ISSN No:-2456-2165

Design and Construction of LPG Detection and Control System with SMS Alert

Usman Magaji

ISSN No:-2456-2165

ABSTRACT

A liquefied petroleum Gas (LPG) leakage is an accident waiting to happen. Fire incidents resulting from LPG are quite dangerous as it could lead to loss of lives and properties. Therefore, it is very important to measure liquid petroleum gas concentration in an environment and to device a means to control it to prevent any possibility of fire incident. This work aims at designing a system that detects LPG leakage and alert the user through alarm and status display and besides, the system has the capability to turn close off the gas supply channel with an electrically controlled valve as a primary safety measure. Reviews of previous studies in controlling the LPG leakage have shown that electrically controlled valve can make significant job in preventing the gas to escape into environment as failure to do is quite dangerous. This present study will extend the capability of the previous designs by incorporating a means of simultaneously alerting the user via an electronic text message and ringing a buzzer as well. The system built was after the modification of the electrical circuits in the previous designs and it was tested using a cigarette lighter. The lighter contains inflammable gas (methane gas). As the lighter was opened up and the gas concentration near the device's sensor was allowed to reach the threshold value of 45ppm (indicated on LCD), the system automatically activated itself and following events occurred: the buzzer rang, the supply line valve was shut down and sixty seconds later, a gas leakage detection notification (SMS) was sent to the user via the predefined phone number. The shutting of the supply valve stopped further gas flow to prevent occurrence of fire incident. LPG users either at home or industry need to take preventive measure to detective potential gas leakage in their environment. One way of achieving the objective of detecting and controlling gas leakage is to incorporate a device that can automatically take action in the event of a leakage. The system designed and constructed in this project demonstrates that it can automatically detect and stop gas leakage in vulnerable premises.

CHAPTER ONE

BACKGROUND OF THE STUDY

A. Introduction

Liquefied Petroleum Gas also abbreviated as LPG which is a mixture of burnable hydro-carbons. Liquefied petroleum gas leakage happens in house, business locations, and gas powered vehicle and in vehicles that transport gas. This leakage is hazardous as it causes fire incidents. The developed system gives the alarm after detection of the presence of gas and leakage can be controlled by valve resulting to a continuous real time monitoring of Leak Gas.

It is of great importance to know the concentration of LPG in an environment in order to prevent accident of fire. Many incidents of fire due LPG leakage occurred as a result of forgetting to turn off gas cylinder valve after cooking and many people do not usually check the valve status the next time they want to cook. In this situation, once the diffused gas is ignited, it will just explode and this will lead to the loss of lives and properties.

This is the reason this system becomes very important. The major problem about this system is how it responds when gas level is risen to high.

This system is designed to monitor the concentration of gas and display on an LCD the status of the gas. When gas level detected is high, the system will automatically close the valve, sounds alarm and sends SMS to the predefined mobile number about the status of the gas. The system is programmed to resend the SMS after every 60 seconds for three times.

B. Motivation

Liquefied petroleum gas leakage happens inside a home, commercial premises, gas powered vehicle and in gas transportation vehicles. The causality caused by LPG leakage is common news in media. In November 2015 in Kano state, fire outbreak occurred at Sabon Gari Market and as a result of it, properties worth more than N186m were destroyed by the outbreaks. Recently, a fire accident has occurred in Potiskum Yobe state as a result of LPG leakage which caused newly married couple lost their lives. As an Electrical/Electronics Engineering student, it is one of the requirements in pursuing a degree certificate to carry out an intelligent piece of work that will solve a certain problem such as fire outbreaks due to LPG leakage.

C. Statement of the Problem

Several times people forget to turn off their gas cookers, especially those that are not familiar to using a gas cooker. In a situation the person accidentally ignites a flame, then there will be a serious explosion which will result to loss of lives and properties. Additionally, sometimes leakage happens from the gas supply host which is also a dangerous case.

D. Aim and Objectives

- **Aim**

This project is aimed at the design and implementation of LPG detection and control system with a SMS alert.

- **Objectives**

The following are the objectives to be achieved in this project:

- To interface an MQ3 sensor with Arduino ATmega328p microcontroller.
- Design and construction of the gas supply channel control (solenoid valve)
- To interface the microcontroller with a GSM module
- To interface a buzzer with the microcontroller.
- To interface a LCD with the microcontroller to display the status of the gas.
- To program the Arduino ATmega328p microcontroller to perform the requited task.

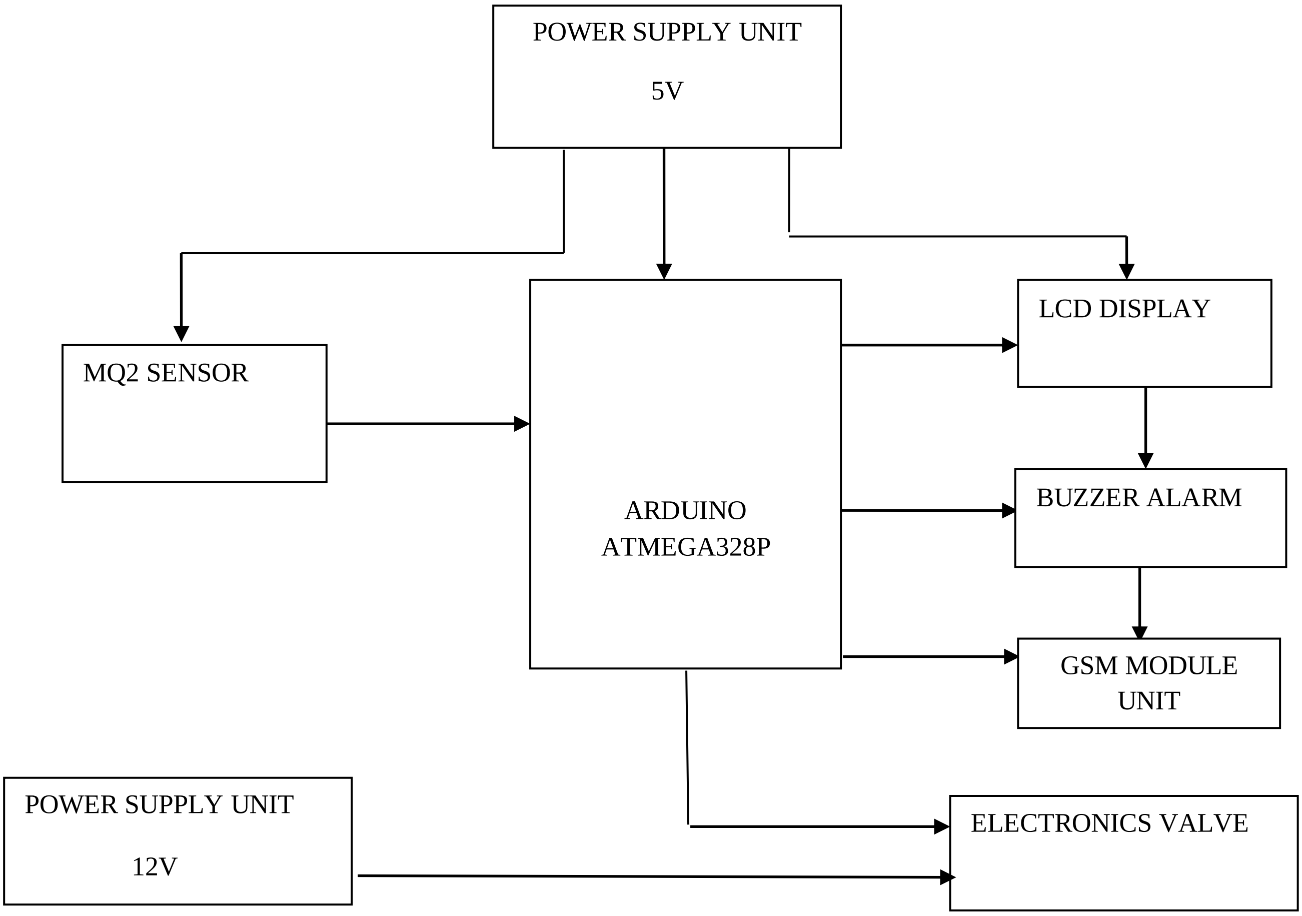

Fig. 1 : SYSTEM BLOCK DIAGRAM

E. Project Methodology

This system consists of five main sections. In the first section, the MQ-3 gas sensor with the help portable gas leak detector, detects the presence of gas particles. Second part consists of microcontroller unit which is coded with the requited instructions. When gas concentration detected by the sensor reaches high level, the sensor sends signal to the microcontroller. In third part, microcontroller unit compares the signal with the reference and also sends signal to the display unit which shows the concentration value of the leaked gas, and to the fourth part of the system, that is alarm unit followed by sending a text message to the owner of the premises with the help of GSM SIM900 module. In fifth part, electromechanical or solenoid valve turns off after receiving signal from the microcontroller with the help of relay and the solenoid valve closes the main gas supply.

