**DESIGN OF LPG, SMOKE, AND ALCOHOL DETECTION SYSTEM WITH AUTOMATIC MAINS CUT-OFF**

***A Report submitted***

***in partial fulfillment for the Degree of***

**B. Tech**

**in**

**Electronics & Communication Engineering**

***by***

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pursued in

**Department of Electronics & Communication Engineering**

**Techno International Newtown**

To



**TECHNO INTERNATIONAL NEWTOWN**

**KOLKATA**

**OCTOBER, 2020**

**TECHNO INTERNATIONAL NEWTOWN**

**NEWTOWN, KOLKATA**

**DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING**

****

CERTIFICATE

This is to certify that the project report entitled **Design of LPG, Smoke, and Alcohol Detection System with Automatic Mains cut-off** submitted by **Anupam Roy, Achintya Roy, Aditi Ray, Aditi Das, Pratima Maiti, and Debayan Mukherjee** to the Techno International Newtown, Kolkata, in partial fulfillment for the award of the degree of **B. Tech in (Electronics & Communication Engineering)** is a *bona fide* record of project work carried out by them under our supervision. The contents of this report, in full or in parts, have not been submitted to any other Institution or University for the award of any degree or diploma.

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Communication Engineering Communication Engineering

Kolkata

October, 2020

DECLARATION

We declare that this project report titled **Design of LPG, Smoke, and Alcohol Detection System with Automatic Mains cut-off** submitted in partial fulfillment of the degree of **B. Tech in (Electronics & Communication Engineering)** is a record of original work carried out by us under the supervision of **Prof. (Dr.) Pradip Kumar Ghosh and Prof. (Dr) Subhankar Bhattcharjee**, and has not formed the basis for the award of any other degree or diploma, in this or any other Institution or University. In keeping with the ethical practice in reporting scientific information, due acknowledgements have been made wherever the findings of others have been cited.

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ABSTRACT

Household and Hotel fires have been taking place frequently and the threat to human lives and properties is growing in recent years. Liquid petroleum gas (LPG) is highly inflammable and can burn even at some distance from the source of leakage. Most fire accidents are caused because of a poor-quality rubber tube or the Gas Regulator not turned off when not in use. Therefore, developing the gas leakage alert and control system is very essential. Hence, in this project we have proposed a LPG, Smoke, and Alcohol detection system with automatic mains gas supply cut-off.

The system will work such that if there’s a LPG leakage from gas cylinders, it’ll ring an alarm, turn off the gas regulator key to stop further gas leakage. It’ll also detect smoke and inflammable liquids like Ethanol (Alcohol) near the gas cylinders which poses a threat to normal working of the gas cylinders.

So, our build up will be a hit for household and hotel kitchen uses as it is smart and cheap which not only acts as a detecting system but also can take care of the leakage. Our work was also focused on how to make it affordable to general public.

CHAPTER 1

# INTRODUCTION

## Problem Definition

Gas leakage poses great danger in this modern era where the use of gas has become an important source of energy for industries, homes and vehicles alike. The leakage of Liquefied Petroleum Gas (LPG) is known to cause serious accidents which have resulted in loss of lives and properties worth billions of dollars across the globe. The 2019 statistics of National Crime Records Bureau (NCRB) show that 346 people died in Tamil Nadu because accidental fire due to cooking gas cylinders. Maharashtra registered 285 such deaths. Tamil Nadu tops the southern states in the category, far above Andhra Pradesh (93), Karnataka (286) and Kerala (53). This means more than 6 people in Tamil Nadu die every week because of accidental fire due to cooking gas cylinders. On the whole, there have been 2143 such deaths in 2019 and in 2681 deaths in 2018.

LPG is one of the most commonly used fuels in India. In a survey conducted by National Statistical Office between July and December 2018, it revealed that 48.3% household in rural areas and 86.6% household in urban areas making the average 61.4% Indians who use LPG as cooking fuel. With Pradhan Mantri Ujjwala Yojana started by PM Narendra Modi Ji in 2016, the numbers are rapidly rising especially in the rural areas of India.

LPG is made up of mixtures of propane and butane which are inflammable chemicals. Due to the odourless nature of these chemicals, Ethyl Mercaptan is added as odorant in order to make the gas detectable by smell. However, some people have poor sense of smell especially at low concentrations and so a more effective and reliable means of detecting the gas has to be adopted in homes, industries and vehicles that rely on the use of LPG. One of the preventive methods of stopping accident associated with LPG leakage is to install gas leakage detection devices.

Even though there have been great strides in developing effective LPG leakages detection and response systems over the past years, there are still improvements that can be made to previous designs. Most systems developed focus on the detection of the leakage and sounding of an alarm in response to the detection. Other systems detect the gas and use a microcontroller to activate an alarm and also send SMS to the appropriate personnel. These designs even though prudent do not solve the leakage problem.

The purpose of this project is to design a system capable of detecting the leakage of LPG and automatically shutting down the supply of the gas. The system consists of an MQ-6 gas sensor which is highly sensitivity to propane (C3H8) and butane (C4H10), MQ-3 alcohol sensor which are highly sensitivity to Ethanol (Alcohol) and smoke, an alarm, a microcontroller and a servo motor. This system does not only detect LPG leakage but shuts down supply to minimise wastage, accidents and cut down cost associated with the leakage.

It’ll also detect smoke and inflammable liquids like Ethanol (Alcohol) near the gas cylinders which pose a threat to normal working of the gas cylinders.

Table 1.1 Injuries and Deaths due to Accidental Fire due to Cooking Gas Cylinder in 2019

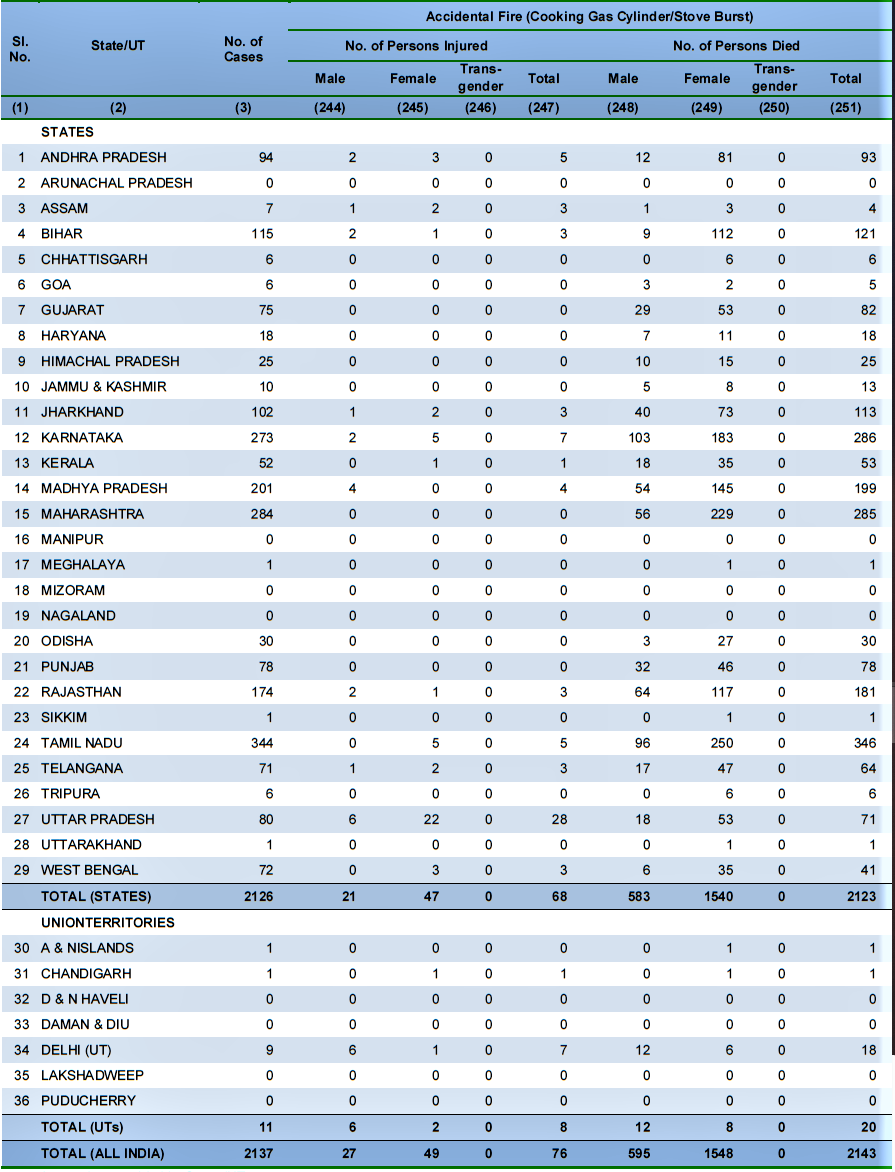
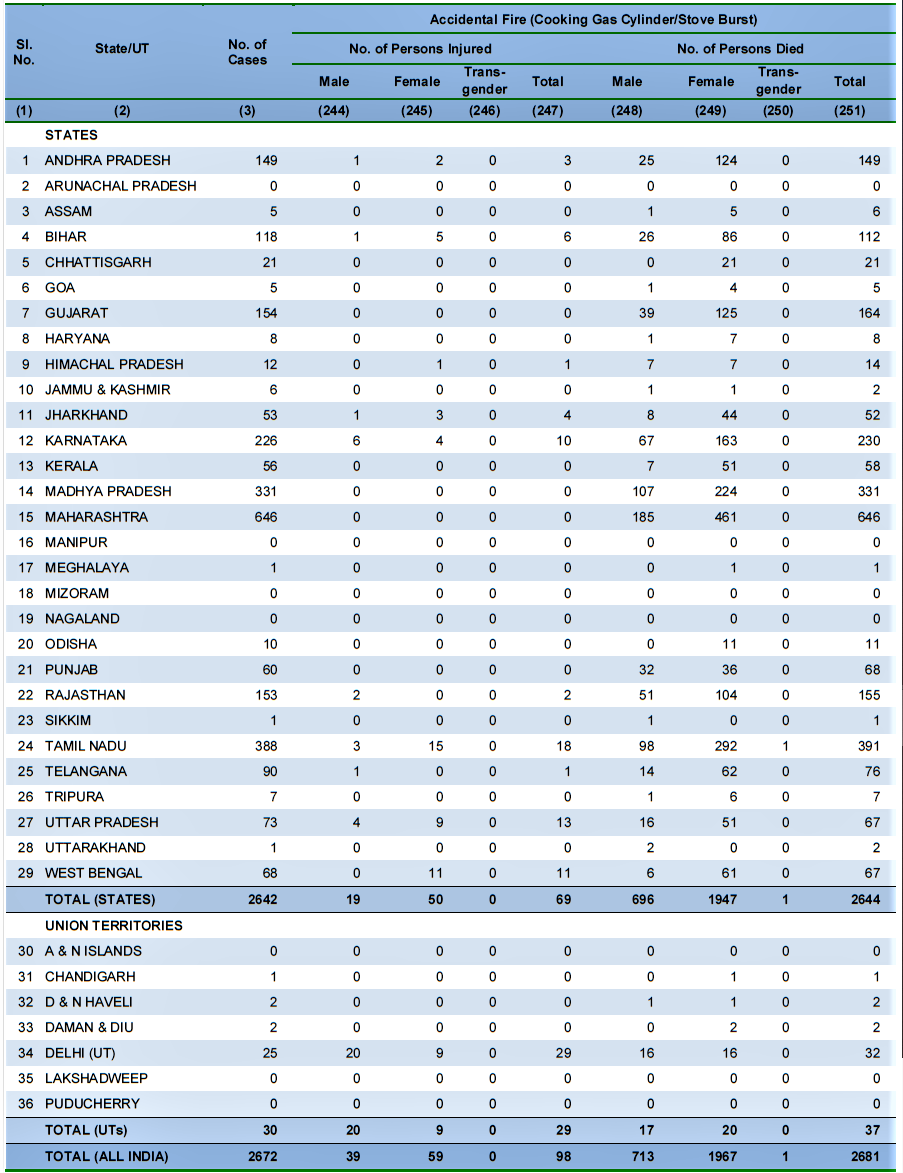
(Source: NCRB, 2019)

