# SMART NOSE

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## CERTIFICATE OF CORRECTNESS AND APPROVAL

It is certified that work contained in this thesis "Smart Nose", was carried out by Sarah Iftikhar, Hamid Iqbal, Shahzad Rafee, Farhat Mahmood, Sadaf Basit under the supervision of Col. Abdul Ghafoor (PhD) for partial fulfillment of Degree of Bachelor of Electrical (Telecommunication) Engineering, is correct and approved.

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# ABSTRACT

Over the past few years, the scientific advances have brought changes in every aspect of our lives and they have created both a positive and a negative impact simultaneously. When we consider the advantages, our lifestyle has become more luxurious and comfortable. However, everything has a price and it is now being paid in terms of global warming, more frequently happening natural disasters, shortage of food and clean water in many parts of the world and an alarming level of pollution of every form. These have increased the risk of the loss of human life in the current environment.

One of the factors that play a significant role in our daily lives is the presence of dangerous gases in the air. The most occurring is natural gas, commonly known as Sui gas, which is being used in heaters, geysers and other appliances. Sometimes, gas cylinders containing LPG are also used in its place. Besides its usefulness, if these gases get leaked in our houses, offices and industries, they can cause serious casualties. Not just Methane and LPG but there have been numerous cases of Carbon Monoxide poisoning as well. All of these gases impose a great threat to human life. On 22$^{nd}$ January, 2014 it was reported that four persons of a family including husband, wife and their two children were found dead due to suffocation caused by gas leakage. In December 2017, at least seven people died of suffocation or burns in ten incidents of gas leaks and gas explosions reported to the police. Another incident in the same year was a blast due to gas leakage in PWD Colony of Rawalpindi which killed three people and injured many others.

Natural gas is colorless and odorless on its own, so the gas company adds an odorant as a safety precaution. The pungent odor, which is almost like rotten eggs, helps detect it immediately if there is any gas leak. However, lately it has been revealed that the odorant of the gas is quiet expensive and the companies have decreased its amount in the gas being supplied. No odor and color and gas load shedding on the top of that in winters often makes gas leak and its detection difficult and hence leads to these accidents.

Gas detectors and sensors available in the market can detect only one gas in one module. Moreover, if user is not physically present at the site of detection, there can be made no safety measures as the current devices only detect the gas. Therefore one compact device for detection of two dangerous gases namely; carbon-monoxide and LPG is designed and implemented on a small scale to serve as a prototype. When gas is detected and measured above the threshold value, the user is informed via audio visual alarms along with a text message. Moreover, the device itself will take some precautionary measures to stabilize the environment which include the cut off of the main electric and gas supply thus preventing explosion caused by sparking of the gas. In case of fire, the device will detect it and notify the user in the same manner as mentioned above. Hence, a Smart Nose is designed and implemented to provide user with all the features mentioned above.

# DEDICATION

"If Allah assists you, then there is none that can overcome you, and if He forsakes you, who is there then that can assist you after Him? And on Allah should the believers rely."(3:160)

Dedicated to our beloved families and country Pakistan

# ACKNOWLEDGEMENT

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## LIST OF SYMBOLS/ABBREVIATIONS

| | |
|---|---|
| cc | cubic centimeters |
| LEL | Lower explosive limit |
| ppm | parts per million |
| LPG | Liquefied Petroleum Gas |
| CO | Carbon Monoxide |
| VOCs | Volatile Organic Compound |
| psi | pounds per square inch |

***Chapter: 1***

# INTRODUCTION

## 1.1 Background

In 1914, Alexander Graham Bell noted:

*"Did you ever measure a smell? Can you tell whether one smell is just twice strong as another? Can you measure the difference between one kind of smell and another? It is very obvious that we have very many different kinds of smells, all the way from the odour of violets and roses up to asafetida. But until you can measure their likeness and differences, you can have no science of odor. If you are ambitious to find a new science, measure a smell"*. In the decades since Bell made this observation, no such science of odor materialized, and it was not until the 1950s and beyond that any real progress was made.

“Electronic sensing" refers to the capability of reproducing human senses using sensor arrays and pattern recognition systems. Since 1982, research has been conducted to develop technologies, commonly referred to as electronic nose, that could detect and recognize odors and flavors.

## 1.2 Problem Statement

Natural gas is commonly used for domestic purposes. Besides its usefulness, if it is leaked in our houses, offices or factories and not sensed in time, it may lead to a fatal disaster, and can even cause human loss. The presence of harmful gases even in small amounts is very dangerous and can have health problems. These include headaches, dizziness, and restlessness to coma, asphyxia, and convulsions. It can also cause serious long term health problems such as brain damage. Badly fitted or poorly maintained gas appliances can produce a highly poisonous gas called carbon-monoxide (CO) which can leak into the residence. It can’t be seen, tasted or smelled it but it can kill quickly and with no warning. Un-burnt natural gas (90% methane) and LPG are not poisonous in the same way that carbon-monoxide is but both can lead to fires and explosions. For this purpose, we came forward with an idea that serves as a solution to this crisis.

## 1.3 Solution

The solution to this problem is to design a Smart Nose that integrates the major sensing elements with other features of the device that include the GSM module and the safety measures using Arduino as the central processing unit. This one compact indoor device will detect carbon-monoxide and LPG along with fire as well and will allow the user to be notified instantly in case of any hazardous situation.

## 1.4 Inspiration

Many cases are recorded due to negligence of inhabitants and unannounced load shedding of gas which caused an increase in sudden death rates due to gas poisoning. The main drivers behind this project are real cases in different parts of world especially in Pakistan recently. The first case was reported in Quetta, Pakistan where one person was killed and three were injured in an explosion after a gas leak at a house in Pashtun Abad area. According to the family, the explosion occurred as they lit a match for the preparation of Fajr prayers. The six room house was completely destroyed by the explosion. The blast was so severe that it also damaged nearby buildings and electricity poles.

In the second case occurred in Qilla Saifullah, Pakistan where two brothers went to sleep in a room after igniting a heater. The deceased were suffocated after coal-run heater absorbed the entire oxygen in the room. They were shifted to a nearby hospital where the doctors pronounced them dead.

In the third case mentioned here, five members of a family including husband, wife and three children died due to suffocation in their home at Baldia town of the city. As reported in newspaper account, the family died apparently due to gas poisoning after the electricity generator was left running throughout the night.

One girl was killed and six persons, including a woman, were injured in twin explosion after different incidents of gas leakage in one day at Quetta, Pakistan. According to Police, the first explosion occurred after gas filled in the office of Sui Southern Gas Company (SSGC) near the Eastern Bypass. An official was severely injured by the fire that erupted after the explosion. Seven rooms of the officer's mess were completely destroyed by the blast. The second blast took place at a house located at Wali Khan Chowk at the area of Pashtun Abad where a heater was left burning. A girl was killed and five persons, including a woman, were injured in the incident.

These all cases mentioned above are just some examples from the daily accidents took place inside Pakistan. However, the dizziness caused by Carbon-dioxide and the silent death caused by Carbon-monoxide is not reported. All these cases could be avoided if there was some detecting mechanism which would detect the gases before they cause dizziness or any other harm. Moreover, we believe that this system should be present in every house as a recent survey indicates that there are no specifications for gas related safety precautions included in building laws of most housing societies of Pakistan. Therefore there is a need to design an electronic device that is portable and detects most of the harmful gases that might be present within the household because of leakage or any other unforeseen failure.

### 1.5 Objectives

The Smart nose should be able to detect the two mostly encountered and dangerous gases in houses and residential buildings that are

i. Carbon-monoxide
ii. LPG
iii. Fire and Smoke

The device is equipped with both audio and visual alarms in case of a situation when the gas will be detected and has reached above the threshold level. The electronic nose will be interfaced to GSM and as soon the gas or fire is detected a text message will be sent to user which will contain information of the gas detected and requesting the user to take action. As the gas is detected a safety providing device is turned on automatically to keep the concentration of the gas detected as low as possible and to prevent further sparking of the gas. This will be done by the cut off of the main gas and electric supply at the receiver end of the device which will receive instructions according to the type of gas present.

## 1.4 Document Organization

Chapter 2 gives a review of literature studied for the completion of project including Gas sensors and origin of Electronic Nose concept. Chapter 3 discusses sources of gases and their harmful effects on our health. Chapter 4 provides the comprehensive details on design and schematic of Smart Nose. Chapter 5 discusses the details of the components of Smart Nose. Chapter 6 discusses the functional components of GSM architecture used for sending and receiving of text messages. Chapter 7 details the results and simulations obtained from testing. Chapter 8 discusses the applications of Smart Nose in detail.