The system to be built take its power supply of 240V/50Hz from the mains using a stepped down 12V transformer and rectify using a bridge rectifier. The output is regulated to 5VDC using LM7805.

F. Scope of the Study

This work presents the design and implementation of a LPG detection and control system using SMS alert. It is designed to sense the presence of a LPG gas leakage in an environment and tells microcontroller the status of the gas in the immediate environment. If the concentration of a gas reaches the level that can cause an accident, the microcontroller is programmed to automatically send a signal to the GSM module that will send a warning message to the house owner, turn off the gas supply channel and activate a buzzer.

G. Conclusion

The chapter discusses the aim of the project which is a design and construction of LPG detection and control system using SMS alert with Atmega328p microcontroller. The method to be used to achieve the aim is also discussed.

CHAPTER TWO

LITERATURE REVIEW

A. Introduction

Literature review was carried out for this project is the previous project and thesis that is related to this project. Other sources are also included such as books, journals and articles obtained from internet. This chapter discusses the previous works/projects related to this project.

B. Literature Review

Mahalingam, et al (2015) designed and implemented an Economical Gas Leakage Detector. In this project when the sensor detects no gas in the air, it produces a voltage below 1.2V on the output pin, which is connected to port RA0 of the microcontroller. But when the sensor detects the present of the gas in the air, the voltage rises above 1.2V. The voltage ranges varies from 1.2V to 5V. It is depended on the amount of gas sensed. If the value of voltage falls within the range of 1.2V to 4V, the microcontroller activates a low level early warning by turning-on LEDs and buzzer. The low level warning signal is maintained for 100ms (slow mode) before it stops. This loop is repeated until the voltage drops to 1.2V and below or rises to beyond 4V. If the voltage rises above 4V, then the high level dangerous warning sign is activated by sending signals to turn-on LEDs and the buzzers (BUZ1 and BUZ2) respectively. These signals are supplied for 50ms (fast mode) and then stop. This step is repeated until the voltage drops below 4V. The system remains active until the gas level is reduced below the acceptable limit of less than 400ppm.

An improvement to the above system is that when a leakage occurs, the gas supply channel is automatically closed using an electronic valve that is controlled by the microcontroller. Also, in the existing system, there was no provision of GSM module to send an SMS to a pre-defined number, but in my system, a GSM module is incorporated. It is used for sending warning message to a pre-defined number.

Rajitha, et al (2012) designed a security alert system using GSM for gas leakage. The aim of the project is to monitor for liquid petroleum gas (LPG) leakage to avoid fire accidents. The system detects the leakage of the LPG using gas sensor and alerts the consumer about the gas leakage by sending SMS. When the system detects LPG concentration in the air exceeds the certain level then it immediately alert the consumer by sending SMS to specified mobile phone and alert the people at home by activating the alarm which includes LED, buzzer simultaneously and display the message on LCD display to take the necessary action and switch on the exhaust fan to decrease the gas concentration in the air.

An improvement to this system is that when a leakage occurs, the gas supply channel is automatically turned off using an electronic valve (solenoid valve) that is controlled by the microcontroller.

Fraiwan, (2011) designed a wireless home safety gas leakage detection system.This project aim to design the system to improve the drawback of the work reviewed. The system will be monitoring the presence of LPG gas in an environment. When gas is detected, the microcontroller will activate buzzer to make an audible sound, GSM module to send a message "Gas Leakage Detected" to the predefined phone number indicating the concentration value of the gas detected, LCD to display the gas status and the electronic valve which will automatically close the gas supply channel.

C. MQ-3 Gas Sensor

An MQ3 is one of the commonly used gas sensors in MQ sensor series. It is a Metal Oxide Semiconductor (MOS) type Gas Sensor also known as Chemi-resistors. The detection is based upon change of resistance of the sensing material when the Gas comes in contact with the material. It uses a simple voltage divider network in detection of the concentration of gas.

a) Working Principle MQ-3 gas sensor

MQ-3 gas sensor is used for, gas leakage detection system because it is suitable for detecting H2, LPG, CH4, CO, Alcohol, Smoke or propane. Due to its high sensitivity and fast response time, measurement can be taken as soon as possible. The sensitivity of the sensor can be adjusted by potentiometer. The MQ-3 sensor detects LPG gas, and compare its output voltage with reference voltage. It rises a HIGH output when LPG gas is detected. The MQ3 gas sensor module is easy to interface with the microcontroller (Agnihotri, 2018).

D. Liquid Crystal Display (LCD)

An LCD is short for Liquid Crystal Display. It is basically a display unit which uses liquid crystals to produce a visible image. Here we shall concentrate on the small monochrome, alphanumeric type which displays alphabetical, numerical and symbolic characters from the standard ASCII character set.

When current is applied to this special kind of crystal, it turns opaque blocking the backlight that lives behind the screen. As a result that particular area will become dark compared to other. And that's how characters are displayed on the screen. A 16×2 line Hitacchi HD44780 display is shown in fig 2.3. The display is a standard LM016L which displays 2 lines of 16 characters (16×2). Each character is 58 pixels, making it 80×16 pixels overall. The display receives ASCII codes for each character at the data inputs (D0 – D7).

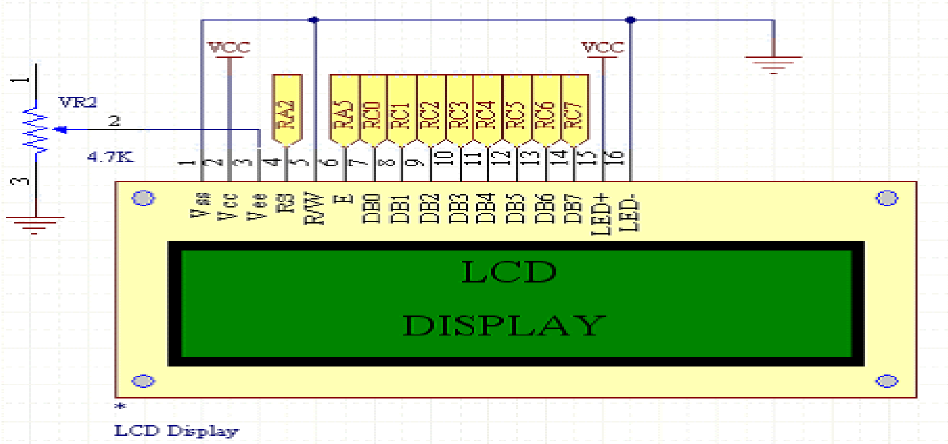

Fig 2 : A 16×2 line Hitacchi HD44780 display

E. Solenoid Valve

A solenoid valve is an electromechanical device in which the solenoid uses an electric current to generate a magnetic field and thereby operate a mechanism which regulates the opening of fluid flow in a valve.

Solenoid valves differ in the characteristics of the electric current they use, the strength of the magnetic field they generate, the mechanism they use to regulate the fluid, and the type and characteristics of fluid they control. The mechanism varies from linear action, plunger-type actuators to pivoted-armature actuators and rocker actuators. The valve can use a two-port design to regulate a flow or use a three or more port design to switch flows between ports. Multiple solenoid valves can be placed together on a manifold (Loshali, 2017).

The figure 2.4 below shows solenoid valve

Fig. 3 : Solenoid Valve

F. ATmega328 Microcontroller

The microcontroller used in this unit is the high-performance Atmel 8-bit ATmega328 microcontroller shown in figure 2.8 below which is a low-power, high-performance based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1KB EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, a single 16-bit Timer/Counter with independent prescaler, compare and capture modes. The ATmega microcontroller is used because it is easier to program, cheap, and its availability in the market.