Table 1.2 Injuries and Deaths due to Accidental Fire due to Cooking Gas Cylinder in 2018

(Source: NCRB, 2018)

The image as given in Figure 1.1 shows the percentage of households with different types of fuel usage.

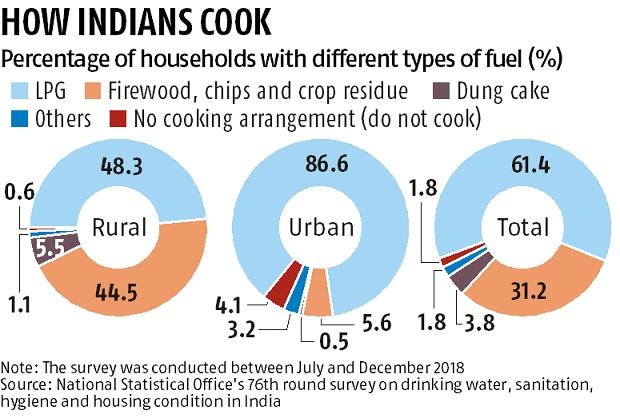


Fig 1.1 Percentage of households with different types of fuel usage

## 1.2 Objective

The objectives of this project are:

To design a system that monitors LPG leakage in an enclosed area;

To design a system that alarms the user of the leakage;

To design a system that switch off the gas regulator key during leakage;

* To design a system that propels out the already leaked gas; and
* To design a system that detects fire and alcohol near a gas cylinder.

## 1.3 Methods Used

The research methods adopted include:

* Review of related literature;
* Use of datasheet in selecting suitable components for the circuit design;
* Circuit design and simulation; and
* Analysis of results from simulation.

## 1.4 Facilities Used

The facilities used during this project include:

* Internet access;
* Personal computer.

## 1.5 Scope of Work

This work is limited to the design of an efficient system for monitoring LPG leakage in a susceptible area, alerting the user and shutting down the gas supply using an arduino based detection system.

## 1.6 Work Organization

This work is organised into five chapters. The first chapter deals with the problem definition, project objectives, methods used, facilities used for the project and the scope of work. Chapter two gives the review of the related literature. Chapter three focuses on the proposed design and component selection for the LPG leakage detection and response system. The fourth chapter provides a detailed analysis of results from simulation and the last chapter talks about conclusion and recommendations.

CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

LPG consists of a mixture of Commercial Propane and Commercial Butane having saturated as well as unsaturated hydrocarbons. It is an odourless gas due to which Ethyl Mercaptan is added as powerful odorant so that leakage can easily be detected. LPG is commonly used in homes for heating and cooking. This energy source is primarily composed of propane and butane which are highly flammable chemical compounds.

LPG was first produced in 1910 by Walter Snelling (Didpaye1, 2015) and is classified as a hazardous material because of its flammable properties and explosive potential when stored under pressure. Before the development of electronic household gas detectors in the 1980s and 90s, gas presence was detected with a chemically infused paper that changed its colour when exposed to the gas (Didpaye1, 2015). Since then, many technologies and devices have been developed to detect, monitor, and alert the leakage of a wide array of gases. Hence the requirement of an efficient system to detect leakage of LPG is inevitable, which may be used for domestic and commercial purposes.

## 2.2 Classification of Leakage Detection Technologies

There are various classifications available for leakage detection. Several criteria are considered for classification, some of which are, the amount of human intervention needed, the physical quantity measured and the technical nature of the methods (Murvaya, 2011). If the degree of intervention needed from a human, by each detection method is used for classification, three categories are used to distinguish between them (Murvaya, 2011):

Automated detection – complete monitoring systems that, can report the detection of a gas leak without the need of a human operator, once they are installed (e.g. fibre optic or cable sensors);

Semi-automated detection – solutions that need a certain amount of input or help in performing some tasks (e.g. statistical or digital signal processing methods); and

Manual detection – systems and devices that can only be directly operated by a person (e.g. thermal imagers or Light Detection and Ranging (LIDAR) devices).

Most detection techniques rely on the measurement of a certain physical quantity or the manifestation of certain physical phenomenon. This can be used as a rule for classification as there are several commonly used physical parameters and phenomena namely; acoustics, flow rate, pressure, gas sampling, optics and sometimes a mix of these. Because of the great variety of these detection solutions, leak finding technologies are sometimes classified into optical and non-optical methods (Batzias *et al*., 2011).

Leakage Detection Mthod

Non-technical

Hardware Based

Acoustic

Cable Sensor

Vapor Sampling

Optical

Soil Monitoring

Ultrasonic Flow Meter

Software Based

Pressure Point Analysis

Statistical

Method

Real Time Transient Modelling

Mass/Volume Balance

Negative Pressure Wave

Digital Signal Processing

Some authors see the technology as fitting into two great categories direct methods and indirect or inferential methods (Folga, 2007 and Liu *et al*., 2008). The direct detection is made by patrolling along the pipelines using either visual inspection or handheld devices for measuring gas emanations. Thanks to technological advancements it is now common to use helicopter or airplane-mounted optical imaging devices especially for very long pipelines (Liu *et al*., 2008). Indirect or inferential methods detect leaks by measuring the change of certain pipe parameters such as flow rate and pressure.

Leakage Detection Method

Non-technical Method

Hardware Based Method

Acoustic

Cable Sensor

Vapour Sampling

Optical

Soil Monitoring

Ultrasonic Flow Meter

Software Based Method

Pressure Point Analysis

Statistical

Real Time Transient Modelling

Mass/Volume Balance

Negative Pressure Wave

Digital Signal Processing

Fig. 2.1 Classification of Gas Leak Detection Techniques Based on Technical Nature (Source: Murvaya, 2011).

The most common way of classifying leak detection methods is based on their technical nature (Scottand, 2003). Thus, two main categories can be distinguished; hardware based methods and software based methods. These two categories are sometimes mentioned as externally or internally based leak detection systems. Fig. 2.1 illustrates these main categories and the different methods associated with each of them. This classification is similar to the one presented in the previous paragraph with the remark that indirect or inferential methods overlap with the software based methods while the direct methods cover both hardware methods and non-technical methods.

Non-technical leak detection methods are the ones that do not make use of any device and rely only on the natural senses (i.e. hearing, smelling and seeing) of humans and/or animals.

