balance and trade-off between cost-effectiveness and quality of the system.

By this design it can be concluded that power theft can be effectively suppressed by detecting where the power theft occurs and informing the authorities. The ability of the proposed system to inform or send data digitally to a remote station by using GSM modem adds a large amount of possibilities to the way the power supply is controlled by the electricity board. So, hopefully, with the implementation of the suggested modifications of the existing power system, the country will see an improved power sector and recovered revenues.

5.2 Limitations of the Work

To make this project is involving some limitation, the main limitation of the project is power is limited so we cannot use when need extra power. We need extra power then whole project system is changing so this system is expensive. Wide range of frequencies is required to facilitate large number of users. To overcome this, carrier levels can be changed from region to region. Presently, it required a power supply 220v for the operation, but a small battery with automatic charging facility can be provide in real time. If implemented on a large scale it my take lot of time and manual input.

5.3 Recommendations for future work

To make this protective system more advantageous remote sensing is required. We can develop this system by using a modulating and a demodulating device. An amplitude

modulated wave will be generated at the pole end which is modulated by the current at that end. This modulated wave will be demodulated at the load end. This demodulated wave will be compared with the current at the load end. If there is any difference between these two currents the system will be activated.

5.4 summary

This chapter we discuss our project final conclusion, limitations of the work and recommendation for future work or scope.