When the gas sensor detects the gas concentration and gives signal to the microcontroller (ATmega328) with the help of ADC, the microcontroller receives the signal and sends activation signal to other external devices attached with it. This activates the buzzer, message display on liquid crystal display, GSM module which send warning SMS to the user and lastly close uo the supply by turning off the solenoid valve.

a) Pin Diagram of ATmega328**:-**

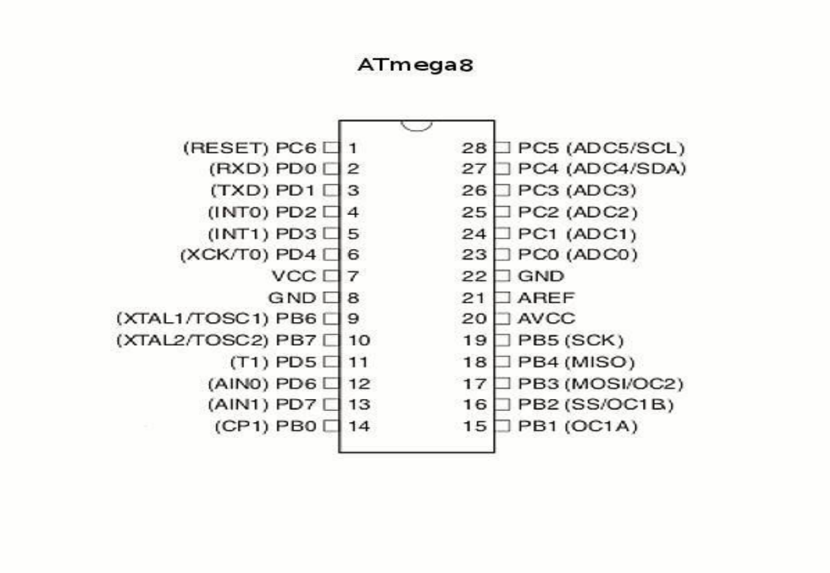

Fig. 4 : ATmega328 Pins

VCC	Voltage for digital purposes
GND	Groung
Port B (PB7 to PB0) TOSC1/TOSC2/XTA L1/XTAL	Port B can be used as input or output. That is why it is called bidirectional input/output port and pull up register for each bit is used. When the pull up register is activated port B pins are kept as low. When reset condition is kept high, port B pins reached in tri state. In this situation, clock pulse may or may not run. Inverting oscillator amplifier input comes from the PB6, PB7 is used as output of inverting oscillator amplifier.
Port C (PC5 to PC0)	Port C can also be used as input and output. So it is also bidirectional as port B. Pull up register is also used for each bit of port C (PC0 to PC7)
PC6/Reset	PC6 bit is different from all other bits of Port C. this is used as input/output pin when RSTDISBL fuse is programmed.
Port D (PD7 to PD0)	Port D can be used as input or output. That is why it is called bidirectional port and pull up register for each bit is used. When the pull up register is activated, port D pins are kept as low.
Reset data	Reset is used to reset the values of all the ports, registers and interrupts of the microcontroller

Table 1 : Descriptions of the Pin of ATmega8

EPROM	512BYTES
FLASH MEMORY	8 KILOBYTES
DC CURRENT PER I/O PIN	40 milli Ampere
STATIC RAM	1 KILO BYTES
DIGITAL I/O PINS	4
ANALOG I/O PIN	6

Table 2 : ATmega328 Specifications

G. Crystal Oscillator

Crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency. This frequency is often used to keep track of time, as in quartz wristwatches, to provide a stable clock signal for digital integrated circuits and to stabilize frequencies for radio transmitters and receivers. The figure 2.7 below shows the crystal oscillator.

Fig. 5 : Crystal Oscillator

H. SIM900 GSM Module

SIM900 GSM/GPRS shield is a GSM modem, which can be integrated into a great number of IOT projects. You can use this shield to accomplish almost anything a normal cell phone can; SMS text messages, Make or receive phone calls, connecting to internet through GPRS, TCP/IP, and more! To top it off, the shield supports quad-band GSM/GPRS network, meaning it works pretty much anywhere in the world (lastminuteengineers.com). The figure 2.8 below shows the SIM900 GSM module.

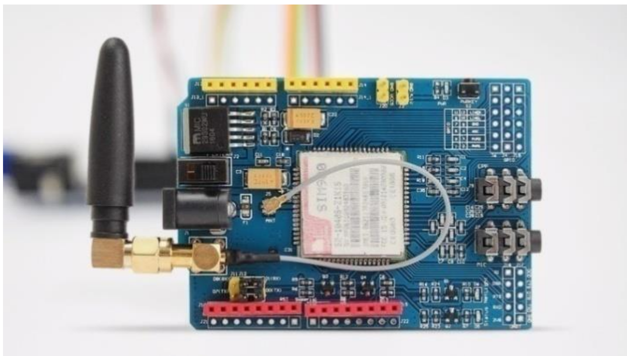

Fig. 6 : SIM900 GSM Module

I. Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. Buzzer is an integrated structure of electronic transducers, DC power supply, widely used in computers, printers, copiers, alarms, electronic toys, automotive electronic equipment, telephones, timers and other electronic products for sound devices. The figure below shows the a buzzer.

Fig. 7 : BUZZER

J. Discrete Electronics Components

These are the individual passive and active electronic components other than the microcontroller or any other integrated circuit (IC) used in the circuit.

The discrete electronic components used in this project circuit are capacitors and resistors, which are shown in Figure 2.15

ISSN No:-2456-2165

Fig. 8 : Discrete Electronic Components

(a) Ceramic capacitor (b) Fixed Resistor (c) Electrolytic capacitor

The electrolytic capacitor is used to filter ripples in the power supply circuit, and the ceramic capacitors are used for the stabilization of the 8mHz crystal oscillator frequency. While the resistor was used as current limiters as well as pull – up resistors. Pull up means to hold a particular data pin in a high position or signal to enable smooth operations or signal to enable smooth operations in the microcontroller or other integrated circuit.

K. Conclusion

The chapter review some effort made to achieve LPG leakage detection and control system using which is widely accepted as one of the most effective ways to prevent injuries caused by fire accident due to the gas leakage in houses.

ISSN No:-2456-2165

CHAPTER THREE

DESIGN AND IMPLEMENTATION

A. *Introduction*

This chapter aims to explain the design of a circuit that will realize a liquefied petroleum gas (LPG) detection and control system with a SMS alert. The analysis and calculations of all the units that make up the system such as the power supply unit, the gas sensor unit, the gas status display unit, the alarm unit, the alert unit, and the control unit are presented. The various units were designed and tested separately.

B. *Design of the overall project*

The approach used in this design is the modular one where the overall design is first broken into six functional units, where each unit represents a section of the circuit that carries out a specific function. The functional block diagram of Fig. 3.1 shows the interconnections between these units. Each section of the block is analyzed below:

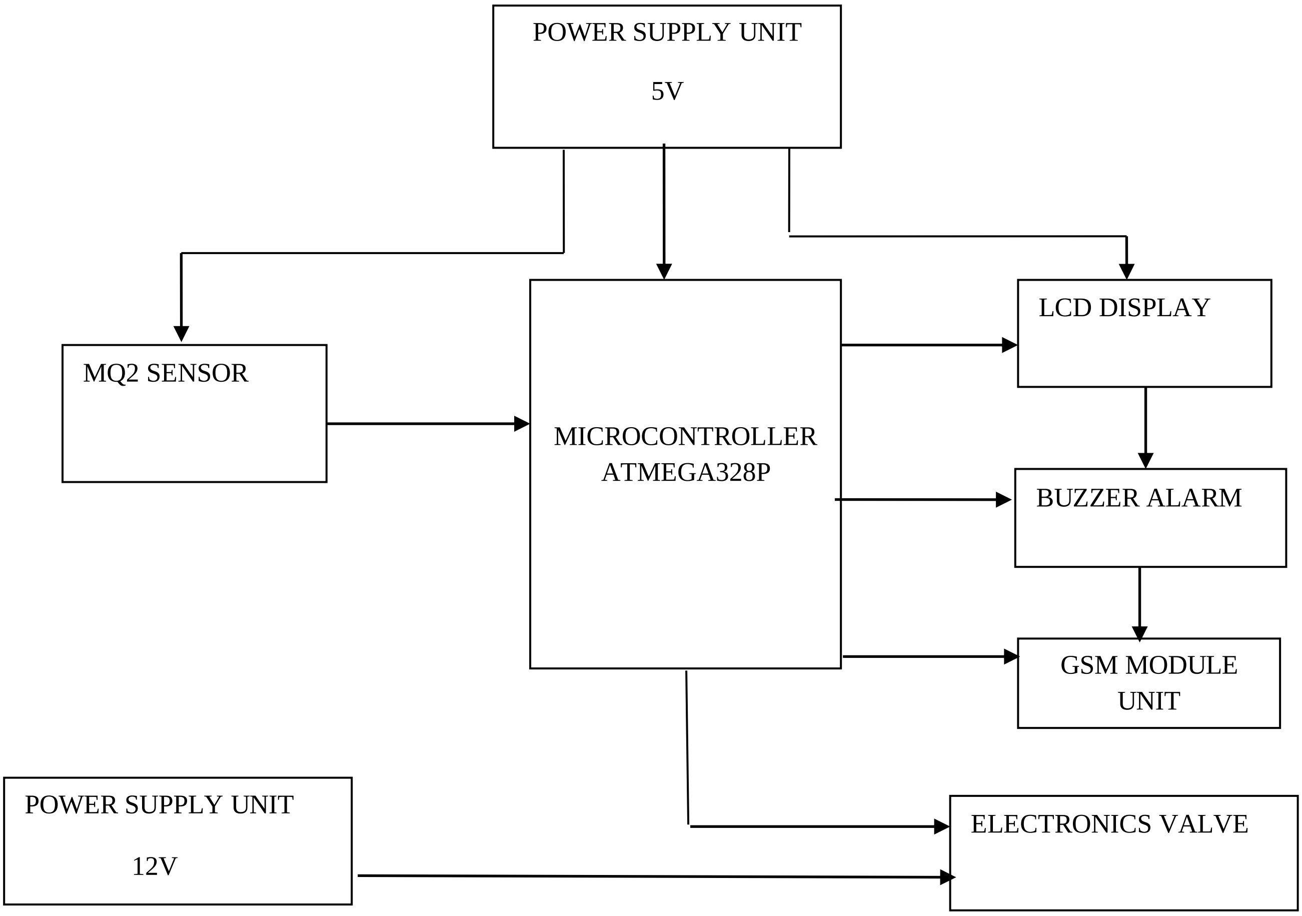

Fig. 9 : Block diagram of a LPG Detection and Control System Using SMS Alert

a) Design of Power Supply

The power supply unit consists of a 240V/18V, 50Hz 500mA step down transformer, Bridge rectifiers, filter capacitors and voltage regulators. Voltage from the mains = 240V AC at the frequency of 50Hz. This voltage is the rms value and is stepped down to 18V by the 240V/18V transformer.

ISSN No:-2456-2165

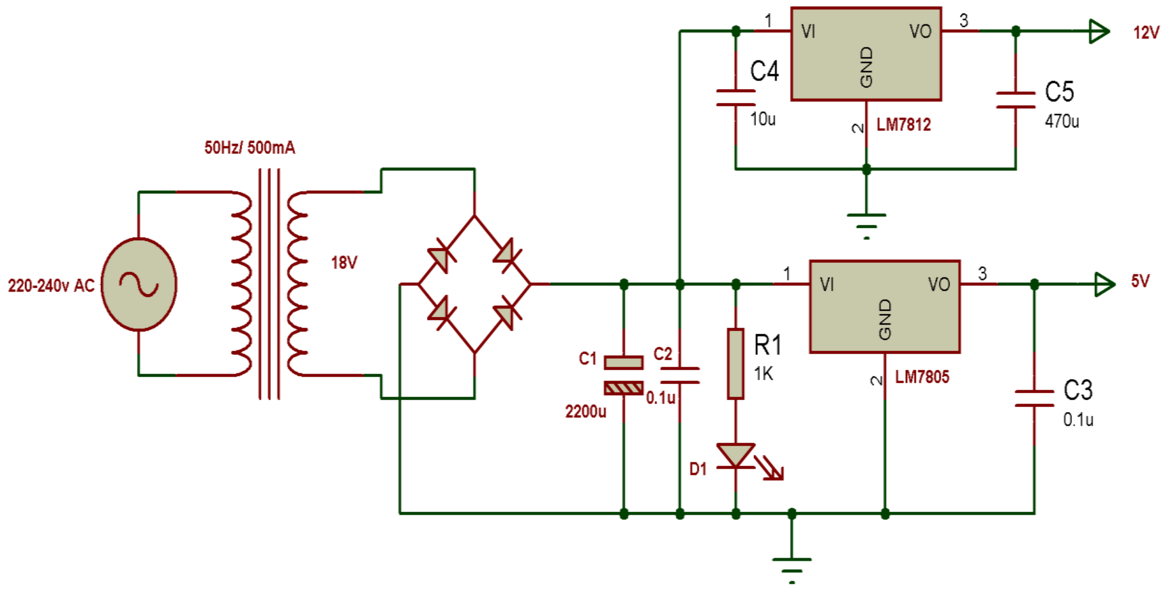

Fig. 10 : Circuit for the Power Supply Unit

The values of the components used in the power supply are calculated as follows;

b) 3.2.1.1 Rectifier Section

The peak voltage is given by;

$$V_m = V_S \times \sqrt{2} \qquad ...(1)$$

Where V_s is the rms value of the secondary transformer voltage,

V_s= 18V

So, $V_m = \sqrt{2}\times 18$, $V_m = 25.46$

The DC value of the rectified voltage is given by;

$$V_{dc} = \frac{2}{\pi} V_m \qquad ...(2)$$

$= 0.636V_m$

$= 0.636 \times 25.46$

$$V_{dc} = 16.19V$$

The maximum load current is given by;

$$I_m = \sqrt{2} \times I_{rms} \qquad ...(3)$$

$$I_m = \sqrt{2} \times 500mA$$

$$I_m = 707.1mA$$

Hence the Average load current can be obtained from;

$$I_{dc} = \frac{2}{\pi} I_m$$

$$I_{dc} = 0.636 \times 707.1mA$$

$$I_{dc} = 449.72mA$$

The ripple voltage (V_r) is represented by the equation below;

$$V_r = 0.308V_m \qquad ...(4)$$

Therefore,

$$V_r = 0.308 \times 25.4$$

$$V_r = 7.8417V$$

The filtering capacitor is calculated as shown below, a peak to peak ripple of 1% is chosen i.e 0.01 is approximated. Hence the ripple factor is 0.01

The shunt capacitor filter is obtained from;

$$V_r(rms) = \frac{I_{dc}}{4\sqrt{3FC}} \qquad ...(5)$$

Therefore;

$$C = \frac{I_{dc}}{4\sqrt{3}fV_r(rms)r}$$

Where I_{dc} = current taking by the load (mA);
f = frequency of supply (Hz);
C = shunt filtering capacitor (microfarads); and
$V_r(rms)$ = rms value of the ac component ripple voltage.
And, I_{dc} = 449.72mA, r = 0.01, F = 50Hz, and ,V_r(rms) = 7.84V

$$C = \frac{449.72 \times 10^{-3}}{50 \times 0.01 \times 7.84 \times 4\sqrt{3}}$$
$$C = 1.6559mF$$
$$C = 1655.9\,\mu F$$

Hence, due to standard and capacitor size, the final capacitor specification chosen is $2200\,\mu F, 35V$.

c) Voltage Regulation Section

Due to the 5V(dc) and 12V(dc) requirement of the circuit components used in the implementation of the microcontroller based Electronic Security Guard, it is sufficient to use a fixed positive voltage integrated circuit regulators. Thus, LM 7805 (+5V) and LM7812 (+12) regulators were chosen, they can provide up to 1000mA load current.

Characteristic	**LM7805**			**LM7812**			Units
	Min.	Typical	Max.	Min.	Typical	Max.	
output voltage (V_o)	4.8	5.0	5.2	11.5	12	12.5	V
Input voltage (unless stated)	7.5	10	20	14.5	19	27	V
Drop out voltage	-	2.0	-		2.0		V
load regulation (ΔV_o)		2.0	50		3.0	120	mV
Line regulation (ΔV_o)		3.0	50		4.0	120	mV
Peak output current at 25^{o}C		2.4			2.4		A

Table 3 : Datasheet Specifications for LM7805 and LM7812

d) MQ-3 Gas Sensor Section

MQ-3Gas sensor works on 5V DC and draws around 800mW. It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide concentrations anywhere from 40 to 10000ppm. The sensitive material in MQ-3 sensor is tin dioxide (SnO_2). When this material is heated at high temperature in air, oxygen is adsorbed on the surface. In clean air, electrons (donors) in the material are given up to oxygen which is adsorbed on the surface of the SnO_2. This stops the flow of electric current. In the case of reducing agent, electrons are released into SnO_2, thereby allowing electric current to flow freely viathe sensor. The table below depicts the specifications of MQ-3 gas sensor.