Hardware based methods rely mainly on the usage of special sensing devices in the detection of gas leaks. Depending on the type of sensors and equipment used for detection, these hardware methods can be further classified as: acoustic, optical, cable sensor, soil monitoring, ultrasonic flow meters and vapour sampling.

Software based methods, as the name states, have software programs at their core. The implemented algorithms continuously monitor the state of pressure, temperature, flow rate or other pipeline parameters and can infer, based on the evolution of these quantities, if a leak has occurred. The software methods can use different approaches to detect leaks: mass/volume balance, real time transient modelling, and acoustic/negative pressure wave, pressure point analysis, statistics or digital signal processing.

## 2.3 MQ Series Semiconductor Gas Sensors

These are highly sensitive devices that are used for detecting the presence of a variety of gases in an area. They range from MQ-2 through to MQ-9, MQ303, MQ306, MQ307, MQ131 and MQ135 to MQ138 with sensitivity to different kind of gases. Table 2.1 shows the various types of MQ sensors and their specifications.

Table 2.1 MQ Series Specifications

|  |  |
| --- | --- |
| **Semiconductor Sensor for Flammable Gas, Plastic or Metal Cover** | |
| **Model** | **Target Gas** |
| MQ-2 | General combustible gas |
| MQ-3 | Alcohol |
| MQ-4 | Natural gas, Methane |
| MQ-5 | LPG, Natural gas, Coal gas |
| MQ-6 | LPG, Propane |
| MQ-7 | Carbon Monoxide |
| MQ-8 | Hydrogen |
| MQ-9 | CO and Combustible gas |
| MQ306 | LPG, Propane |
| MQ307 | Carbon Monoxide |
| MQ303 | Alcohol |
| MQ131 | Ozone |
| MQ135 | Air Quality Control |
| **Semiconductor Sensor for Toxic Gas** | |
| MQ136 | Sulphureted Hydrogen (H2S) |
| MQ137 | Ammonia (NH3) |
| MQ138 | Volatile Organic Compound (Mellow, Benzene, Aldehyde, Ketone, Ester ) |

(Source: Anon., 2015)

## 2.4 Related Works

Various research groups are working all over the world for the development of LPG leakage detectors and response systems. Before the development of electronic household gas detectors in the 1980s and 90s, gas presence was detected with a chemically infused paper that changed its colour when exposed to the gas. Since then, many technologies and devices have been developed to detect, monitor, and alert the leakage of a wide array of gases.

Bhattacharjee et al , 2011, designed a system entitled “Design and Development of a Flexible Reliable Smart Gas Detection System”. The system composed of three modules; the base station, wireless sensor array and an intelligent wireless alarm unit, which offers high reliability, flexibility and uninterrupted sensing. These are achieved by incorporating various intelligent protocols like auto sensor calibration, sensor handover, wireless threshold fixation and intelligent alarm mechanism. The sensor node consists of three gas sensors, one temperature sensor and one pyro-electric infrared sensor (PIR) which enhances the sensing intelligence.

Somov et al ,2012, designed a Energy-Aware Gas Sensing Using Wireless Sensor Networks focusing on a sensor node, a relay node, a wireless actuator and a network coordinator. The network coordinator is the main unit of the WSN. It supports the network operation by wireless communication based on the IEEE 802.15.4 standard and the ZigBee specifications. The network coordinator is also responsible for alerting a network operator or an emergency service using the Ethernet network or sending a SMS using a GSM/GPRS modem. In fact, upon receiving the alert message from the sensor node, the network coordinator can perform the first counter action by deactivating the source of gas emission via the wireless actuator.

A similar project by Sunithaa and Sushmitha, 2012, has a system that detects the leakage of the LPG and alerts the consumer about the leak and as an emergency measure, the system switches on an exhaust fan to circulate the gas. An added feature of the system is that the approximate consumption is indicated in terms of the total weight. The proposed system makes use of GSM module in order to alert user about the gas leakage via an SMS. Whenever the system detects the increase in the concentration of the LPG it immediately alerts by activating an alarm and simultaneously sending message to the specified mobile phones. The exhaust fan is switched on. The device ensures safety and prevents suffocation and explosion due to gas leakage

Ashish et al., 2013, designed a GSM based LPG detection system which consisted of a Philip microcontroller, MQ-6 sensor and a GSM module. The MQ-6 sensor is very sensitive to LPG and Propane and hence is capable of detecting the smallest leakage of the gas. The microcontroller response to the leakage detected by the sensor by sending an SMS through the GSM module to the authority for appropriate response.

In the year 2014, Hitendra Rawat, Ashish Kushwah, Khyati Asthana, Akanksha Shivhare, designed a system, They provided security issues against thieves, leakage and fire accidents. In those cases their system sends SMS to the emergency number provided to it. In the proposed system we have designed “LPG gas monitoring and automatic cylinder booking with alert system”. These report focus on detection of economic fuels like petroleum, liquid petroleum gas, alcohol etc., and alert the surrounding people about the leakage through SMS. It also sense surrounding temperature, so that no fire accidents occurs.

# CHAPTER 3

# PROPOSED DESIGN HARDWARE & SOFTWARE SELECTION

## 3.1 Introduction

This project as stated earlier on is aimed at designing an efficient system that would be capable of detecting LPG leakage and turning off the gas regulator key in order to prevent wastage and accidents in Indian homes where the use of LPG is very common. The system consists of a microcontroller with an MQ-6 gas sensor used to detect gas leakages If leakage is detected, it’ll ring an alarm, turn off the gas regulator key to stop further gas leakage, switch on a propeller to fan out the already leaked gas. It’ll also detect smoke due to fire and inflammable liquids like Ethanol (Alcohol) near the gas cylinders which poses a threat to normal working of the gas cylinders. To implement this idea we’ve used Arduino platform to code into the hardware assembled on a PCB.

## 3.2 MQ-6 Sensor Module

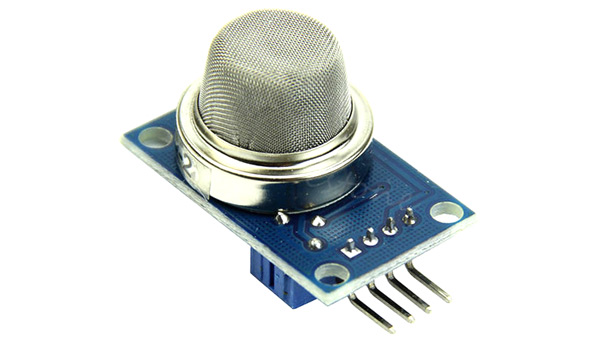


Fig. 3.1 MQ-6 Sensor Module (Source: Components101, n.d.)

The MQ-6 sensor module as shown in Fig 3.1 comes with a Digital Pin which makes this sensor to operate even without a microcontroller and that comes in handy when you are only trying to detect one particular gas. When it comes to measuring the gas in ppm the analog pin has to be used, the analog pin also TTL driven and works on 5V and hence can be used with most common microcontrollers.

MQ-6 is a semiconductor type gas sensor which detects the gas leakage. The sensitive material of MQ-6 is tin dioxide (SnO2). It has very low conductivity in clean air (Ashish, *et al*., 2013). This Gas sensor not only has sensitivity to propane and butane but also to other natural gases, low sensitivity to cigarette smoke and alcohol.

The concentration range of MQ-6 gas sensor is 200-1000 ppm. This sensor is available in 6 pins package, out of which 4 pins are used for fetching the signals and other 2 pins are used for providing heating current. This sensor has fast response time. The sensor has different resistance value in different concentration. Fig 3.1 shows an MQ-6 Sensor Module.

### 3.2.1 Features

The features of an MQ-6 sensor module are:

* Operating Voltage is +5V
* Can be used to detect LPG or Butane gas
* Analog output voltage: 0V to 5V
* Digital Output Voltage: 0V or 5V (TTL Logic)
* Preheat duration 20 seconds
* Can be used as a Digital or analog sensor
* The Sensitivity of Digital pin can be varied using the potentiometer

### 3.2.2 Construction

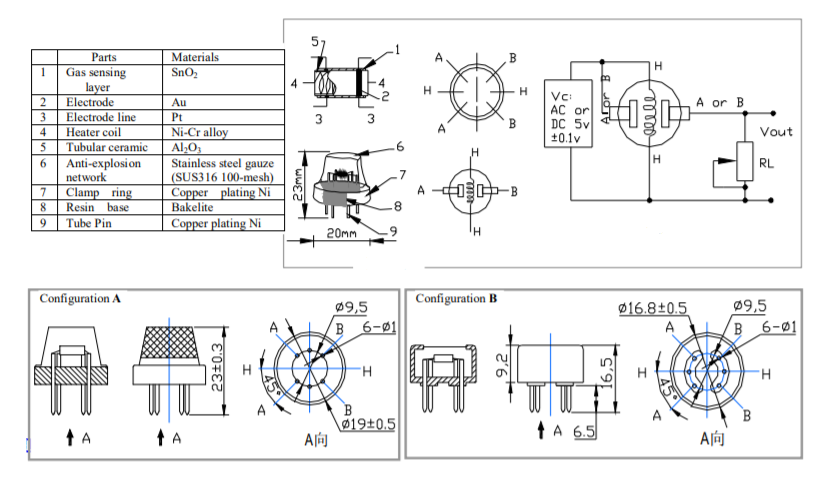


Fig. 3.2 Internal structure and construction materials used in MQ-6 Gas Sensor (Source: Components101, n.d.)