*Chapter: 2*

# LITERATURE REVIEW

## 2.1 Introduction

This chapter starts with the basic review of Gas sensors and their different types are explained. The sensor type used is discussed with its operation and components in detail.

## 2.2 Gas Sensors

Gases are the key measures in numerous mechanical or local exercises. In the most recent decade solid identification of dangerous, unsafe, or harmful gases has turned into a noteworthy issue because of more stringent natural and security controls worldwide as the consciousness of the need to ensure the earth has developed. Single gas sensors can, for cases, be utilized as flame indicators, spillage locators, controllers of ventilation in autos and planes, alert gadgets cautioning the surpassing of edge fixation estimations of unsafe gases in the work places. The discovery of unpredictable natural mixes (VOCs) or scents created from sustenance or family unit items has additionally turned out to be progressively vital in nourishment industry and in indoor air quality, and multisensory frameworks (regularly alluded to as electronic noses) are the advanced gas detecting gadgets intended to break down such complex ecological blends.

A short list of solid state gas sensors is described below

**Table 2-1 Types of solid state gas sensors with the corresponding physical change used as gas detection principle.**

| Type of Gas sensors | Physical change |
|---|---|
| Semiconductor gas sensors | Electrical conductivity |
| Field effect gas sensors | Work function (electrical polarization) |
| Piezoelectric sensors | Mass |
| Optical sensors | Optical parameters: surface Plasmon resonance, reflection, interferometry, absorption, fluorescence, refractive index or optical path length |
| Catalytic gas sensors | Heat or temperature |
| Electrochemical gas sensors | Electromotive force or electrical current |

### 2.2.1 Semiconductor Gas Sensors

Semiconductor gas sensors (SGS), referred to likewise as chemo resistive gas sensors, are regularly in light of metal oxides (e.g. SnO2, TiO2, In2O3, WO3, NiO, and so on.). Semiconductor gas sensors (metal oxide sensors) are electrical conductivity sensors. The obstruction of their dynamic detecting layer changes because of contact with the gas to be distinguished. In the perfect case, the gas responds with the sensor surface in a totally reversible response.

### 2.2.2 Field Effect Gas Sensors

In field impact sensors innovation depends on the field impact created by gases in metal oxide semiconductor field-impact transistor (MOSFET) gadgets with reactant metals. The charging of the entryway contact by the gas atoms brings about a voltage change in the sensor flag. The collaboration of gases with the synergist door metal initiates dipoles or charges, which give an extra voltage to the entryway contact. The decision of task temperature, entryway metal, and structure of the door metal decide the selectivity of the gas reaction.

This gives reaction time in the request of milliseconds because of the quick substance responses. Besides, the reactant metal stays clean even in exceptionally defiled conditions.

### 2.2.3 Piezoelectric Gas Sensors

A piezoelectric sensor is a device that uses the piezoelectric effect (the electric charge that accumulates in certain solid materials in response to applied mechanical stress), to measure changes in pressure, acceleration, strain or force by converting them to an electrical charge.

### 2.2.4 Optical Sensors

The optical gas sensors assume a vital part in detecting field for the estimations of substance and organic amounts. To begin with optical substance sensors depended on the estimation of changes in assimilation range. At display an extensive assortment of optical techniques are utilized as a part of substance sensors and biosensors including ellipsometry, spectroscopy (iridescence, glow, fluorescence, Raman), interferometry, spectroscopy of guided modes in optical waveguide and a surface Plasmon reverberation (SPR) in which the swaying of electrons changes of the protest at which light falls changes. In these sensors a coveted amount is dictated by estimating the refractive record, absorbance and fluorescence properties of the analytic atoms or a chemo-optical transducing component.

### 2.2.5 Catalytic Gas Sensors

Synergist identifiers depend on the rule that when gas oxidizes it produces warm, and the sensor changes over the temperature change by means of a standard Wheatstone Bridge-type circuit to a sensor flag that is relative to the gas fixation. The sensor segments comprise of a couple of warming curls (reference and dynamic). The dynamic component is installed in an impetus. The response happens on the surface of the impetus, with ignitable gases responding exothermically with oxygen noticeable all around to raise its temperature. These outcomes in a difference in obstruction.

There is additionally a reference component giving an inactive reference motion by residual non-receptive to gas, in this way going about as a steady pattern flag to make up for ecological changes which would some way or another influence the sensors temperature.

### 2.2.6 Electrochemical Gas Sensors

The most established electrochemical sensors go back to the 1950s and were utilized for oxygen observing. All the more as of late, as the Occupational Safety and Health Administration (OSHA) started requiring the observing of dangerous and burnable gases in bound space applications, new and better electrochemical sensors have been produced.

By the mid-1980s, scaled down electrochemical sensors ended up accessible for discovery of a wide range of poisonous gases in PEL ranges, with the sensors showing great affectability and selectivity. At present, an assortment of electrochemical sensors is being utilized broadly in numerous stationary and convenient applications for individual security. Figure 2-1 demonstrates a little gathering of such electrochemical sensors.

***Figure 2-1:*** **Electrochemical Sensors**

## 2.3 Electronic Nose

### 2.3.1 Origin of Electronic Nose

The sensor innovation of fake olfaction had its beginnings with the development of the primary gas multisensory cluster in 1982. Advances in smell sensor innovation, gadgets, organic chemistry and man-made brainpower made it conceivable to create gadgets equipped for estimating and describing unpredictable fragrances discharged from a huge number of hotspots for various applications. These gadgets, known as electronic noses, were built to emulate the mammalian olfactory framework inside an instrument intended to acquire repeatable estimations, permitting distinguishing pieces of proof and groupings of smell blends while wiping out administrator exhaustion. Not at all like other logical instruments, these gadgets permit the ID of blends of natural examples overall (identifiable to a source that discharged the blend) without identifying singular compound species inside the example blend. Several distinct models of fake nose gadgets have been produced to separate complex vapor blends containing a wide range of sorts of unpredictable natural mixes (VOCs). These models all things considered speak to different electronic smell recognition (EAD) advances that use diverse sensor composes including metal-oxide, semiconductive polymers, conductive electro-dynamic polymer, optical, surface acoustic wave and electrochemical gas sensors.

Most uses of EAD advances heretofore have been in mechanical generation, handling, and assembling. A portion of the more typical assembling applications have been in quality control and reviewing, item consistency and consistency, preparing controls, gas spill identification and natural effluents checking. Applications are persistently being created in numerous new territories of connected research, for example, for unpredictable outflows appraisals, country security, natural insurance, biomedical judgments, faculty wellbeing, and in item advancement explore.

## 2.4 Summary

To summarize, in this chapter an introduction to Gas sensors was provided. Six types of gas sensors were discussed and Operation of Electrochemical gas sensors was provided in detail with description of major components. Origin and concept of Smart Nose were also discussed.

# SOURCES OF GASES AND THEIR HARMFUL EFFECTS

## 3.1 Introduction

.Indoor air pollution can put risk to our health as we go about our day to day lives. Sources of indoor pollution are gas particles produced due to poor quality of air indoors. People who are exposed to these harmful gases get the most effected which mainly consists of young, ill patients and the elderly suffering from respiratory and other diseases.

## 3.2 Sources of Gases

### 3.2.1 Carbon-dioxide ($CO_2$)

There are natural and human sources of carbon-dioxide emissions. The concentration of CO2 has been on an exponential rise due to human activities of industrial revolution. They have increased so much that these levels have not been seen in the last 3 million years.

### 3.2.2 Carbon-monoxide (CO)

Kerosene accumulation and gas from heaters, leakage of furnaces and chimneys, , gas water heaters, fireplaces, wood stoves, gas stoves; generators, charcoal grills, lawnmowers, snow blowers, other yard equipment and other equipment that is being powered by gasoline, tobacco smoke are some of the mentioned sources of CO. During combustion, the process of incomplete oxidation in kerosene and gas heaters causes carbon monoxide to rise in concentration and thus lowering the indoor air quality. Other major sources can be poorly adjusted and corroded combustion devices. Some of other sources of CO are the gas emission from vehicles and other transportation methods along with the different ongoing industrial processes as well.

### 3.2.3 Methane ($CH_4$)

Methane emission is done at both human and natural levels. Natural sources contribute to 36% of the emission of natural gas. Whereas human sources of methane emission includes livestock farming, fossil fuels and landfills. Human sources of methane emissions have been growing since the beginning of industrial era.