Operating voltage	5V
Load resistance	20KΩ
Heater resistance	33Ω ± 5%
Heating consumption	<800mw
Sensing resistance	10kΩ - 60kΩ
Concentration scope	200 – 1000ppm
Preheat time	Over 24 hour

Table 4 : MQ-3 Gas sensor specifications

e) Microcontroller Unit

The microcontroller used in this unit is the high-performance Atmel 8-bit ATmega328 microcontroller shown in figure 3.3 below which is a low-power, high-performance based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1KB EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, a single 16-bit Timer/Counter with independent prescaler, compare and capture modes.

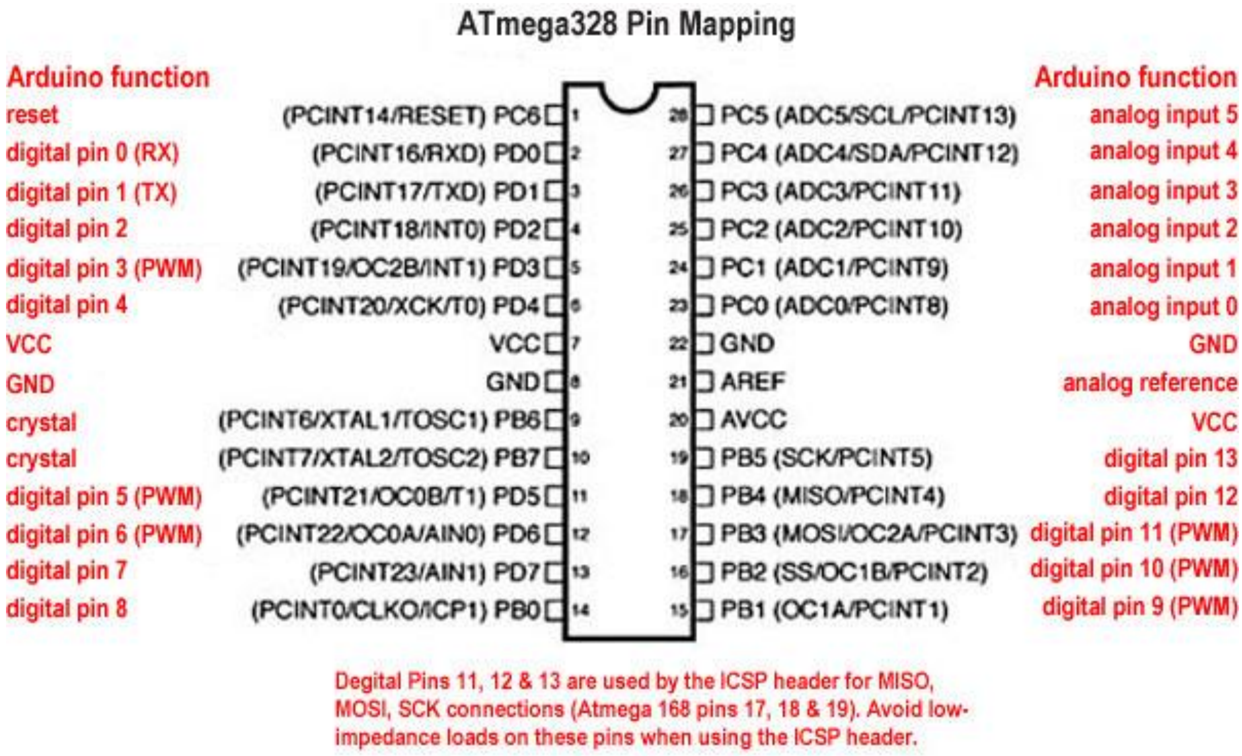

Fig. 11 : ATmega328 Pin Connection (Source: www.datasheet.com/ATmega328p)

Other core features of the ATmega328 microcontroller are highlighted below.

- Wide operating voltage range: 1.8V to 5.5V
- Maximum operating frequency : 20 MHZ
- CPU: 8-bit AVR.
- 2 cycle multiplier
- Data retention for 20 years at 85°C and 100 years at 25°C
- 10 bit, 6 channel analog to digital Converter

f) Oscillator Circuit

The crystal oscillator is used for high speed performance. Two loading capacitors C_1 and C_2 were added to increase the stability of the oscillator and increase the start up time. The crystal oscillator is also used to provide a clock signal for the whole circuit. The crystal oscillator is placed nearer to the microcontroller, so as to avoid any interference on lines on which microcontroller is receiving a clock. Usually, the crystal oscillator and its corresponding capacitor size is chosen from range of values (www.datasheet.com/ATmega328p).

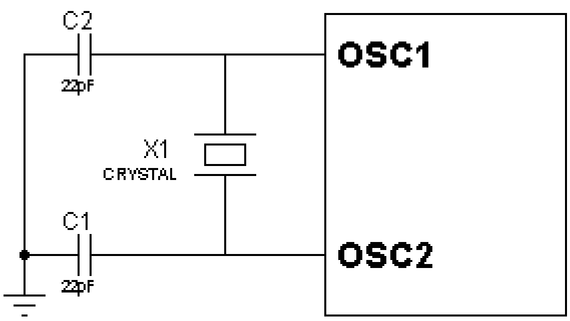

Fig. 12 : Circuitry for Internal Clock of the Microcontroller

Mode	Frequency	C1	C2
LP	32 kHz	33pF	33Pf
	200 kHz	15pF	15Pf
XT	200 kHz	26 - 68pF	26 - 68Pf
	1.0 MHz	15pF	15Pf
	4.0 MHz	20 - 30pF	20 - 30pF
HS	4.0 MHz	15pF	15pF
	8.0 MHz	15-33Pf	15-33pF
	20 MHz	15-33Pf	15-33pF
	25 MHz	15-33Pf	15-33pF

Table 5 : Specification for Crystal Oscillator
(www.datasheet.com/crystaloscillator)

A crystal oscillator 16MHz with capacitor value 22pF is chosen for the design. Hence, the internal frequency of operation of the microcontroller and period or machine cycle needed to execute an instruction are computed below:

$$f_{INT} = \frac{f_{QUARTZ}}{4} \qquad ...(6)$$

$$f_{INT} = \frac{16}{4} = 4\,MHz$$

$$T = \frac{1}{f_{INT}} \qquad ...(7)$$

$$T = \frac{1}{4 \times 10^6}$$

$$= 0.25\,\mu s$$

Where, F_{QUARTZ} is the frequency of the crystal quartz; F_{INT} is the internal clock frequency of the microcontroller; and *T* is the period or machine cycle for executing an instruction.

g) Coupling Capacitor
The coupling capacitor is used to minimize the effects of rapid changes in power demands by the devices in the circuit.

This component is connected between V_{DD} and V_{SS}. It is placed to the microcontroller as close as possible. A small capacitor value equal 22 pF was chosen for the design.

h) Display Unit
LCD is a flat panel display, either electronic visual display or video display that uses the light modulating parameters of liquid crystals. LCD's do not emit light directly; they are available to display arbitrary images (as in a general purpose computer display).

A "16×2" LCD is employed in this design. It has input ports D0……….D7, a cathode "K", anode "A", enable "E", reset "R/S", read and write "R/W" pins respectively as well as V_{DD} supply pin, a variable resistor pin which is used to set the contrast of the LCD, and ground Vss.

The LCD is used to display the state of the device before, during and after intrusion.

The LCD has the following functions;

- Pin 1 and pin 2, are V_{ss} and V_{dd} respectively (power supply)
- Pin 3 is Vo (Contrast adjust)
- Pin 4 is R/S, Pin 5 is R/W and Pin 6 is E (control line) select either instruction or character.
- Pin D0……………….D7 (Data line) Transfer data or instruction.
- Pin 15 is A and Pin 16 is K (Back light) LED

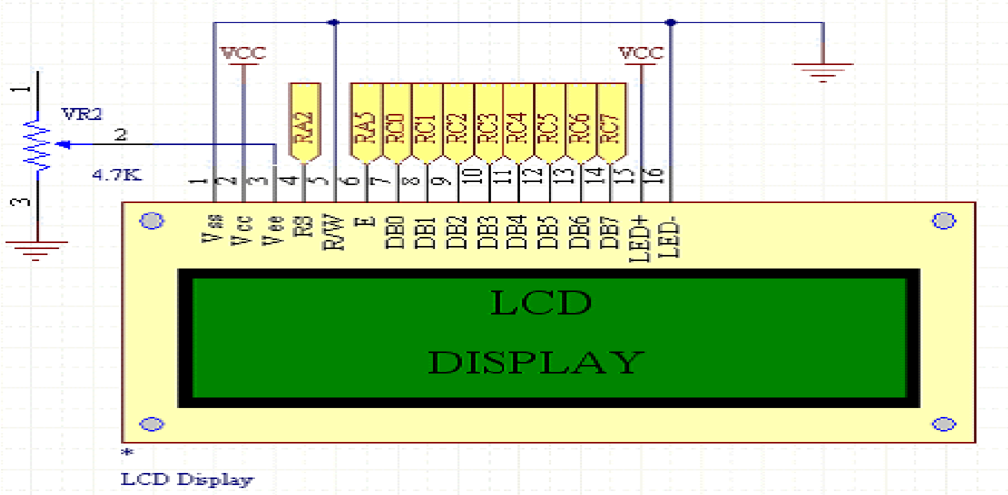

Fig. 13 : Display unit.