Structure and configuration of MQ-6 gas sensor as shown in Fig. 3.2 (Configuration A or B), sensor composed by micro AL2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-6 has 6 pin, 4 of them are used to fetch signals, and other 2 are used for providing heating current.

### 3.2.3 Pinout Configuration

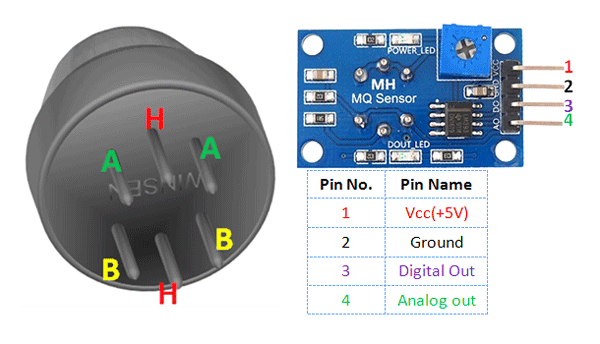


Fig. 3.3 Pinout diagram of an MQ-6 Sensor Module (Source: Components101, n.d.)

Fig. 3.3 shown above gives the standard pinout diagram of an MQ-6 Sensor Module. Table 3.1 provides the standard pinout configuration and description of an MQ-6 Sensor Module in a tabular form.

Table 3.1 Pinout Configuration and description of an MQ-6 Sensor Module

|  |  |  |
| --- | --- | --- |
| 1 | Vcc | This pin powers the module, typically the operating voltage is +5V |
| 2 | Ground | Used to connect the module to system ground |
| 3 | Digital Out | You can also use this sensor to get digital output from this pin, by setting a threshold value using the potentiometer |
| 4 | Analog Out | This pin outputs 0-5V analog voltage based on the intensity of the gas |

(Source: Components101, n.d.)

### 3.2.4 Applications

The applications of an MQ-6 gas sensor are:

* Detect or measure Gases like LPG, and butane
* Air quality monitor
* Gas leak alarm
* Safety standard maintenance
* Maintaining environment standards in hospitals

## 3.3 MQ-3 Sensor Module



Fig. 3.4 MQ-3 Sensor Module (Source: Components101, n.d.)

MQ-3 gas sensor module as shown in Fig 3.4 is suitable for detecting Alcohol, Benzene, CH4, Hexane, LPG, CO. Sensitive material of MQ-3 gas sensor is SnO2, which with lower conductivity in clean air. When the target alcohol gas exist, the sensor’s conductivity is higher along with the gas concentration rising. MQ-3 gas sensor has high sensitivity to Alcohol, and has good resistance to disturb of gasoline, smoke and vapor.

This sensor provides an analog resistive output based on alcohol concentration. When the alcohol gas exist, the sensor’s conductivity gets higher along with the gas concentration rising. In the picture the blue colored square shaped component on the module is a potentiometer which is used to set the sensitivity of the sensor. By rotating it we can set the sensitivity of the sensor (rotating anti-clockwise will result decrease in sensitivity and rotating clockwise will result the increase in sensitivity). There are two LEDs on the module. One is power LED and other one is D0-LED. D0-LED will show the output of the sensor i.e whether alcohol is present in the environment or not. The IC present on the module is a comparator IC; it will compare the signal coming from the potentiometer and the signal coming from the sensor. The output will be shown through D0 pin (Either 0 or 1). A0 is the direct analog output; the quantity of alcohol sensed by the sensor will be shown by A0. A0 and D0 will be fed to the Arduino board for further programming. Whenever the amount of alcohol sensed by the sensor will increase the voltage at A0 pin will also increase and vice-versa.

### 3.3.1 Features

The features of an MQ-3 gas sensor module are:

* Sensor Type - Semiconductor
* Easy SIP header interface
* Compatible with most of the microcontrollers
* Low-power standby mode
* Requires heater voltage
* Good sensitivity to alcohol gas
* Fast response and High sensitivity
* Long life and low cost
* Requires simple Drive circuit

### 3.3.2 Construction

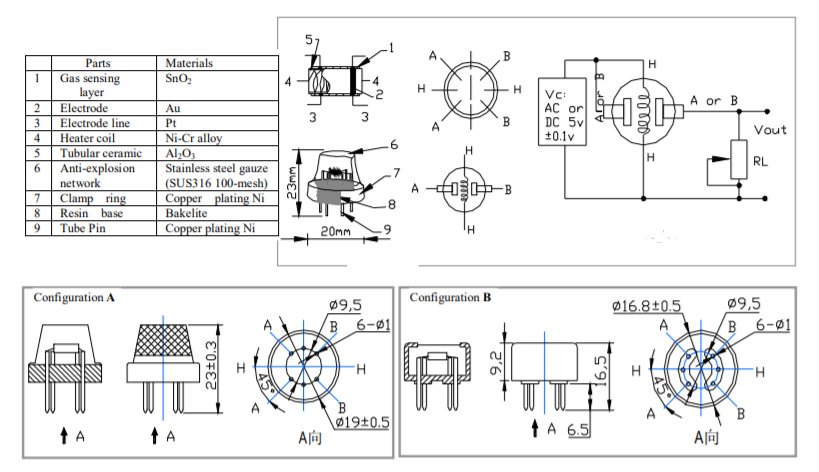


Fig. 3.5 Internal structure and construction materials used in MQ-3 Alcohol Sensor (Source: Components101, n.d.)

Structure and configuration of MQ-3 gas sensor is shown in the Fig. 3.5 (Configuration A or B), sensor composed by micro AL2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-3 has 6 pin, 4 of them are used to fetch signals, and other 2 are used for providing heating current.

There is a resistance across A and B inside the sensor which varies on detection of alcohol. The higher the alcohol detected, the lower is the resistance. The alcohol is measured by measuring this resistance. The sensor and load resistor form a voltage divider, and the lower the sensor resistance, the higher the voltage reading will be.

### 3.3.3 Pinout Configuration

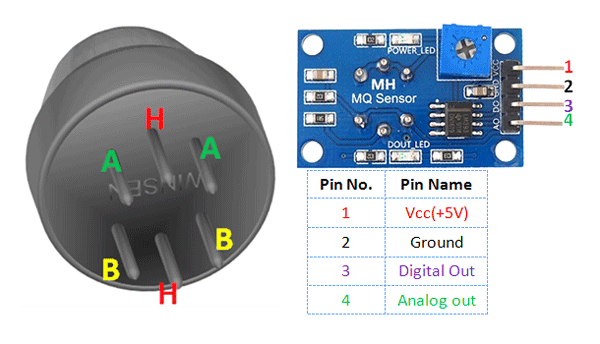


Fig. 3.6 Pinout Diagram of an MQ-3 Sensor Module (Source: Components101, n.d.)

Fig. 3.6 shown above gives the standard pinout diagram of an MQ-3 Sensor Module. Table 3.2 provides the standard pinout configuration and description of an MQ-3 Sensor Module in a tabular form.

Table 3.2 Pinout Configuration and description of an MQ-3 Sensor Module

|  |  |  |
| --- | --- | --- |
| 1 | Vcc | This pin powers the module, typically the operating voltage is +5V |
| 2 | Ground | Used to connect the module to system ground |
| 3 | Digital Out | You can also use this sensor to get digital output from this pin, by setting a threshold value using the potentiometer |
| 4 | Analog Out | This pin outputs 0-5V analog voltage based on the intensity of the gas |

(Source: Components101, n.d.)

### 3.3.4 Applications

The applications of an MQ-6 gas sensor are:

Gas level over-limit alarm

Breath analyser

Portable alcohol detector

Stand-alone/background sensing device

Environmental monitoring equipment

## 3.4 Arduino Uno Rev3

## https://store-cdn.arduino.cc/usa/catalog/product/cache/1/image/500x375/f8876a31b63532bbba4e781c30024a0a/a/0/a000066_front_8.jpg

Fig. 3.7 Arduino Uno Rev3 (Source: Official Arduino Store, n.d.)

In this project, an Arduino Uno Rev3 microcontroller board as shown in Fig. 3.7 is used to control the automatic mains gas supply and the Buzzer. After the MQ-6 gas sensor has detected the leakage of LPG, the microcontroller acts by turning off the LPG gas regulator, ring the alarm bell to alert the household members.