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APPENDIX

Program of this project: -

```
#include <SoftwareSerial.h>
#include <LiquidCrystal.h>
#include "ACS712.h"
#include <EEPROM.h>

SoftwareSerial GSM_Serial(8, 7);
ACS712 acs_sensor(ACS712_30A, A0);

const int rs = 9, en = 6, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

//const int sensorIn = A0;
const int voltageSensorIn = A1;
//int mVperAmp = 66; // use 100 for 20A Module and 66 for 30A Module

float AmpsRMS = 0;
float VoltRMS = 0;
float power = 0;
float maxPower = 60;
float maxVoltage = 230;
float maxCurrent = 0.3;
int warn = 0;
String num = "01755829767";
String num2 = "01726875546";
String message;
```

```
float kwh_now = 0.0f;
float maxKwh = 15.3f;
float kwh = 0.0f; //get from eeprom
uint32_t p_kwh_m_time;
uint32_t start_time;

void setup() {
pinMode(12, OUTPUT);
pinMode(11, OUTPUT);
EEPROM.get(0, kwh);
if (kwh == 0) {
kwh = maxKwh;
}
//set up the LCD's number of columns and rows:
lcd.begin(16, 2);
Serial.begin(9600);
while (!Serial);

//Being serial communication with Arduino and SIM800
GSM_Serial.begin(9600);
GSM_Serial.println("AT+CMGF=1");
delay(1000);

acs_sensor.calibrate();
lcd.print("Initialized");
}
```

```
void loop(0)
{
warn = 0;
digitalWrite(12, LOW);
AmpsRMS = (acs_sensor.getCurrentAC() - 0.04) * 0.8;
VoltRMS = getVoltage();
power = AmpsRMS * VoltRMS;
calc_kwh();

lcd.clear();
lcd.print(VoltRMS);
lcd.print("V");
lcd.setCursor(9, 0);
lcd.print(AmpsRMS);
lcd.print("A");
lcd.setCursor(0, 1);
lcd.print(power);
lcd.print("W");
lcd.setCursor(9, 1);
lcd.print(kwh);
lcd.print(" U");

if (VoltRMS > maxVoltage) {
lcd.clear();
lcd.print("Warning !!!");
lcd.setCursor(0, 1);
lcd.print(VoltRMS);
lcd.print(" V");
```

```
start_time = millis();
while (VoltRMS > maxVoltage) {
AmpsRMS = (acs_sensor.getCurrentAC() - 0.04) * 0.8;
VoltRMS = getVoltage();
power = AmpsRMS * VoltRMS;
calc_kwh();
lcd.clear();
lcd.print("Warning !!!");
lcd.setCursor(0, 1);
lcd.print(VoltRMS);
lcd.print(" V");
lcd.setCursor(11, 1);
lcd.print((millis() - start_time) / 1000);
lcd.print("s");
if ((millis() - start_time) > 20000) {
//Send SMS content
message = "Warning!!! High Voltage " + (String)VoltRMS + " V. System Shuttingdown.";
send_msg(num, message);
delay(1000);
message = "Customer:15X8G. High Voltage " + (String)VoltRMS + " V. System Shuttingdown.";
send_msg(num2, message);
delay(1000);
Serial.println("SMS Sent!");
//cut line;
```

```
while (1) {
digitalWrite(12, HIGH);
}
}
if (((millis() - start_time) > 5000) && warn == 0) { warn = 1;
//Send SMS content
message = "Warning!!! High Voltage " + (String)VoltRMS + " V.";
send_msg(num, message);
Serial.println("SMS Sent!");
}
if ((millis() - start_time) > 5000) {
digitalWrite(11, HIGH);
delay(10);
digitalWrite(11, LOW);
}
}
}
else if (power > maxPower) {
lcd.clear();
lcd.print("Warning !!!");
lcd.setCursor(0, 1);
lcd.print(power);
lcd.print(" W");

start_time = millis();
while (power > maxPower) {
AmpsRMS = (acs_sensor.getCurrentAC() - 0.04) * 0.8;
VoltRMS = getVoltage();
power = AmpsRMS * VoltRMS;
calc_kwh();
lcd.clear();
```

```
lcd.print("Warning !!!");
lcd.setCursor(0, 1);
lcd.print(power);
lcd.print(" W");
lcd.setCursor(11, 1);
lcd.print((millis() - start_time) / 1000);
lcd.print("s");
if ((millis() - start_time) > 20000) {
//Send SMS content
message = "Warning!!! High Power " + (String)power + " W.System shutting down";
send_msg(num, message);
digitalWrite(12, HIGH);
delay(4000);
message = "Customer:15X8G. illegal consumption detected" + (String)power + " W.System
shutting down";
send_msg(num2, message);
delay(1000);
Serial.println("SMS Sent!");

//cut line;
while (1) {
digitalWrite(12, HIGH);
}
}
if (((millis() - start_time) > 5000) && warn == 0) { warn = 1;
//Send SMS content
message = "Warning!!! High Power " + (String)power + " W.System may shutdown";
send_msg(num, message);
Serial.println("SMS Sent!");
}
```

```
if ((millis() - start_time) > 5000) {
digitalWrite(11, HIGH);
delay(10);
digitalWrite(11, LOW);
}
}
}
else if (kwh == 0) {
message = "Your balance is zero. Please recharge"; send_msg(num, message);
lcd.clear();
lcd.print("Please Recharge");
while (1) {
digitalWrite(12, HIGH);
}
}
Serial.print(AmpsRMS);
Serial.print(",");
Serial.print(VoltRMS);
Serial.print(",");
Serial.println(power);
}

void calc_kwh() {
kwh_now = ((power / 1000.0) * ((millis() - p_kwh_m_time) / (1000.0 * 60 * 60))) * 30000.0;
p_kwh_m_time = millis();
kwh = kwh - kwh_now;
if (kwh <= 0) {
kwh = 0.0f;
}
```

```
EEPROM.put(0, kwh);
}
float getVoltage() {
float result;
int readValue;
int maxValue = 0;
int minValue = 1024;

//value read from the sensor
// store max value here
// store min value here

uint32_t start_time = millis();
while ((millis() - start_time) < 1000) //sample for 1 Sec
{
readValue = analogRead(voltageSensorIn);
//see if you have a new maxValue if (readValue > maxValue)
{
/*record the maximum sensor value*/
maxValue = readValue;
}
if (readValue < minValue)
{
/*record the maximum sensor value*/
minValue = readValue;
}
}
// Subtract min from max
result = ((minValue + ((maxValue - minValue) / 2.0)) / (1024)) * 220;
return result;
}
```

```
void send_msg(String num0, String msg)
{
GSM_Serial.print("AT+CMGS=\"");
GSM_Serial.print(num0);
GSM_Serial.print("\"");
GSM_Serial.write(13);
GSM_Serial.write(10);//enter
delay(1000);
GSM_Serial.print(msg);
GSM_Serial.write(26);//ctrl+Z
}
```