Alarm Unit

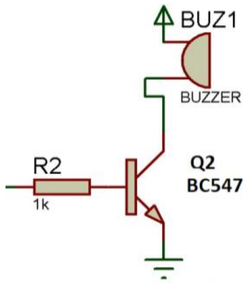

Fig 14 : Buzzer Connection

$R_2$is also calculated by quoting from the data sheet of BC547 I_{Bmax} = 200mA,base to emitter voltage drop (V_{BE}) = 0.7V and V_{CC} from the output of Port of the microcontroller is 5V.

Using the equation;

$$R_2 = \frac{V_{CC} - V_{BE}}{I_{Bmax}} = \frac{5-0.7}{200 \times 10^{-3}} = 0.0215K\Omega$$

i) SIM900 GSM Module
SIM900 GSM/GPRS shield is a GSM modem, which can be integrated into a great number of IOT projects.

j) Electromechanical Valve Controlling Unit
Owing to the load current required by relay and the electronic valve, the output from the microcontroller is not sufficient to drive them. Therefore, transistor was connected to the microcontroller and used as a switch to power on the relay and the valve. To shut the transistor off, a minimum amount of base current is required and therefore a resistor is required to connect the output of the microcontroller to the base of the transistor. The value of the resistor was obtained as follows;

For DC relay of 12V, I_{max} = 100mA
Operating voltage = 12V
A transistor BC547 was chosen for switching the DC relay.
A general purpose medium power BC547 (BJT) transistor was used for this system and it has the following features:

- $Ic_{(max)}$=100mA
- hf_e = 110 – 220
- V_{CEO} = 50V
- Frequency = 300MHz

ISSN No:-2456-2165

- Vce = 0.6V
- Power dissipated = 0.6W
- $V_{min} = \pm 5V$
- V_{BE} = 900mV

$R_L = 75\Omega$ for DC electronic valve.

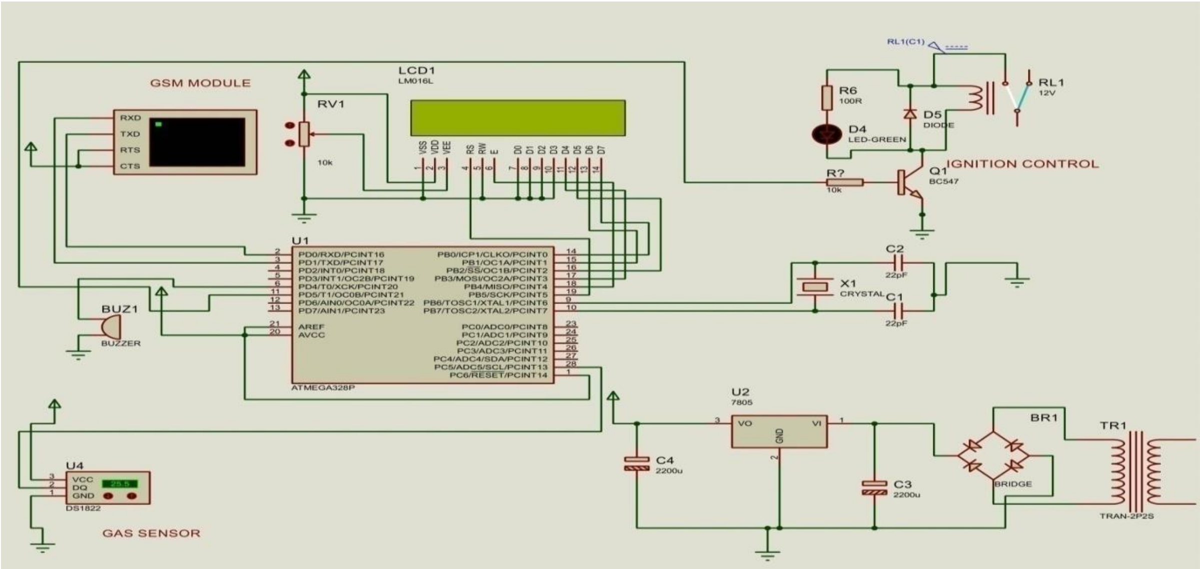

Fig 15 : The circuit diagram of the system

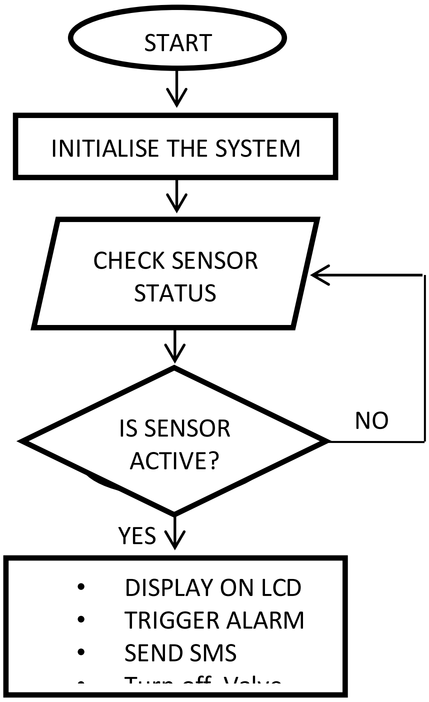

Fig. 16 : Program Flow Chart

C. Conclusion

The chapter described the design of the entire project including the calculations, software flowchart and operation sequence to achieve the desired goal.

CHAPTER FOUR

TEST, RESULTS, AND DISCUSSION

A. Introduction

This chapter presents the description of the construction details and test performance on the project and their corresponding results obtained from the design analysis.

B. Software Testing, Simulation and Debugging

a) Simulation and Debugging

Circuit simulation and debugging are two processes that are mostly carried out simultaneously. Technically, simulation is a process of observing the behavior of a circuit before actually constructing it, while debugging means correcting errors. In this project, an iterative and schematic capture simulator which is capable of detecting logical errors in the source codes were used. Arduino IDE and the Proteus were used to debug. Each part of the code was debugged properly. Also, all units of the system hardware were tested and it was ensured that they were working as desired. Then, all unit were interfaced and implemented individually with the microcontroller board. Each unit of the application was tested individually, this made it easy to debug errors found in each unit.

Simulation starts as soon as the proteus software is put on with the required circuit diagram. The circuit did not function as required in the first place due to some syntax errors in the source code. The source code was debugged and all the connections were corrected and the circuit was run again. This process was carried out repeatedly until the required functionality is achieved. Below is the simulated and debugged diagram.