## 3.3 Effects of Gases

### 3.3.1 Carbon-dioxide

Different health effects caused due to exposure to CO are stated as follows:

**Table 3-1: Effects and Symptoms of carbon-dioxide at different concentrations**

| $CO_2$ Concentration | Effects and Symptoms |
|---|---|
| 400 ppm | Normal outdoor fresh air |
| 400-1000 ppm (0.04-0.1%) | Typical level found in occupied spaces with good air exchange. |
| 1000-2000 ppm (0.1-0.2%) | Over ventilation |
| 2000-5000 ppm (0.2-0.5%) | Shortness of breath and increased heartbeat frequency |
| 5000 ppm (0.5%) | Hygienic limit value |
| 15,000-50,000 ppm (1.5-5%) | Headaches, sleepiness, and stagnant, stale, stuffy air. Poor concentration, loss of attention, increased heart rate and slight nausea may also be present |
| 75,000 ppm (7.5%) | Headaches, dizziness, restlessness, breathlessness, increased heart rate and blood pressure, visual distortion |
| 100,000 ppm (10%) | Impaired hearing, nausea, vomiting, loss of Consciousness |
| 300,000 ppm (30%) | Coma, convulsions, death |

### 3.3.2 Carbon-monoxide

Health effects caused due to exposure to CO for more than 1-hour are stated as follows:

**Table 3-2: Harmful effects of carbon-monoxide at different ppm**

| CO Concentration | Harmful effects |
|---|---|
| 0-9 ppm | No health risk; normal CO levels in air. |
| 10-29 ppm | Problems over long-term exposure; chronic CO problems such as headaches, nausea- not the most dangerous level |
| 30-35 ppm | Flu-like symptoms begin to develop, especially among the young and the elderly |
| 36-99 ppm | Flu-like symptoms among all; nausea, headaches, fatigue or drowsiness, vomiting. |
| 100 ppm+ | Severe symptoms; confusion, intense headaches; ultimately brain damage, coma, and/or death, especially at 300 to 400 ppm+ |

Carbon-monoxide is also harmful as it induces resistance to the oxygen carrying capability of blood to all organs of the body like brain and heart. Combination of CO with the blood causes the production of carboxyhemoglobin (*COHb*) which does not carry oxygen. Below is the Percentage of carboxyhemoglobin along with carbon-monoxide concentration.

**Table 3-3: Percentage of carboxyhemoglobin along with carbon monoxide concentration**

| CO in atmosphere (ppm) | COHb in Blood (%) |
|---|---|
| 10 | 2 |
| 70 | 10 |
| 120 | 20 |
| 220 | 30 |
| 350-520 | 40-50 |
| 800-1220 | 60-70 |
| 1950 | 80 |

Symptoms associated with a Given Concentration of COHb are given below:

- **10% COHb** - No symptoms. Even 9% of the COHb can be present in egular and heavy smokers.
- **15% COHb** - Mild headache.
- **25% COHb** - Nausea and serious headache.
- **30% COHb** - Symptoms intensify. With this much exposure, there exists a potential for a long lasting effect on the health's of infants, children, the elderly, heart disease patients and pregnant women.
- **45% COHb** - Unconsciousness
- **50+% COHb** – Death

### 3.3.3 Methane

The adverse effects of methane are as follows:

- Toxic by inhalation and skin exposure
- Chemicals classification: extremely flammable
- Inhalation causes agitation, slurred speech, nausea, vomiting, facial flushing and headache. Severe cases may lead to breathing and heart problems and even coma and death as well.

- Methane is an asphyxiant when taken in its gaseous form, which resists the oxygen supply that is required for major functions, if taken in large amount, of the body like breathing, especially in confined places. Decreased oxygen can cause suffocation and loss of consciousness.

### 3.4 Summary

To summarize this chapter, it has enumerated all the natural and human sources of the four highly dangerous gases inside a building and their effects on human beings.

*Chapter: 4*

# WORK DONE

## 4.1 Introduction

This chapter comprises of the methodology followed in development of the Smart Nose. It starts with design and development of the two parts of Smart Nose which are transmitter part, receiver part and GSM, electric and gas supplies, audiovisual alarm indications and calibrating the sensors to specific thresholds. The transmitter and receiver part are then interfaced wirelessly by using RF modules.

## 4.2 Methodology

Project is divided into following segments

- First portion is the designing of smart nose to detect gases by using gas sensors at threshold level along with alarm system which consists of audiovisual alarms, LCD display, buzzer and LED. All of them are controlled by Arduino, which is acting as brain component of the transmitter part. Following table shows the range of detection of sensors selected for detection of the four gases taken from respective sensor datasheets.

**Table 4-1: Detection range of gas sensors**

| Gas | Sensor | Detection range |
|---|---|---|
| LPG | MQ-5 | 200—10000ppm |
| Carbon Monoxide | MQ-7 | 20-2000ppm |
| Methane | MQ-5 | 200---10000ppm |
| Fire | MQ-7 | No range required |

The gases should be detected before their level becomes dangerous. If the leakage of LPG, methane gas occurs than explosion can occur, and if CO gas exceeds the threshold level than death can occur due to suffocation and prolonged exposure causes bad effects on health. Following table shows threshold limit of each gases that will be detected.

**Table 4-2: Threshold level of gases**

| Gas | Threshold |
|---|---|
| Carbon-monoxide | 200ppm |
| LPG | No threshold required |
| Methane | No threshold required |
| Fire | - |

MQ-7 gas sensor is calibrated at 200 ppm to detect carbon monoxide gas because above 200 ppm carbon monoxide becomes dangerous for life and prolonged exposure causes health problems. This can also be used to sense fire because carbon monoxide is produced from fire. No calibration for MQ-5 gas sensor is required as LPG and methane gas are not normally present in air, if these gases are detected than it means there is leakage which needs to be taken care of.

Thus, these gases are detected before their level becomes dangerous. The smart nose will generate alarm to alert the user when the gas will be detected as it reaches the threshold level. The alarm system will have a buzzer and LED's to show output of system along with character LCD for displaying the name of gas detected. GSM is also attached which will inform the user if he/she is out of home.

i. When no gas is detected.
   1. LED is off.
   2. Buzzer is at off state.
   3. LCD displays no leakage.

ii. When gas is detected.
   1. LED lights on.
   2. Buzzer operates.
   3. LCD displays leakage.

This is the algorithm of transmitter side Arduino:

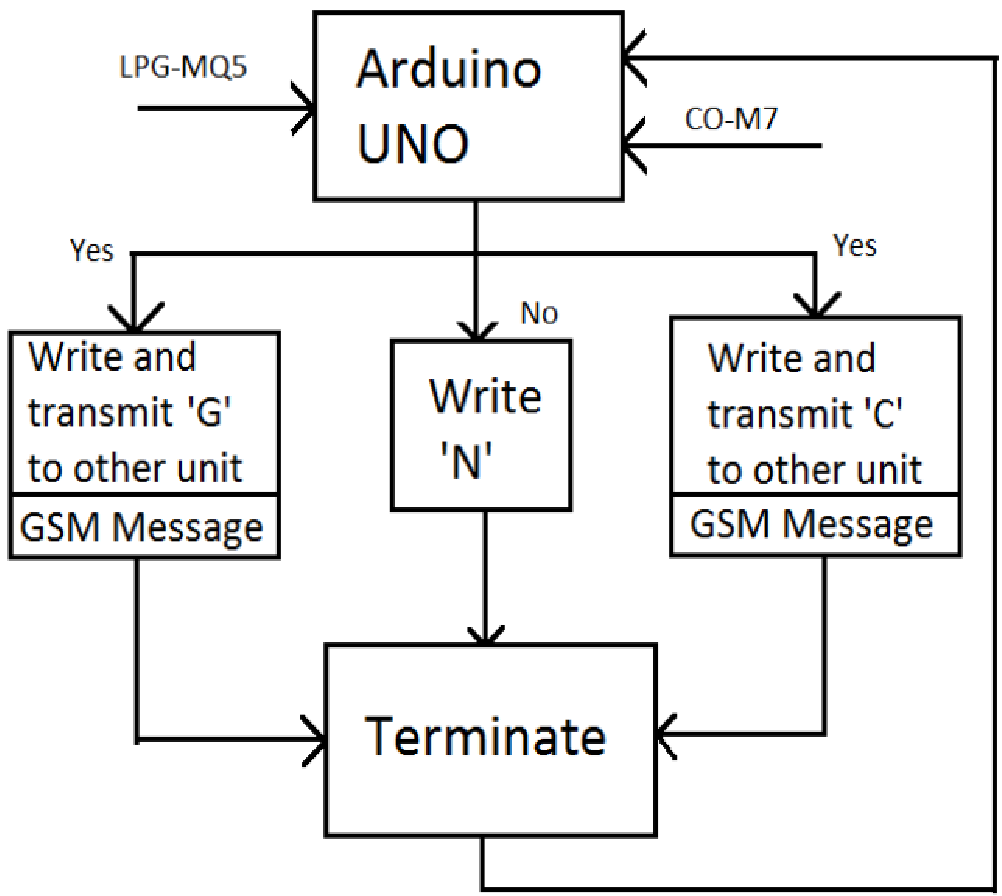



***Figure 4-1:*** **Transmitter sided Arduino algorithm**

- Interfacing of smart nose to GSM. A text message containing the notification about the gas detected will be sent to the user and user will be told about the safety measures taken.
- Designing of the receiver section, also in this Arduino is acting as brain component of the receiver section. It will control the electric and gas supplies. Both supplies are controlled by Arduino by using relays, these are used for switching purpose i.e. for turning on/off the electric and gas supplies. Reverse currents are produced from relays which when travel back to Arduino can damage it. Due to this opto-couplers

which act as insulators are introduced between Arduino and relays to avoid damaging of Arduino by not letting pass the reverse current. Here electric bulb will be used to depict the turning on or off of electric supply and gas valve for depicting the turning on or off of gas supply.

- A ventilation system is also interfaced with receiver Arduino to clean the air in the room.
  - When no gas is detected.

    1-Electric supply is on.

    2-Gas supply is on.

    3-Ventilation system is off

  - When LPG, methane gas is detected.

    1-Electric supply is cutoff.

    2-Gas supply is cutoff.

    3-Ventilation system is turned on

  - When CO gas, fire is detected.

    1-Electric supply on.

    2-Gas supply is cutoff.

    3-Ventilation system is turned on.

  - When CO gas, LPG/methane gas are detected.

    1-Electric supply cutoff.

    2-Gas supply is cutoff.

    3-Ventilation system is turned on.

Here is the algorithm of receiver side Arduino:

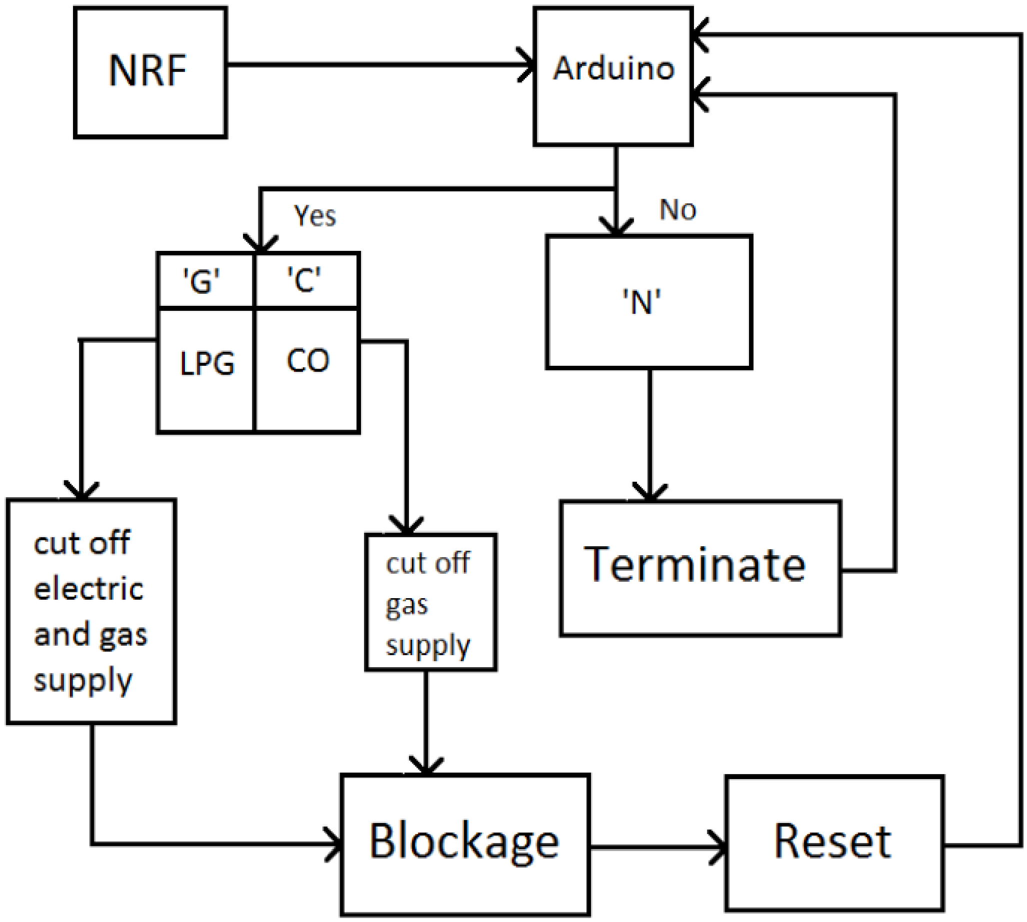



***Figure 4-2:*** **Receiver sided Arduino algorithm**

- Then these two parts transmitter and receiver are interfaced wirelessly by using RF module transceivers which can act as a transmitter or a receiver. One module is at the transmitter part interfaced with Arduino and dictated by it, other one is at the receiver part interfaced with Arduino. When gas is detected Arduino in the transmitter part sends command to its RF module which then send data wirelessly to other RF module and receiver Arduino takes action on the basis of information received. Below is the model schematic of smart node which is divided into different units.

Here is the model schematic:

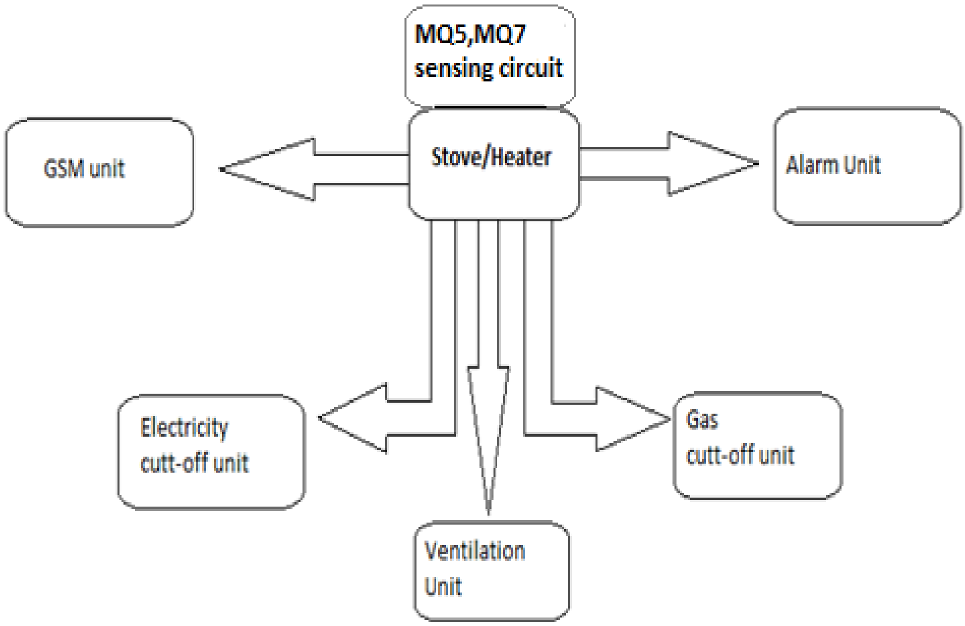



*Figure 4-3:* **Model schematic of Smart Nose**

## 4.3 Circuit Design

### 4.3.1 Power supply circuit for Smart Nose

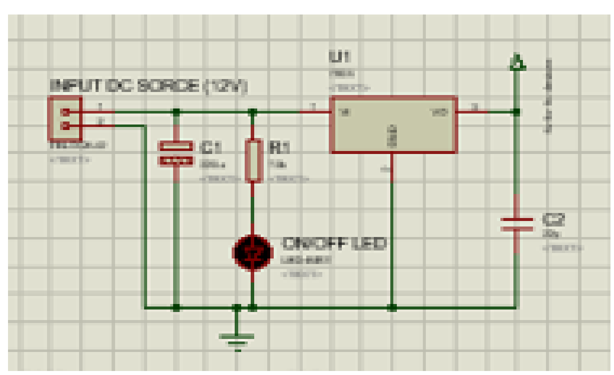



*Figure 4-4:* **Power supply circuit of transmitter side**

Input DC source which is 12 volts is provided by a DC jack. The 12 volts are directly fed to Arduino. But there are devices which operate at different voltage so a circuit is used to convert 12 volts into 5 volts. A capacitor is used after the 12 volts DC jack. In DC circuits capacitors do not have an important purpose. But it is used here by connecting across the terminal of 12 volts source. It is used here to provide a steady current flow as current is stored in it.