**Arduino Uno** is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. We can tinker with your Uno without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

### 3.4.1 Features

The features of an Arduino Uno Rev3 are:

* 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 of which 0.5 KB used by bootloader
* SRAM: 2 KB (ATmega328)
* EEPROM: 1 KB (ATmega328)
* Clock Speed: 16 MHz

### 3.4.2 Pinout Configuration

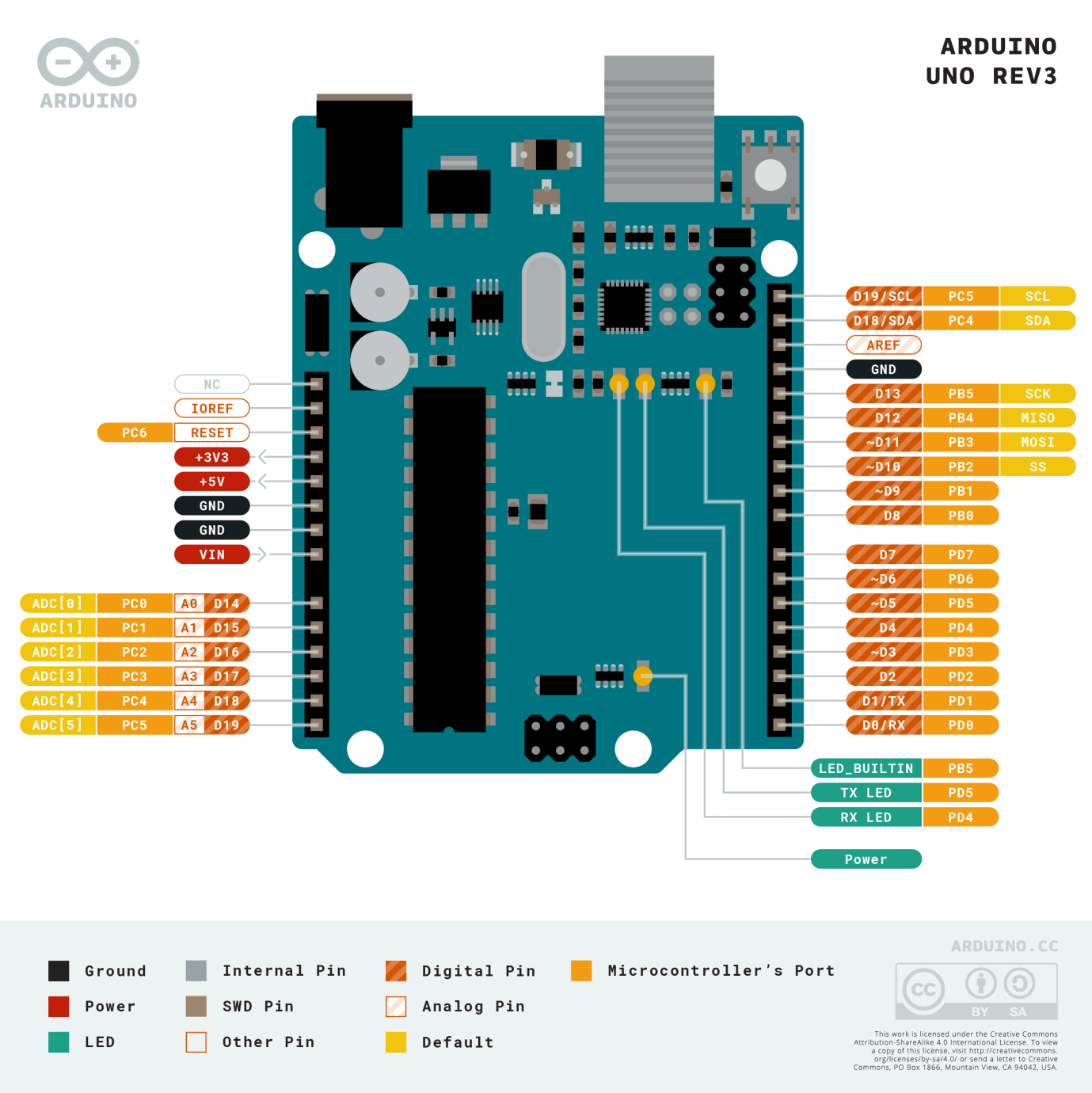


Fig. 3.8 Pinout Diagram of Arduino Uno Rev3 (Source: Official Arduino Store, n.d.)

Fig. 3.8 shown above gives the standard pinout diagram of an Arduino Uno Rev3. Table 3.3 provides the standard pinout configuration and description of Arduino Uno Rev3 in a tabular form.

Table 3.3 Pinout configuration and description of Arduino Uno Rev3

|  |  |  |
| --- | --- | --- |
| Pin Category | Pin Name | Details |
| Power | Vin, 3.3V, 5V, GND | Vin: Input voltage to Arduino when using an external power source.  5V: Regulated power supply used to power microcontroller and other components on the board.  3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA.  GND: ground pins. |
| Reset | Reset | Resets the microcontroller. |
| Analog Pins | A0 – A5 | Used to provide analog input in the range of 0-5V |
| Input/Output Pins | Digital Pins 0 - 13 | Can be used as input or output pins. |
| Serial | 0(Rx), 1(Tx) | Used to receive and transmit TTL serial data. |
| External Interrupts | 2, 3 | To trigger an interrupt. |
| PWM | 3, 5, 6, 9, 11 | Provides 8-bit PWM output. |
| SPI | 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK) | Used for SPI communication. |
| Inbuilt LED | 13 | To turn on the inbuilt LED. |
| TWI | A4 (SDA), A5 (SCA) | Used for TWI communication. |
| AREF | AREF | To provide reference voltage for input voltage. |

(Source: Components101, n.d.)

## 3.5 Micro Servo Motor

Servo is an electromagnetic device uses a negative feedback mechanism to converts an electric signal into controlled motion. Basically, servos behave like as actuators which provide precise control over velocity, acceleration, and linear or angular position. It consists of four things: DC motor, position sensor, gear train, and a control circuit. The gear mechanism connected with the motor provides the feedback to the position sensor.

If the motor of the servo is operated by DC then it is called a DC servo motor and if it is operated by AC then it is called as AC servo motor. The gear of the servo motor is generally made up of plastic but in high power servos, it is made up of metal.

### 3.5.1 Construction

The Servo motor is DC motor which has 5 following parts:-

**Stator Winding**: This type of winding wound on the stationary part of the motor. It is also known as field winding of the motor.

**Rotor** **Winding**: This type of winding wound on the rotating part of the motor. It is also known as an armature winding of the motor.

**Bearing**: These are of two types,i.e, font bearing and back bearing which are used for the movement of the shaft.

**Shaft**: The armature winding is coupled on the iron rod is known as the shaft of the motor.

**Encoder**: It has the approximate sensor which determines the rotational speed of motor and revolution per minute of the motor.

Fig. 3.9 shows the internal construction of servo motors.

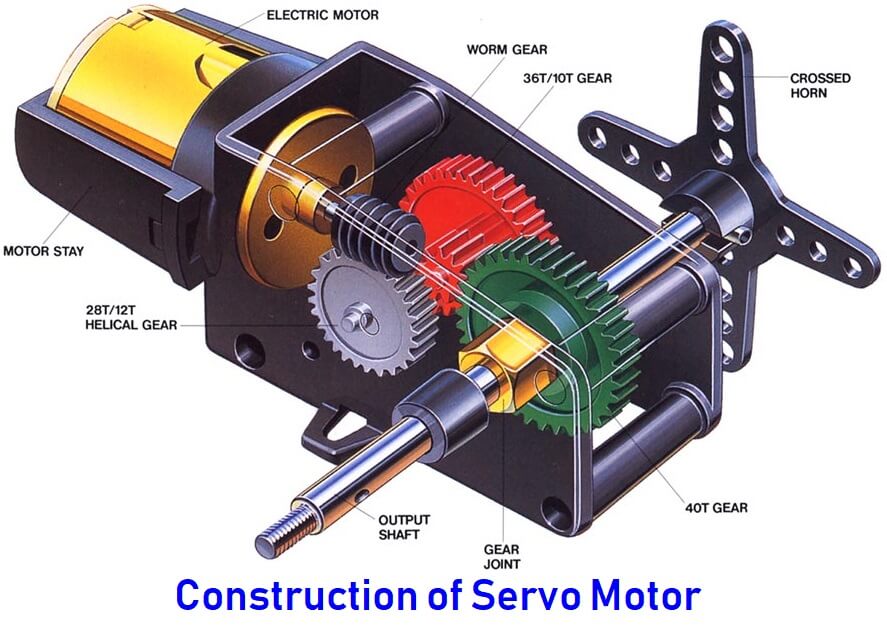


Fig. 3.9 Internal Construction of Servo Motors (Source: electricaltechnology, n.d.)

### 3.5.2 Operation

It consists of three basic types:

* Controlling Device
* Output Sensor
* Feedback system

The servo motor works on the phenomenon of the automatic closed-loop system. The controller is required for this closed-loop system. This controller is composed of a comparator and a feedback path. It has one output and two inputs. In this, for producing an output signal, the comparator is used to compare the required reference signal and this output signal is sensed by the sensor. The input signal for the motor is termed as a feedback signal. On the basis of the feedback signal, the motor starts working. Comparator signal is called a logic signal of the motor. The motor would be ON for the desired time when the logical difference is higher and the motor would be OFF for the desired time when the logical difference is lower. Basically, a comparator is used to decide that motor would be ON or OFF. Proper functioning of the motor can be done with the help of a good controller.

The servo motors can be controlled by the method PWM i.e., Pulse Width Modulation. These send electric signals of inconsistent width to the motor. The width pulse is varied in the range of 1 millisecond to 2 milliseconds and transfers this to the servo motors with repeating 50 times in a second. The width of the pulse controls the angular position of the rotating shaft. In this, three terms are used which shows the controlling of the servomotor i.e., a maximum pulse, minimum pulse and repetition rate.