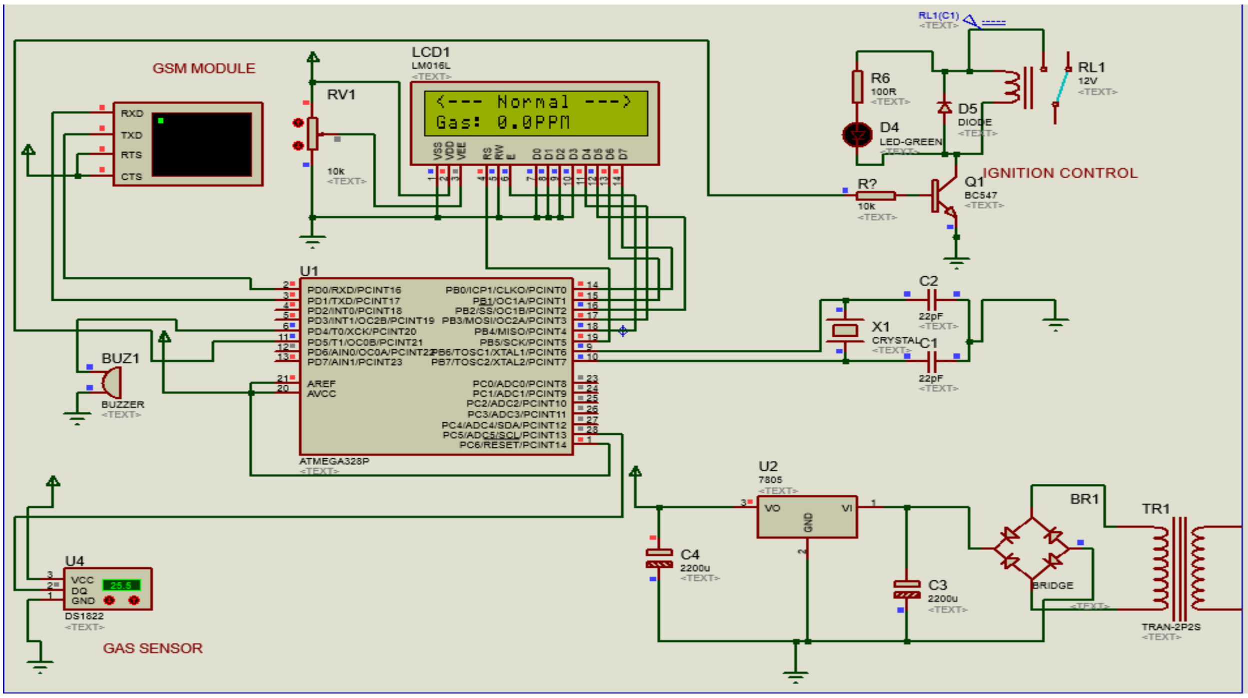

Fig. 17 : Simulation Diagram

b) Simulation Results and Discussion

After the program was written, it was tested on the simulation environment by the output of the MQ-3 gas sensor is sent into the adc input of Atmega328p microcontroller. The gas concentration status was displaying on the LCD. This result is shown in the figure below.

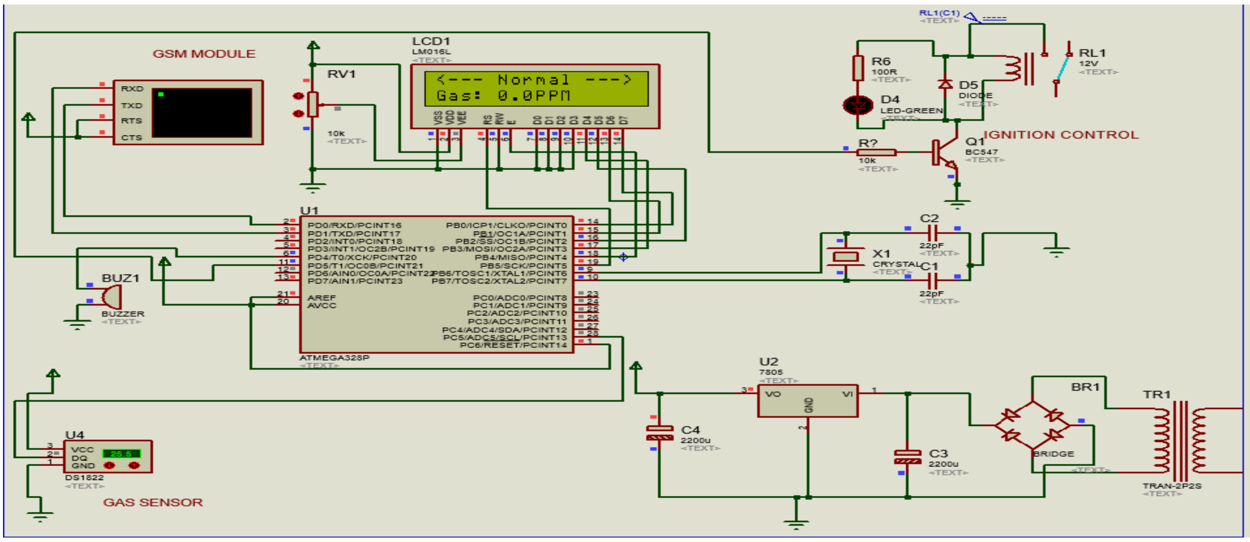

Fig. 18 : Circuit simulation for normal gas status

When the gas is sensed at the concentration that can cause fire accident, in this case 45ppm or more, the LCD also displayed" GAS LEAKAGE DETECTED" as shown in figure 4.3 below;

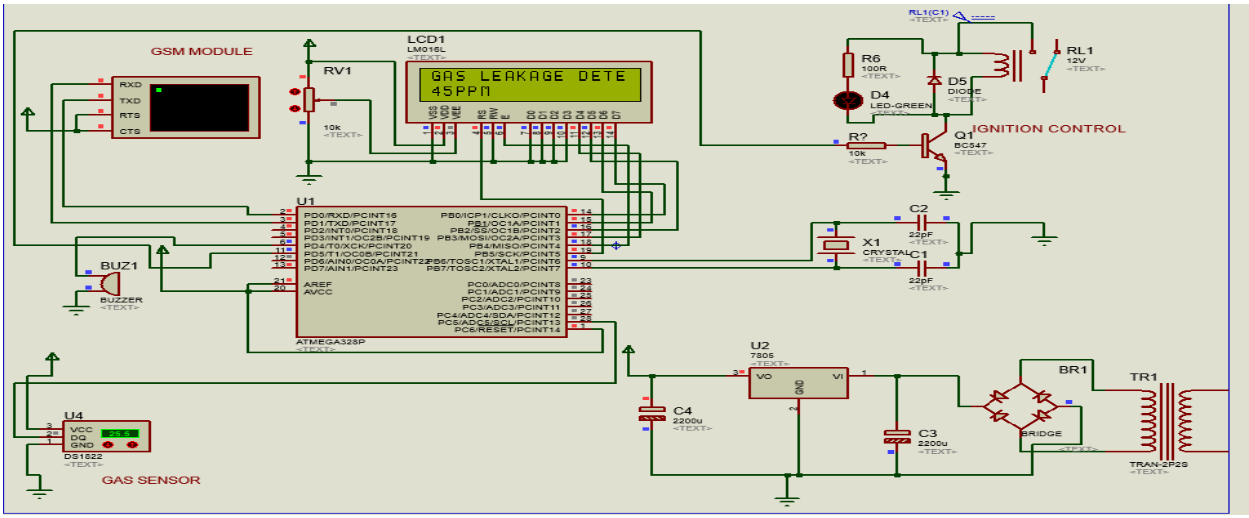

Fig. 19 : Circuit Simulation for Gas Leakage Detected

c) Discussion of the Result Obtained

The result obtained shows how the system works on the simulator (Proteus) environment (i.e what happens to the circuit when the output of the sensor went high). This successfully satisfied the objectives of this project and lead to achieving the project's aim.

C. Construction

Before the construction of a project, the components were tested separately and found to be in the good condition. This is to help in identifying faulty components where then assembled on an academic project testing board, after the components were mounted on the breadboard in sequence with the circuit diagram. The circuit is then supplied with a 9V from the PSU to energize the circuit. After circuit testing on the breadboard, the component in the same order were transferred onto the Vero board, soldered and tested again.

The circuit was packaged in a plastic casing; the circuit itself was tied on the main frame but was isolated from the main frame electrically for safety. As it was on the Vero board, wire ran from one end to the other without any components attached. These wires are called jumper wires which are used to transfer current or signal from one point to the required point.