### 4.3.2 Circuits for Smart Nose

This part includes the circuits of Smart Nose.

#### 4.3.2.1 Transmitter part circuit of Smart Nose

The circuit diagram of the transmitter part of smart nose in shown below in which all the components are interfaced.

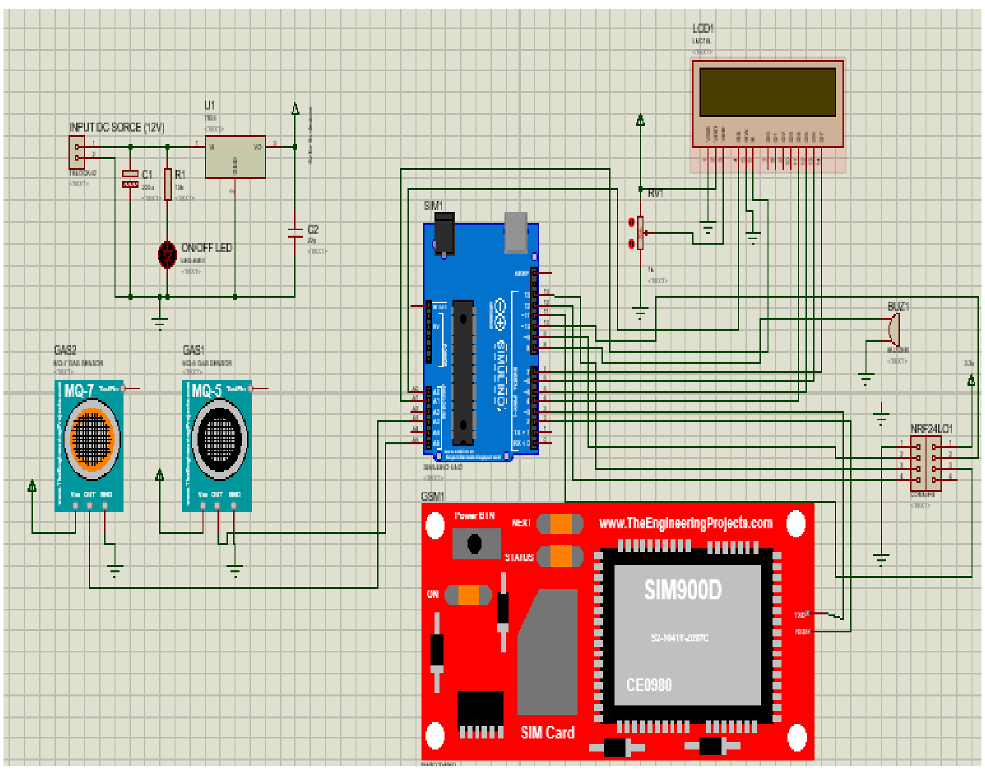



***Figure 4-5:*** **Transmitter part circuit of Smart Nose**

The main brain of the transmitter section is Arduino UNO. Which is very popular for its parallel processing. It has six analogue pins namely A0, A1, A2, A3, A4, A5 which are connecting Arduino to other components. It is given 12 volts directly from the DC jack used.

An LCD display is interfaced with Arduino Uno to alert the user by displaying the gas leakage warnings. A0 and A1 pins of Arduino are connected with enable and reset pins of LCD, pin 1 of LCD is grounded, and 5 volts to the LCD are provided at pin 2 from the power supply circuit. Pin 3 is connected to a variable resistor of 1 kilo ohm with which the brightness of LCD can be adjusted. Pin 4 and pin 5 which are enable and reset pin are connected to A0 and A1 pin of Arduino. Pin 11, 12, 13, 14 are used as data lines and connected to pin 4, 5, 6, and 7 of Arduino Uno. Pin 16 of LCD is grounded and pin 15 is connected to 5 volts.

It is getting two inputs from sensors which are MQ-5 and MQ-7 sensors. MQ-5 sensor is used for LPG and MQ-7 is used for CO and fire detection. Analogue and digital pins of MQ-7 sensor are connected to A2 and A3 pins of Arduino and analogue and digital pins of MQ-5 sensor are connected to A4 and A5 pins of Arduino. Both sensors are given 5 volts from the power supply circuit. These sensors detect gases by upon change in their resistance.

GSM module is connected with Arduino Uno so that user can alerted by sending SMS. GSM module has two pins TX and RX. TX pin is connected to pin 3 of Arduino Uno and RX pin is connected to pin 2 of Arduino. A 1000 micro farad capacitor is connected between 5 volts and ground pin of GSM module.

Buzzer and LED that are used are audiovisual alarming are connected to pin 8 and pin 1 of Arduino Uno.

For wireless transmission between transmitter and receiver part, an RF module NFR24L01 is interfaced with Arduino .It operates at 3.3 volts. This module is a transceiver which means it can act as both transmitter and receiver. Here it is used as a transmitter, it will be commanded by Arduino to send information to the receiver. MOSI and MISO pins of module are connected to 11 and 12 pins of

Arduino. CE and CSN pins are connected to 9 and 10 pins of Arduino Uno. SCK pin which is used for clock synchronization is connected to pin 13 of Arduino Uno. It operates at 2.4 GHz.

#### 4.3.2.2 Receiver part circuit of Smart Nose

The circuit diagram of the receiver part of smart nose in shown below in which all the components are interfaced.

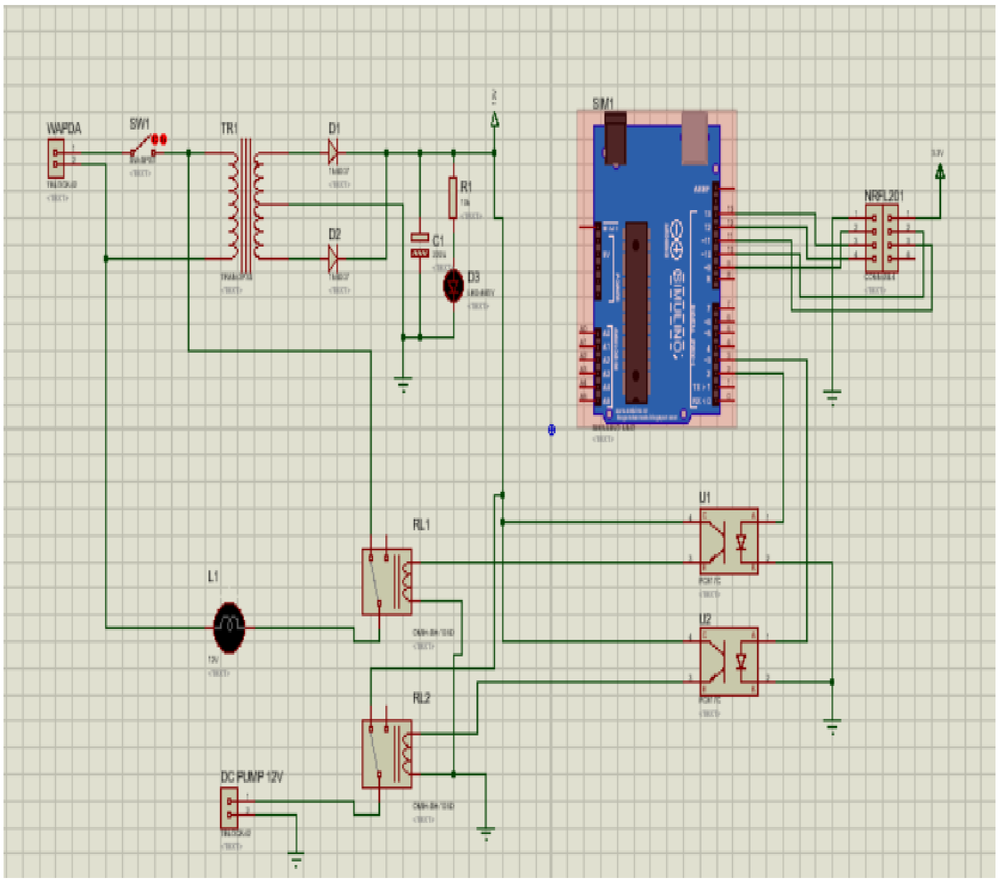



***Figure 4-6:*** **Receiver part circuit of Smart Nose**

For wireless transmission between transmitter and receiver part, an RF module NFR24L01 is here interfaced with Arduino in the receiver part too. It has good data speed of 2 Mbps and operates at 2.4 Giga hertz. It operates at 3.3 volts.