For example, the servo moves with the pulse of 1 millisecond to turn motor towards 0˚ whereas a pulse of 2 milliseconds to turn motor towards 180˚ Between the angular positions, the pulse width interchange by itself. Therefore, the servo turns to the 90˚ with the pulse of width 1.5 milliseconds as shown in Fig. 3.10.

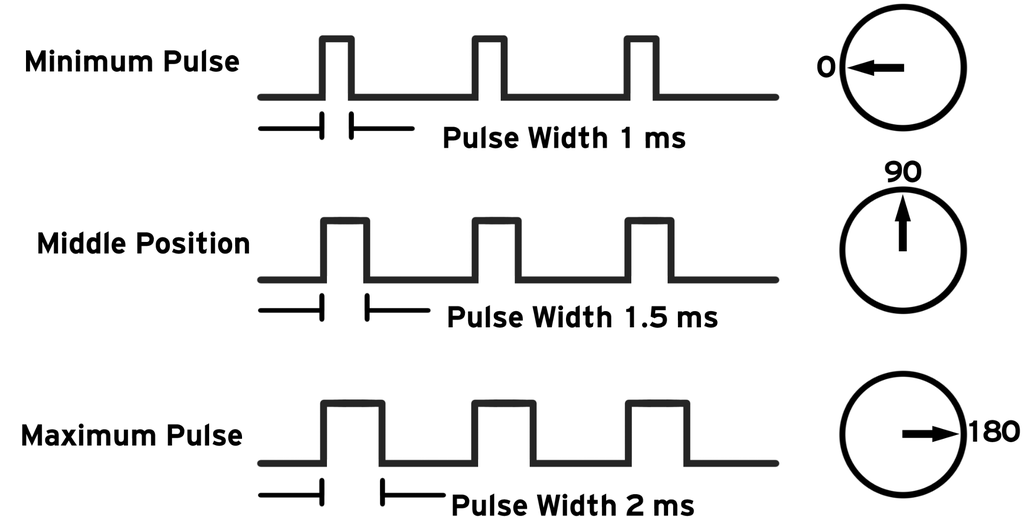


Fig. 3.10 Controlling of Servo Motors (Source: [Cornelam](https://www.instructables.com/member/cornelam/) , n.d.)

There are three wires or leads in every servo motors. The two wires used from positive supply and ground supply whereas the third wire is used to control the signal.

### 3.5.3 Wire Configuration



Fig. 3.11 Wire Configuration of Micro Servo Motor (Source: Components101, n.d.)

The wire configuration of a micro servo motor is shown by Fig. 3.11. Table 3.4 provides the standard wire configuration and description of Micro Servo Motor in a tabular form.

Table 3.4 Wire Configuration and description of Micro Servo Motor

|  |  |  |
| --- | --- | --- |
| Wire Number | Wire Colour | Description |
| 1 | Brown | Ground wire connected to the ground of system |
| 2 | Red | Powers the motor typically +5V is used |
| 3 | Orange | PWM signal is given in through this wire to drive the motor |

(Source: Components101, n.d.)

## 3.6 Piezo Active Buzzzer



Fig. 3.12 Piezo Active Buzzer (Source: Ashutosh, 2011)

**Piezo Active Buzzer as shown in** Fig. 3.12 is an electronic device commonly used to produce sound using an internal oscillator, so all that is needed is a DC voltage Light weight, simple construction and low price make it usable in various applications like car/truck reversing indicator, computers, call bells etc. Piezo buzzer is based on the inverse principle of piezo electricity discovered in 1880 by Jacques and Pierre Curie. It is the phenomena of generating electricity when mechanical pressure is applied to certain materials and the vice versa is also true. Such materials are called piezo electric materials. Piezo electric materials are either naturally available or manmade. Piezoceramic is class of manmade material, which poses piezo electric effect and is widely used to make disc, the heart of piezo buzzer. When subjected to an alternating electric field they stretch or compress, in accordance with the frequency of the signal thereby producing sound. Encapsulated in a cylindrical plastic coating, it has a hole on the top face for sound to propagate.

### 3.6.1 Features

The features of a Piezo Active Buzzer are:

* Operating Voltage: 3-12V DC
* Rated current: <30mA
* Sound Type: Continuous Beep
* Resonant Frequency: ~4 kHz
* Round shape
* Small and neat sealed package
* Breadboard and PCB friendly

### 3.6.2 Pinout Configuration

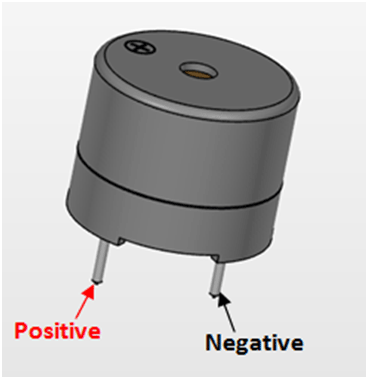


Fig. 3.13 Pinout Diagram of a Piezo Active Buzzer (Source: Components101, n.d.)

Fig. 3.13 shown above gives the standard pinout diagram of a Piezo Active Buzzer. Table 3.5 provides the standard pinout configuration and description of a Piezo Active Buzzer in a tabular form.

Table 3.5 Pinout Configuration and description of a Piezo Active Buzzer

|  |  |  |
| --- | --- | --- |
| Pin Number | Pin Name | Description |
| 1 | Positive | Identified by (+) symbol or longer terminal lead. Can be powered by 6V DC |
| 2 | Negative | Identified by short terminal lead. Typically connected to the ground of the circuit |

(Source: Components101, n.d.)

### 3.6.3 Applications

The applications of a Piezo Active Buzzer are:

* Alarming Circuits, where the user has to be alarmed about something
* Communication equipments
* Automobile electronics
* Portable equipments, due to its compact size

## 3.7 Light Emitting Diode

## Red Led Icon On White Background Led Sign Light Emitting Diode Flat Style Led Stock Illustration - Download Image Now - iStock

Fig. 3.14 Pinout Diagram of a Piezo Active Buzzer (Source: Components101, n.d.)

A Light emitting diode (LED) as shown in Fig. 3.14 is a two-lead semiconductor light source, which emits lights when activated. When an appropriate voltage is applied to the LED terminal, then the electrons are able to recombine with the electron holes within the device and release energy in the form of photons. This effect is known as electroluminescence. The **color of the LED** is determined by the energy band gap of the semiconductor. We have used a 5mm round led emitting red color wavelength in our project hardware.

### 3.7.1 Features

The Features of a 5mm Round LED is:

* Superior weather resistance
* 5mm Round Standard Directivity
* UV Resistant Eproxy
* Forward Current (IF): 30mA
* Forward Voltage (VF): 1.8V to 2.4V
* Reverse Voltage: 5V
* Operating Temperature: -30℃ to +85℃
* Storage Temperature: -40℃ to +100℃
* Luminous Intensity: 20mcd

### 3.7.2 Pinout Configuration

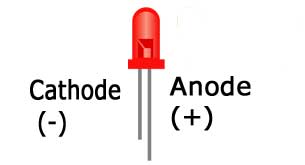


Fig. 3.15 Pinout Diagram of a Piezo Active Buzzer (Source: Components101, n.d.)

Fig. 3.15 shown above gives the standard pinout diagram of a Piezo Active Buzzer. Table 3.6 provides the standard pinout configuration and description of a Piezo Active Buzzer in a tabular form.

Table 3.6 Pinout Configuration and description of a Piezo Active Buzzer

|  |  |
| --- | --- |
| Pin Name | Description |
| Anode | Positive terminal of LED |
| Cathode | Negative terminal of LED |

(Source: Components101, n.d.)

## 3.8 Printed Circuit Board

## See the source image

Fig. 3.16 Blank Printed Circuit Board (Source: Pcbcart, n.d.)

Printed Circuit Board (PCB) as shown in Fig. 3.16 is a copper laminated and non-conductive **Printed Circuit Board**, in which all electrical and electronic components are connected together in one common board with physical support for all components with base of board. When PCB is not developed, at that time all components are connected with a wire which increases complexity and decreases reliability of the circuit, by this way we cannot make a very large circuit like motherboard. In PCB, all components are connected without wires; **all components are connected internally**, so it will reduce the complexity of the overall circuit design. PCB is used to provide electricity and connectivity between the components, by which it functions the way it was designed. PCBs can be customized for any specifications to user requirements. It can be found in many electronics devices like; TV, Mobile, Digital camera, Computers parts like; Graphic cards, Motherboard, etc. It also used in many fields like; medical devices, industrial machinery, automotive industries, lighting, etc.