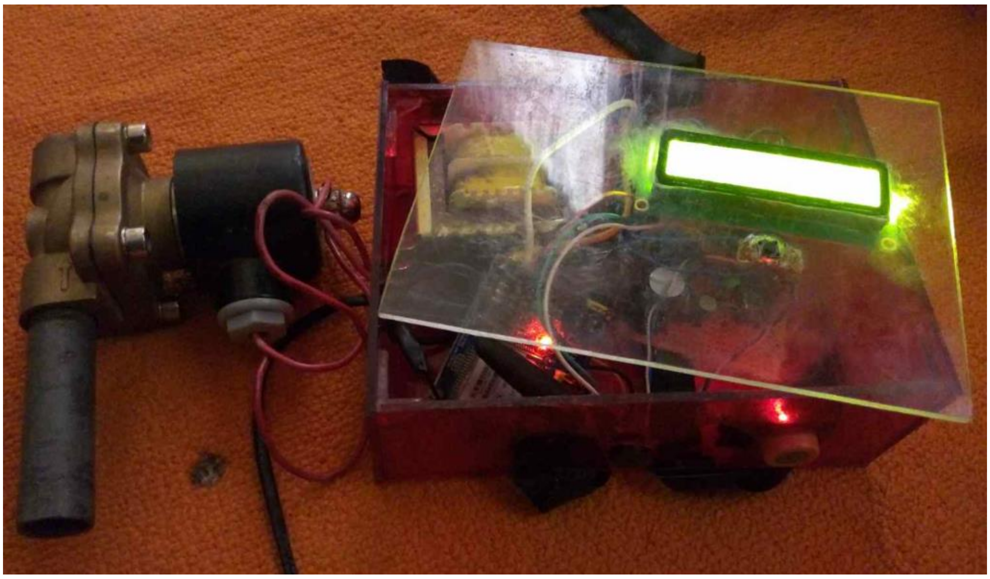

Fig. 20 : Project Construction

D. TESTING

During this project construction, all stages were tested before they were later coupled to make a complete circuit. Digital multi meter was used for the testing of all stages. After testing and fault correction, the whole system was finally transferred and soldered onto the Vero board.

Eventually, the system was powered with 5V DC and 12V DC power supplies. As the circuit was powered, the electronic valve was “ON”. As the gas level reached 45ppm, the valve was “OF”, buzzer was sounding and the SMS was sent. The system was tested using a cigarette lighter which which a butane gas and the system was found to be functioning as expected except that the gsm module failed to send the SMS. The error was in the program code and it was corrected using Arduino IDE. The system had been tested again and found working gas desired.

a) Discussion of the Result

The individual unit was tested and found to be working as desired. Atmega328 microcontroller served as the reader of the current from the output of the gas sensor and communicated effectively with GSM modules. The output result is displayed by the LCD.

The result obtained successfully satisfied the objectives of the project which lead to achieving the project’s aim.

E. Conclusion

This chapter discussed on the results of the design presented in chapter three which include. The circuit was also designed unit by unit and each unit was tested before the unit it succeeds is drawn. It was found that the simulated circuit and the constructed one were aligned and hence, the objectives of the project were met.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

A. Summary

This project is aimed at designing the LPG detection and control system using SMS alert. After construction, the realized system was found to detect the presence of gas at the concentration that can cause fire accident. It is very important to monitor the concentration of LPG so as to avoid fire accident due to its leakage. The theoretical backgrounds of the components used for the same purpose were reviewed and related previous projects. The system is design and the design of each unit was carried out separately starting from the power supply unit which output 5v dc regulated voltage used to supply the circuit, another power supply unit which output 12V used to supply to the electronic valve. The status of the gas is displayed on the LCD whiles GSM module is used to send the text message. The description of the construction details and test performed on the project and their corresponding results obtained from the design analysis is presented.

B. Conclusion

The aim of this project is to design and construct LPG detection and control system. The objectives of this project were met, but usually when theoretical aspect is put into practice, many limitation occur, but proper alteration may give the theoretical result, each unit of the design was tested separately and found to meet design specifications except MQ-3 sensor, the set back was our inability to properly calibrate the sensor to work in the prefer condition. The sensor does not only sense LPG, it also senses the presence of methane, alcohol and other combustible gases. Therefore, the sensor might function as it was programmed to do when LPG is detected.

C. RECOMMENDATION

The project can be improved upon by incorporating the following in the design:

- A fan that will automatically start when gas is sensed, so that the fan will blow away thereby reducing the concentration of the leaked gas in the area.
- A pressure-monitoring device that will be used to know the quantity of gas left in the cylinder, so that when the gas is almost finished, it will alert the owner and when finished.
- A WiFi module can be incorporated within the system so that the gas status can be communicated via an Email.

APPENDIX

sProgram Source Code

```
#include "SIM900.h"
#include <SoftwareSerial.h>
#include "sms.h"
SMSGSM sms;
#include<LiquidCrystal.h>
LiquidCrystallcd(13,12,11,10,9,8);
constint alarm      = 5;  // Analog Knput pin that the potentiometer is attached to
constintgasPin = A5;
float vin = 0,
      gas = 0;

char message[160];
char value_str[10];

constint valve = 4;
constintresetpin = 7;
inti = 0;
void setup()
{
pinMode(alarm, OUTPUT);
digitalWrite(alarm, LOW);
pinMode(resetpin, INPUT);
digitalWrite(resetpin, HIGH);
pinMode(valve, OUTPUT);
digitalWrite(valve, LOW);

lcd.begin(16,2);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("LPG Detection &");
lcd.setCursor(0,1);
lcd.print("Control System");
digitalWrite(alarm, HIGH);
delay(50);
digitalWrite(alarm, LOW);
delay(20);

lcd.clear();
lcd.setCursor(0,0);
lcd.print("with SMS Alert");
lcd.setCursor(0,1);
lcd.print("----------------");
delay(100);

lcd.clear();
lcd.setCursor(0,0);
lcd.print("Usman Magaji");
lcd.setCursor(0,1);
lcd.print("14/05/05/001");
delay(100);

lcd.clear();
lcd.setCursor(0,0);
lcd.print("Supervised By:");
lcd.setCursor(0,1);
lcd.print("Dr B. Abba Goni");
delay(100);

lcd.clear();
```

```
lcd.setCursor(0,0);
lcd.print("Configuring GSM");
lcd.setCursor(0,1);
lcd.print("Please wait...");
delay(10);

Serial.begin(9600);
 }
void loop()
{
  gas = 0;
  vin = 0;
  vin = analogRead(gasPin);
  gas =((100* vin) / 1023);

lcd.clear();
lcd.setCursor(0,0);
lcd.print("<--- NORMAL --->");
lcd.setCursor(0,1);
lcd.print("Gas: ");
lcd.print(gas,1);
lcd.print("PPM");
delay(1000);
digitalWrite(valve, HIGH);   //sms condition
digitalWrite(alarm, LOW);   //sms condition
if (gas >= 45.0 ){
lcd.clear();
lcd.setCursor(0,0);
lcd.print("Gas Lakage Detected");
lcd.setCursor(0,1);
lcd.print("Gas:");
lcd.print(gas,1);
lcd.print("PPM");
delay(100);
digitalWrite(valve, LOW);   //sms condition
digitalWrite(alarm, HIGH);   //sms condition
sms.SendSMS("+2348063005040",message);
sms.SendSMS("+2347081728097",message);
delay(100);
for(i = 0; i< 3; i ++){
message[0]='\0';
strcat(message," Gas Leakage detected, gas Val= ");
itoa(gas,value_str,10);
strcat(message,value_str);
sms.SendSMS("+2348063005040",message);
sms.SendSMS("+2347081728097",message);
Serial.print("Gas Leakage detected, gas Val: ");
Serial.print(gas,2);
Serial.print("PPM");
delay(100);
}
while(digitalRead(resetpin)){
lcd.clear();
lcd.setCursor(0,0);
lcd.print("Press Reset Key");
delay(100);
 }
digitalWrite(valve, HIGH);   //sms condition
digitalWrite(alarm, LOW);   //sms condition
  }
 }
```

REFERENCE

[1.]Onengiye M. Georgewill and Chukwunazo J. Ezeofor, 2016. Design and Implementation of SMS-Based Industrial/Homes Gas Leakage Monitoring & Detection Alarm System. International Journal of Engineering Trends and Technology (IJETT) – Volume 35 Number 9 – May 2016.
[2.]Ashish Shrivastava, RatneshPrebhsker, Rajeev Kumar and Rahul Verma., 2013. GSM Based Gas Leakage Detection System. International Journal of Technical Research and Applications e-ISSN: 2320-8163, Volume 1, Issue 2 (may-june 2013, PP.42-45.
[3.]S.Rajitha and T.Swapna., 2012. A Security Alert System Using GSM for Gas Leakage. International Journal of VLSI and Embedded Systems-IJVES, ISSN:2249-6556, Vol: 03, Issue 04, September-October 2012.
[4.]A.Mahalingam, R. T. Naayagi and N. E. Mastorakis., 2016. Design and Implementation of an Economic Gas Leakage Detector. Recents Researches in Applications of Electrical and Electronics Engineering, ISBN: 978-1-61804-074-9.
[5.]https://www.google.com/amp/s/lastminuteengineers.com/mq2-gas-sensor-arduino-tutorial/amp/