This module is a transceiver which means it can act as both transmitter and receiver. Here it is used as a transmitter, it will be commanded by Arduino to send information to the receiver. MOSI and MISO pins of module are connected to 11 and 12 pins of Arduino. CE and CSN pins are connected to 9 and 10 pins of Arduino Uno. SCK pin which is used for clock synchronization is connected to pin 13 of Arduino Uno.

When the transmitted information from the transmitter module is received by transceiver module in the receiver part which is acting as a receiver here, this information is sent to Arduino which than takes action on the basis of received information by cutting off the electric and gas supplies.

Here 220 volts are coming from the electric supply, but we require 12 volts which is obtained by converting 220 volts to 12 volts by using a center tap step-down transformer. Then two rectifiers are used to convert AC supply to DC supply.

A 220 volt bulb is used to show the electric supply and a 12 volt DC gas valve is used to denote the gas supply. Both gas and electric supplies are controlled by pin 2 and pin 3 of Arduino Uno.

Relays are used for switching purpose. When they change their state to 6 volt upon command from Arduino then both electric and gas supplies are cut off because bulb operates at 220 volts and gas valve operates at 12 volts.

Reverse currents are produced from relays which when travel back to Arduino can damage it. Due to this opto-couplers which act as insulators are introduced between Arduino and relays to avoid damaging of Arduino by not letting pass the reverse current.

## 4.4 GSM monitoring through use of AT Commands

The mini GSM module used here is controlled by the AT commands. AT is used to mean Attention. Hayes generated these commands for communicating between devices and Hayes smart modems also used these commands for communicating. These commands start with AT which means attention, this attention is from the devices which is controlling it. The dial up service providing and wireless MODEMs (these are devices which involve communication that is between a machine to another machine) require AT commands to communicate with a laptop or a computer. AT commands when used with a GSM module can be used to do many tasks which are written below:

1- Sending information to a mobile or a SIM card placed in a GSM module and is also used for their configuration.
2- Sending message (SMS) to user.
3- Sending an MMS.
4- To send fax.
5- Can use the mobile network for data and voice services.

### 4.4.1 AT-Command set overview

Following are some of the AT commands used:

| Command | Description |
|---|---|
| AT | Check if serial interface and GSM modem is working. |
| ATE0 | Turn echo off, less traffic on serial line. |
| AT+CNMI | Display of new incoming SMS. |
| AT+CPMS | Selection of SMS memory. |
| AT+CMGF | SMS string format, how they are compressed. |
| AT+CMGR | Read new message from a given memory location. |
| AT+CMGS | Send message to a given recipient. |
| AT+CMGD | Delete message. |

### 4.4.2 Sending SMS through AT Commands:

Mini GSM is controlled by using AT commands which are dictated by Arduino. A sim card is inserted into the module and first it has to ensured that sim card has credit to send message to user. The user number is fed by writing it in the GSM code written in Arduino of the transmitter part. Following are the commands that are used for communication:

```
AT
OK

AT+CMGF=1
OK

AT+CMGW="+923335485578"
> A simple demo of SMS text messaging.

+CMGW: 1
OK

AT+CMSS=1
+CMSS: 20

OK
```

A brief description of each command is given in figure 4-7.

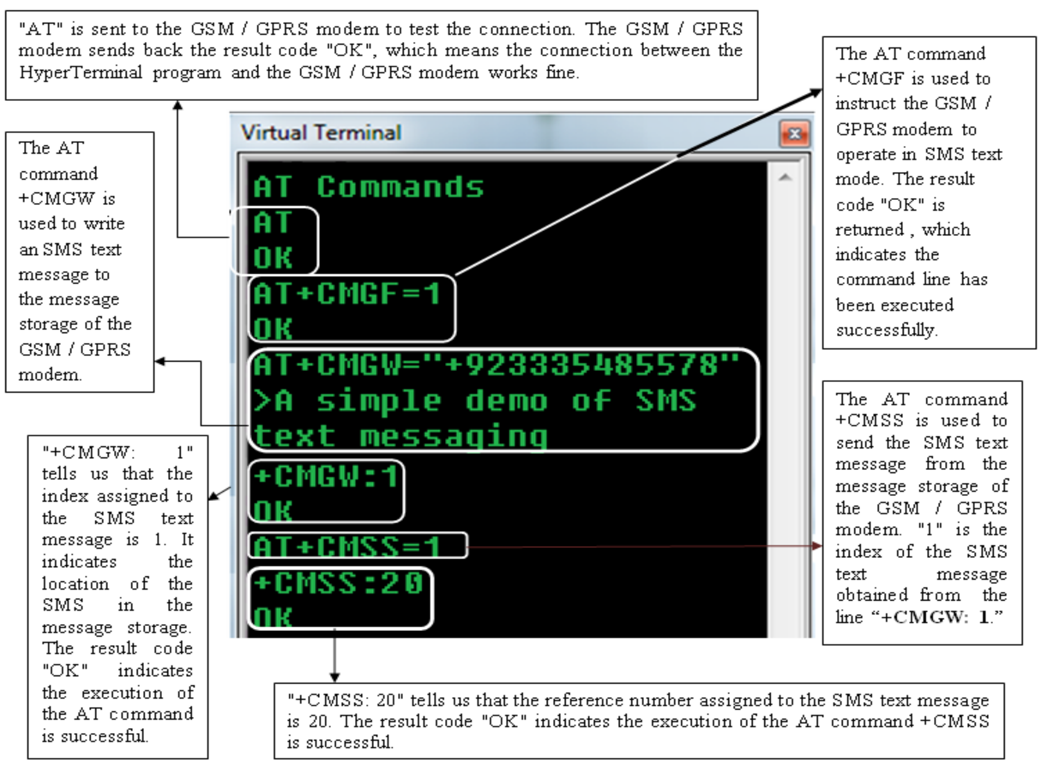



***Figure 4-7.*** **A simple example of sending SMS**

## 4.5 Codes:

This includes the code of transmitter and receiver part:

### 4.5.1 Transmitter Arduino code:

The calibration code for Arduino is also included in this code. There are many ways to calibrate gas sensors but most efficient is the calibration of sensors from their curve by coding in Arduino.

CO gas sensor is calibrated to get ppm values which are compared to the threshold of 200 ppm. The sensor's resistance $R_S$ and $R_L$ forms a voltage divider. The output voltage on the signal pin could be read by Arduino or MCU via ADC. Given a value of $R_L$, Power Supply Voltage, and output voltage, $R_S$ could be derived. Based on the chart provided in the MQ-7 datasheet, $R_S$ in clean air under given temperature and humidity is a constant, which is the "initial" resistance of the sensor named $R_O$. $R_O$ of the resistor could be derived from $R_S$. The main job of the calibration is to calculate the $R_O$ by sampling and averaging the readings when the module is placed in the clean air. Once the $R_O$ is derived, the concentration of target gas could be calculated by using the $R_S/R_O$ ratio as the input. There is no need of calibration of LPG gas sensor as it only occurs when there is leakage. This is the curve of MQ-7 sensor and it is calibrated by using these curve values.