## 3.9 Arduino Software IDE

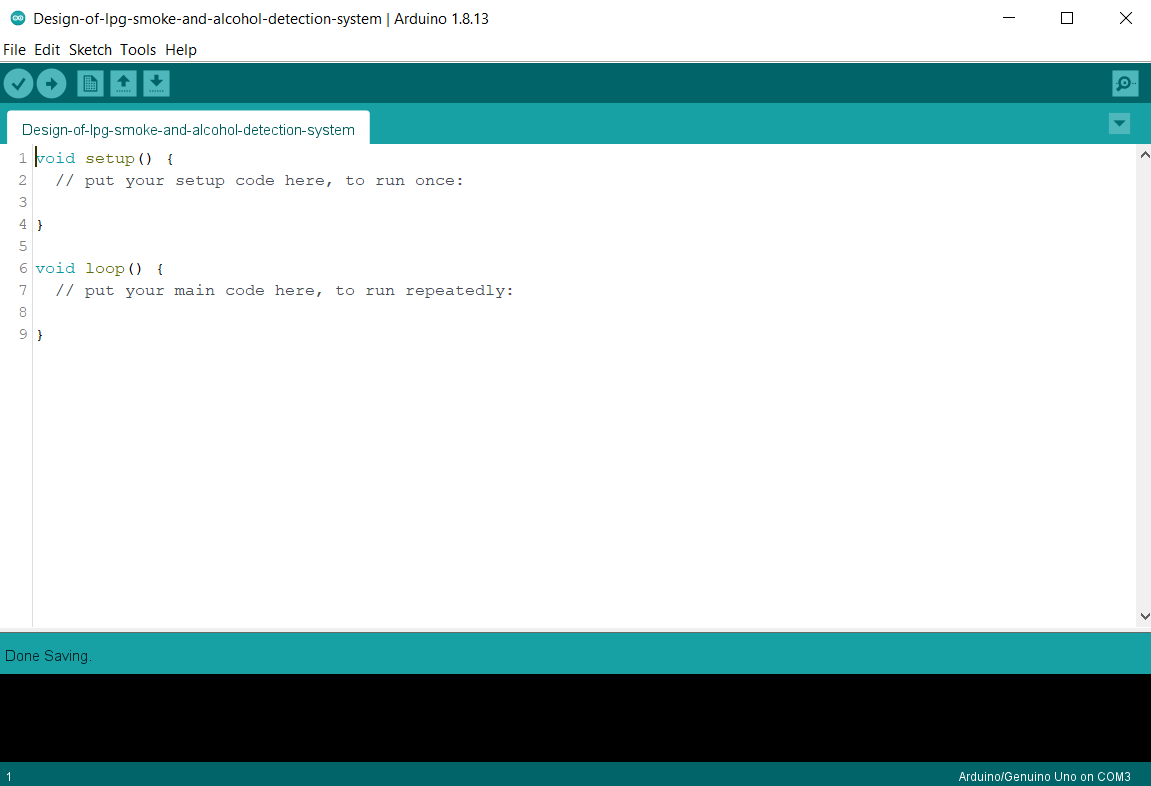


Fig. 3.17 Arduino Integrated Development Platform (IDE) (Source: My Screenshot, 2020)

The Arduino Integrated Development Environment (IDE) as shown in Fig. 3.17 is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. Programming language makes it easy to write code and upload it to the board. Besides any Arduino board this software can be used with other boards if we upload the Arduino sketch on it. Active development of the Arduino software is [hosted by GitHub](https://github.com/arduino/Arduino/).

## 3.10 Proteus Design Suite

## Screenshot (242).png

Fig. 3.18 Proteus Design Suite (Source: My Screenshot, 2020)

The Proteus Design Suite as shown in Fig. 3.18 is a proprietary software tool suite used primarily for [electronic design automation](https://en.wikipedia.org/wiki/Electronic_design_automation). The software is used mainly by electronic [design engineers](https://en.wikipedia.org/wiki/Design_engineer) and technicians to create [schematics](https://en.wikipedia.org/wiki/Schematic) and electronic prints for manufacturing [printed circuit boards](https://en.wikipedia.org/wiki/Printed_circuit_board).

Proteus Virtual System Modeling (VSM) blends mixed-mode SPICE simulation with world leading fast microcontroller simulation. It enables rapid prototyping of both hardware and firmware designs, in software Design, Test and Debug your embedded projects in the Proteus electronic circuit simulator before a physical prototype is ordered. It provides an agile development for the embedded systems workflow.

For embedded engineers, Proteus VSM bridges the gap in the design life cycle between schematic capture and PCB layout. It enables you to write and apply your firmware to a [supported microcontroller](https://www.labcenter.com/buy-vsm/) on the schematic and then co-simulate the program within a mixed-mode SPICE circuit simulation, including MCU peripherals. You can interact with the design using on screen indicators such as LED and LCD displays as well as actuators such as switches and buttons. Proteus VSM also provides extensive debugging facilities including breakpoints, single stepping and variable display for both assembly code and high level language source.

## 3.11 Flowchart of Proposed Design

Fig. 3.19 shows the flowchart of the proposed design.

Check for Leakage

MQ6, MQ3 sensor O/P>=Threshold Value

FALSE

Turn OFF gas regulator

Turn ON Buzzer

TRUE

Turn ON LED

Fig. 3.19 Flowchart of the Proposed Design

# CHAPTER 4

# RESULT, ANALYSIS AND DISCUSSION

## 4.1 Introduction

Simulation is the imitation of the operation of a real-world process or system over time. A model is a representation of the system under study itself, whereas the simulation represents the operation of the system over time. A computer simulation is an attempt to model a real-life or hypothetical situation on a computer so that it can be studied to see how the system works. By changing variables in the simulation, predictions may be made about the behaviour of the system. It is a tool to virtually investigate the behaviour of the system under study (Anon., 2016b).

The aim of the simulation performed in this project is to determine the feasibility and operation of the microcontroller based LPG leakage detection and response system. This chapter gives a detailed result analysis and discussion of the simulation.

## 4.2 Circuit Simulator

The simulation software employed for testing the validity and performance of the proposed design is Proteus Design Suite 8.9 simulator. The software makes it possible for the design to be simulated by mimicking real life situations and also provides the possibility of generating a PCB layout. This makes it easier for the prototype of a design to be constructed devoid of errors.

## 4.3 Analysis of Simulation

Fig. 4.1 shows the operation of the proposed design under normal conditions.

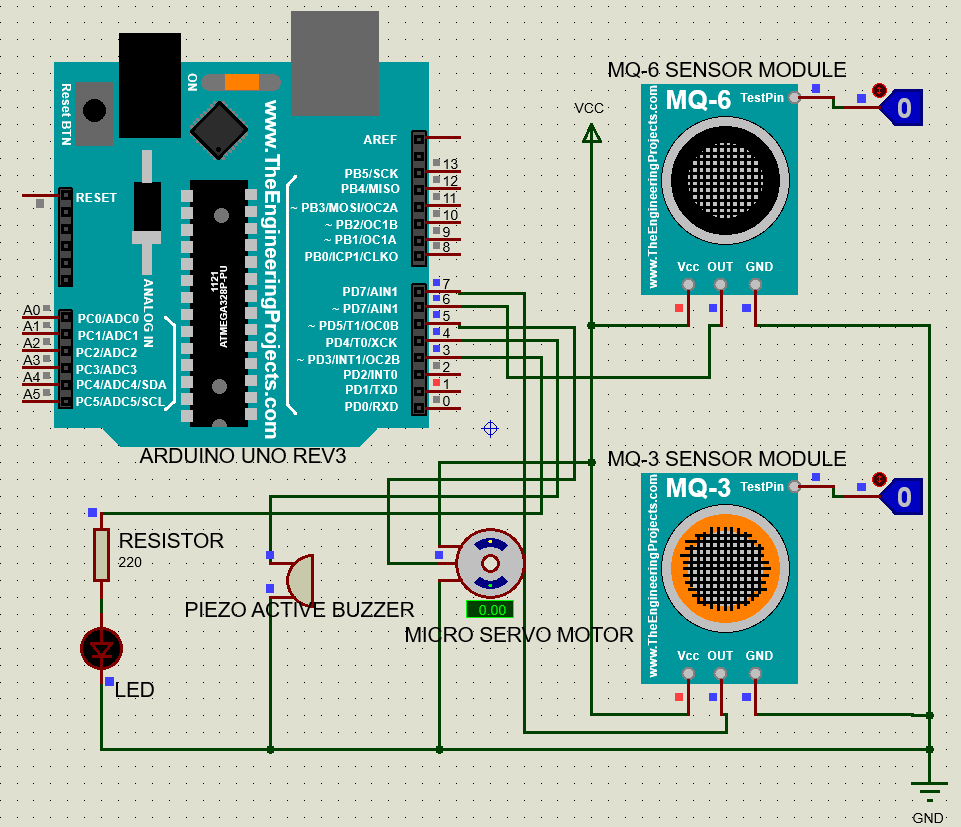


Fig. 4.1 Simulated Diagram of System under Normal Conditions

Fig. 4.2 shows the operation of the proposed design when LPG leakage or smoke is detected by the MQ-6 Sensor Module.