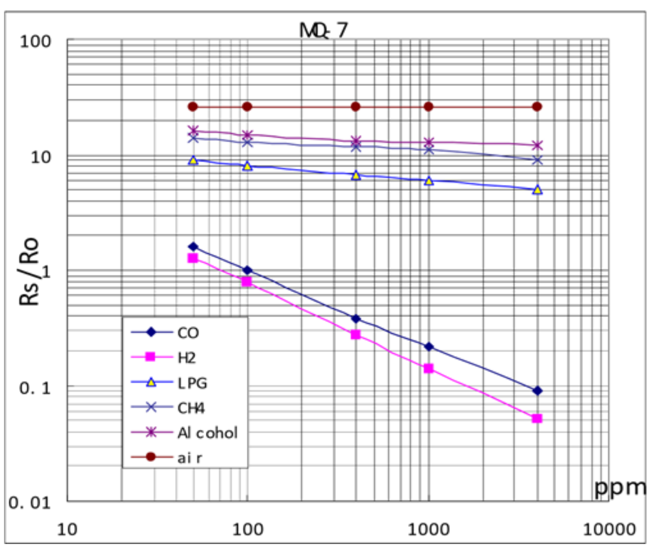



***Figure 4-8*. Calibration Curve for Gas Detection**

Code is written below:

```
const int MQ_PIN=A3;
int RL_VALUE=5;
float RO_CLEAN_AIR_FACTOR=9.83;

int CALIBARAION_SAMPLE_TIMES=50;
int CALIBRATION_SAMPLE_INTERVAL=500;

int READ_SAMPLE_INTERVAL=50;
int READ_SAMPLE_TIMES=5;


#define         GAS_CO              1

float           COCurve[3]  =  {2.3,0.72,-0.34};


float           Ro           =  10;

#include <SoftwareSerial.h>
SoftwareSerial mySerial(3, 2);

#include <LiquidCrystal.h>
const int statusled=1;
int lpgpin=A4;
int copin=A3;
LiquidCrystal lcd(A0, A1, 7, 6, 5, 4);
#include  <SPI.h>
#include "nRF24L01.h"
#include "RF24.h"
char msg[1];
RF24 radio(9,10);
const uint64_t pipe = 0xE8E8F0F0E1LL;
int buzz=8;
void setup(void){
  mySerial.begin(9600);
  radio.begin();
  radio.openWritingPipe(pipe);
  lcd.begin(16, 2);
  lcd.print("CO&LPG DETECTION");
  pinMode(statusled,OUTPUT);
  pinMode(lpgpin,INPUT);
  pinMode(copin,INPUT);
  pinMode(buzz,OUTPUT);
  digitalWrite(statusled,LOW);
  lcd.setCursor(0,1);
  lcd.print("Calibrating...");
  Ro = MQCalibration(MQ PIN);
  lcd.setCursor(0,1);
  lcd.print("done!");
  lcd.print("Ro:");
  lcd.print(Ro);
  lcd.print("kO");
  delay(3000);
}
```

```
void loop(void)
{
  String message;
  digitalWrite(buzz,LOW);
  long iPPM_CO = 0;
  iPPM_CO = MQGetGasPercentage(MQRead(MQ_PIN)/Ro,GAS_CO);
  lcd.setCursor(0,1);
  lcd.print("CO: ");
  lcd.print(iPPM_CO);
  lcd.println(" ppm          ");
  msg[0] = 'N';
  radio.write(msg, 1);
  delay(200);
  if(digitalRead(lpgpin) == LOW)
  {
    message="LPG leakage so main valve and electric supply shutdown";
    digitalWrite(buzz,HIGH);
    lcd.setCursor(0, 1);
    lcd.print("LPG leakage");
    msg[0] = 'G';
    for(int i=0;i<5;i++)
       {
       radio.write(msg, 1);
       }
       flash(statusled,10,5);
       SendMessage(message);  ////gsm
       delay(3000);
  }
 else if(iPPM_CO >= 200)
  {
    message="CO Exceed so gas supply shutdown";
    digitalWrite(buzz,HIGH);
    lcd.setCursor(0, 1);
    lcd.print("CO Exceed");
    msg[0] = 'C';
    for(int i=0;i<5;i++)
       {
       radio.write(msg, 1);
       }
       flash(statusled,10,5);
       SendMessage(message);
       delay(3000);
  }
 else if(digitalRead(lpgpin) == LOW && iPPM_CO >= 200)
  {
     message="Danger so wapda and gas supply shutdown";
    digitalWrite(buzz,HIGH);
    lcd.setCursor(0, 1);
    lcd.print("Danger");
    msg[0] = 'B';
    for(int i=0;i<5;i++)
       {
       radio.write(msg, 1);
```

```
        }
        flash(statusled,10,5);
        SendMessage(message);
        delay(3000);
  }

}
void flash(int pin, int times, int wait) {

 for (int i = 0; i < times; i++) {
 digitalWrite(pin, HIGH);
 delay(wait);
 digitalWrite(pin, LOW);

 if (i + 1 < times) {
 delay(wait);
 }
 }
}
void SendMessage(String data)
{
  String msg=data;
  mySerial.println("AT+CMGF=1");
  delay(1000);
  mySerial.println("AT+CMGS=\"+923060539726\"\r");
  delay(1000);
  mySerial.println(msg);
  delay(100);
   mySerial.println((char)26);
  delay(1000);
}
float MQResistanceCalculation(int raw_adc)
{
  return ( ((float)RL_VALUE*(1023-raw_adc)/raw_adc));
}


float MQCalibration(int mq_pin)
{
  int i;
  float val=0;

  for (i=0;i<CALIBARAION_SAMPLE_TIMES;i++) {
    val += MQResistanceCalculation(analogRead(mq_pin));
    delay(CALIBRATION_SAMPLE_INTERVAL);
  }
  val = val/CALIBARAION_SAMPLE_TIMES;
  val = val/RO_CLEAN_AIR_FACTOR;
  return val;

}


float MQRead(int mq_pin)
```

```
{
  int i;
  float rs=0;

  for (i=0;i<READ_SAMPLE_TIMES;i++) {
    rs += MQResistanceCalculation(analogRead(mq_pin));
    delay(READ_SAMPLE_INTERVAL);
  }

  rs = rs/READ_SAMPLE_TIMES;

  return rs;
}

long MQGetGasPercentage(float rs_ro_ratio, int gas_id)
{
  if ( gas_id == GAS_CO )
  {
     return MQGetPercentage(rs_ro_ratio,COCurve);
  }

  return 0;
}


long  MQGetPercentage(float rs_ro_ratio, float *pcurve)
{
  return (pow(10,( ((log(rs_ro_ratio)-pcurve[1])/pcurve[2]) +
pcurve[0])));
}
```

### 4.5.2 Receiver Arduino code:

```
#include <SPI.h>
#include "nRF24L01.h"
#include "RF24.h"
char msg[1];
RF24 radio(9,10);
const uint64_t pipe = 0xE8E8F0F0E1LL;
int wapda=2;
int gasvalve=3;
void setup(void){
 Serial.begin(9600);
 radio.begin();
```

```
radio.openReadingPipe(1,pipe);
radio.startListening();
pinMode(wapda, OUTPUT);
pinMode(gasvalve, OUTPUT);
digitalWrite(wapda,LOW);
digitalWrite(gasvalve,LOW);
}
void loop(void)
{
if (radio.available())
{

  bool done = false;
  while (!done)

{
    done = radio.read(msg, 1);
    Serial.println(msg[0]);
    delay(300);
    if( msg [0] == 'G')
    {
    digitalWrite(gasvalve,HIGH);
    digitalWrite(wapda,HIGH);
    }
    else if( msg [0] == 'C')
    {
     digitalWrite(gasvalve,HIGH);
    }
    else if(msg [0] == 'B')
    {
     digitalWrite(gasvalve,HIGH);
     digitalWrite(wapda,HIGH);
    }
  }
}

else
{
 Serial.println("No radio available");

}

}
```

## 4.6 Working of Smart Nose:

Smart nose system working can be divided into two parts,

1) Detection of gases, production of alarm and informing the user.
2) Controlling of gas and electric supplies upon detection of gas.

### 4.6.1 Detection of gases, production of alarm and informing the user

Smart nose will detect the gas and after its detection it will produce alarm to inform the user about the detection of gas. Along with alarm the LCD will display the gas leakage message and LED will turn on. If the user is not at the residence when gas is detected then to cater for this issue smart nose will send the text message to the user. Where each sensor is separately in contact with different pins of Arduino and upon interrupt the pulse generated will activate the function of Arduino. The Arduino will send AT commands with some predefined message for interrupted pin to GSM device. The GSM device upon accepting those AT commands will deliver the message to users' cell phone i.e. the number defined inside the Arduino. Arduino will command the RF module to send character L in case of leakage of LPG/methane gas, G in case of CO/fire detection and N in case of no detection.