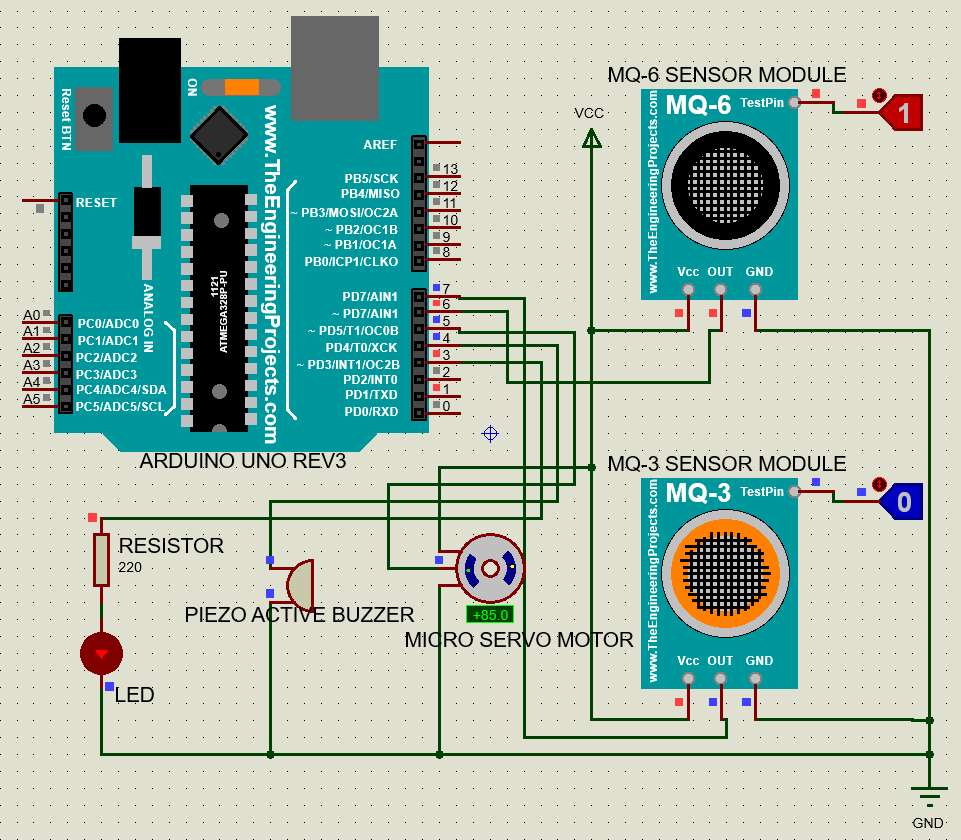


Fig. 4.2 Simulated Diagram of System when MQ-6 sensor module detects leakage.

Fig. 4.3 shows the operation of the proposed design when Alcohol is detected by the MQ-3 sensor.

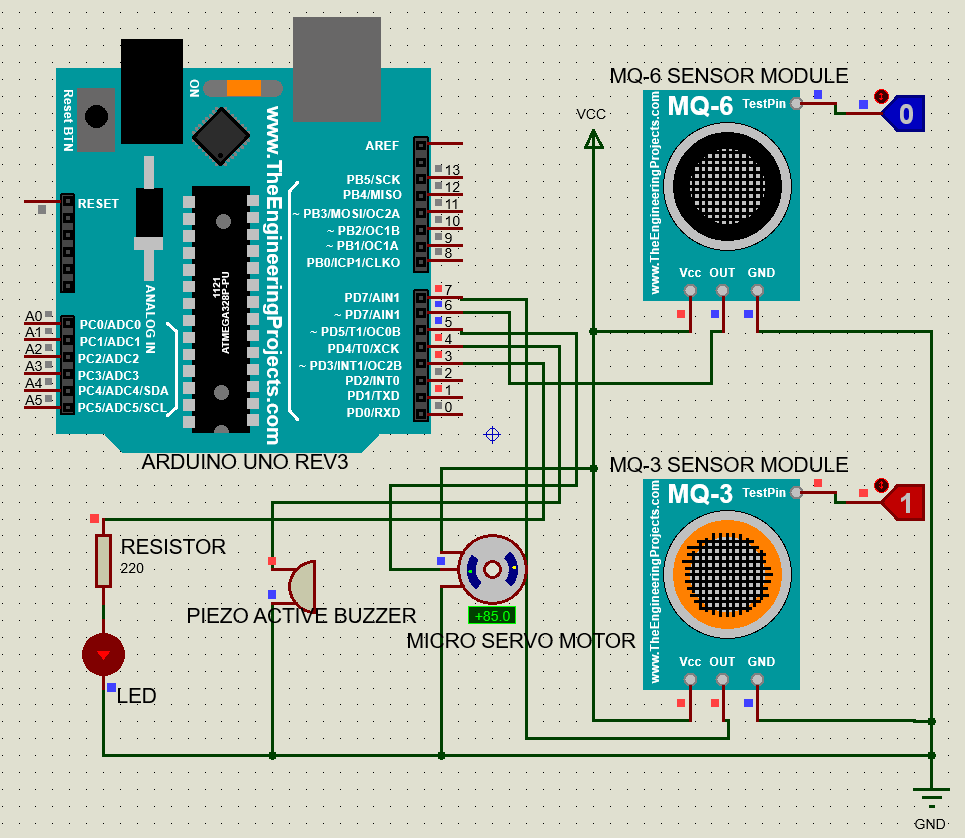


Fig. 4.3 Simulated Diagram of System when MQ-3 sensor module detects leakage.

Fig. 4.4 shows the operation of the proposed design when both the sensors detect leakage.

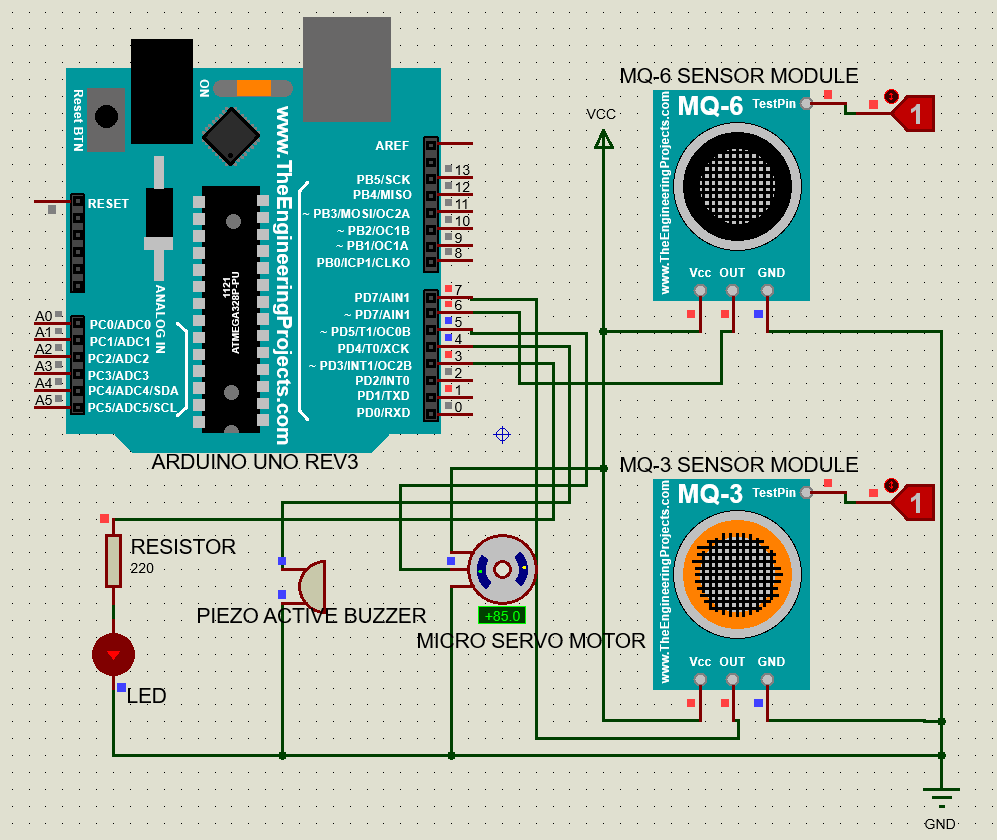


Fig. 4.4 Simulated Diagram of System when MQ-6 and MQ-3 sensor module detects leakage

When leakage is detected, signal is sent to the buzzer to blow an alarm, a red color led is turned on, the servo rotates 85 degrees to turn off the gas regulator key to cut off the mains gas supply.

## 4.4 Cost Estimation

Table 4.1 shows the cost analysis of the proposed design of LPG, smoke and alcohol detection system with automatic mains cut off. The analysis is based on the lowest individual cost of each component used in the simulation while taking into consideration quality, in order to minimize the cost of building the system. This in turn makes the system economical and affordable for domestic use. This analysis is an estimate of the prices of components used in the simulation based on review at online stores like Flipkart.

Table 4.1 Cost Analysis

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Items** | **Quantity** | **Unit Price** | | **INR** |
| **USD** | **INR** |
| MQ-6 Sensor Module | 1 | 3.06 | 225.00 | 225.00 |
| MQ-3 Sensor Module | 1 | 3.11 | 229.00 | 229.00 |
| Arduino Uno R3 with USB Cable | 1 | 6.11 | 449.00 | 449.00 |
| Micro Servo Motor (SG90) | 1 | 1.75 | 129.00 | 129.00 |
| Piezo Active Buzzer | 1 | 0.34 | 25.00 | 25.00 |
| LED (red) | 1 | 0.07 | 5.00 | 5.00 |
| Resistor (220 ohm) | 1 | 0.07 | 5.00 | 5.00 |
| PCB (15\*10 cm) | 1 | 1.36 | 50.00 | 50.00 |
| **Total Price** | | | | **1117.00** |

The USD to INR exchange rate as at the time of this analysis was:

INR