### 4.6.2 Controlling of gas and electric supplies upon detection of gas

Arduino is continuously monitoring the characters which its RF module is receiving. This Arduino will take no action upon reception of N. Upon reception of L it will cut off the gas supply by closing gas valve to prevent further accumulation of gas and also electric supply to prevent explosion due to electric spark. Upon reception of G it will only cut off gas supply only as CO is not combustion. The user will reset the supplies when leakage problem gets solved. It can also be attached to a ventilation system to clean the air.

## 4.7 Summary

To summarize, this chapter has the detailed design and development carried out for the completion of Smart Nose.

# COMPONENTS

## 5.1 Introduction

In this chapter, the components used in the hardware of Smart Nose for buildings and houses are presented and explained in detail.

## 5.2 Description of Components

### 5.2.1 Microcontroller

A micro-controller can be compared to a small standalone computer; it is a very powerful device, which is capable of executing a series of pre-programmed tasks and interacting with other hardware devices. A memory unit along with input/output lines are integrated with the microcontroller f=to easily connect to other devices.

***Figure 5-1*: Microcontroller IC.PIC 16f877A**

The basic pin configuration of PIC-16f877A is shown below

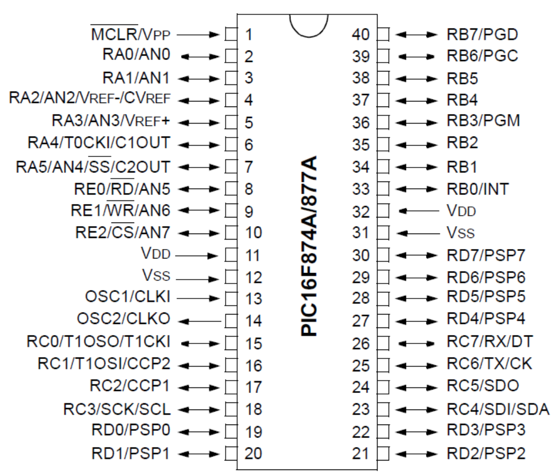



**Figure 5-2: Pin configuration of PIC 16f877A**

The key features of PIC16f887A are given in table below taken from data sheet

**Table 5-1: Feature of PIC 16f877A**

| Key Features | PIC16F877A |
|---|---|
| Operating Frequency | DC – 20 MHz |
| Resets (and Delays) | POR, BOR (PWRT, OST) |
| Flash Program Memory (14-bit words) | 8K |
| Data Memory (bytes) | 368 |
| EEPROM Data Memory (bytes) | 256 |
| Interrupts | 15 |
| I/O Ports | Ports A, B, C, D, E |
| Timers | 3 |
| Capture/Compare/PWM modules | 2 |
| Serial Communications | MSSP, USART |
| Parallel Communications | PSP |
| 10-bit Analog-to-Digital Module | 8 input channels |
| Analog Comparators | 2 |
| Instruction Set | 35 Instructions |
| Packages | 40-pin PDIP<br>44-pin PLCC<br>44-pin TQFP<br>44-pin QFN |

### 5.2.2 Voltage Regulator LM7805

The L7805CV +5V positive voltage regulators can deliver over 1A of regulated output current (subject to adequate heat sinking). The given regulator can be used for current and voltage adjustments of the external devices.

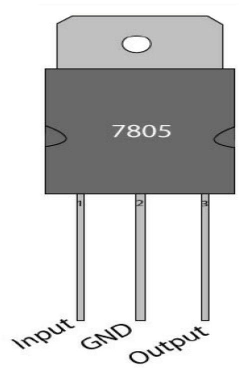



***Figure 5-3*: Voltage Regulator**

Main features of LM-7805 IC are given below taken from data sheet

- Primary Input Voltage: 10V
- Output Voltage Fixed: 5V
- Dropout Voltage $V_{do}$: 2V
- No. of Outputs: 1
- No. of Pins: 3
- Output Current: 500mA
- Voltage Regulator Case Style: TO-220
- Operating Temperature Range: 0°C to +150°C
- SVHC: No SVHC (19-Dec-2011)
- Base Number: 7805
- IC Generic Number: 7805
- Input Voltage Max: 35V
- Input Voltage Min: 7V
- Operating Temperature Max: 150°C
- Operating Temperature Min: 0°C
- Operating Voltage Tolerance +: 4%
- Output Current Max: 1.5A
- Output Voltage: 5V
- Output Voltage Max: 5V
- Package / Case: TO-220
- Packaging Type: Tube
- Supply Voltage Max: 20V
- Supply Voltage Min: 8V
- Termination Type: Through Hole
- Voltage: 5V
- Voltage Regulator Type: Positive Fixed

### 5.2.3 Stepdown transformer 220V to 12V

The circuit will be supplied 220V AC which will be down converted to 12V AC using step down transformer.

***Figure 5-4:*** **Transformer**

### 5.2.4 SIM908

SIM908 is equipped with both GSM/GPRS and GPS engine for wide usage by the global market. The GSM/GPRS engine of this module works as a quad-band device that operates on the frequencies of GSM 850MHz, EGSM 900MHz, DCS 1800MHz and PCS 1900MHz.

### 5.2.5 Relay

The main operation of a relay depends upon its ability to be control an electric circuit by a signal of low power as well. It is also used in places where only one signal can be used to control a lot of circuits. We are using it for connecting/switching 220 volt appliances.

#### 5.2.5.1 Internal Circuit of Relay

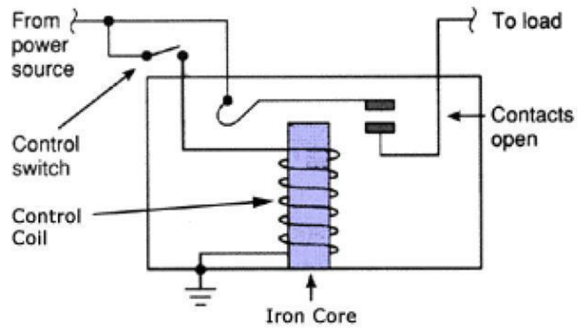



***Figure 5-6:*** **Inside relay**

Fig 5-6 shows an inner section diagram of a relay. An iron core is surrounded by a control coil.

### 5.2.6 Optocoupler PC817

Optocoupler provides the feature of electrical isolation while transferring the electric signals through light between the input and the output. The rapidly changing voltages in a circuit often damage the components used by the flow of reverse currents and hence to prevent this opto coupler is mainly used. It basically contains a light source that performs the conversion of electric current to light energy, a channel for the transfer of the light energy and a photodetector at the output for the detection and conversion of this signal back to the electric form.

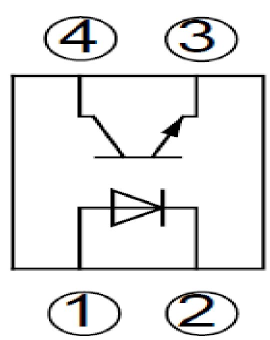



***Figure 5-7:*** **Internal connection diagram of PC817**

### 5.2.7 LCD Display LM016L

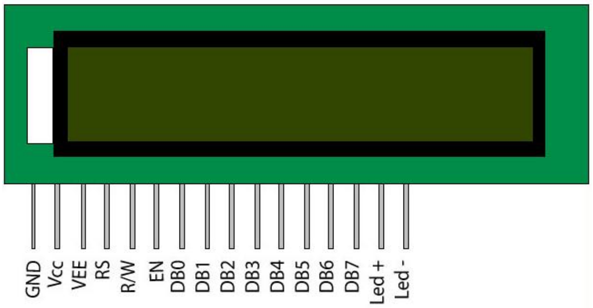



*Figure 5-8:* **LCD Display**

#### 5.2.7.1 Pin Configuration and function of each pin

The table below shows the pin configuration and function of each pin of LCD display.

***Table 5-2*: Pin configuration of LM 016L**

| Pin no. | Function | Name |
|---|---|---|
| 1 | Ground (0V) | Ground |
| 2 | Supply voltage 5V (4.7-5.3) V | VCC |
| 3 | Contrast adjustment through a variable register | VEE |
| 4 | Selects command register when low and data register when high | Register select |
| 5 | Low to write to the register. High to read from the register | Read/write |
| 6 | Sends data to data pins when a high to low pulse is given | enable |
| 7 | Data pin | DB0 |
| 8 | Data pin | DB1 |
| 9 | Data pin | DB2 |
| 10 | Data pin | DB3 |
| 11 | Data pin | DB4 |
| 12 | Data pin | DB5 |
| 13 | Data pin | DB6 |
| 14 | Data pin | DB7 |
| 15 | Backlight $V_{CC}$(5V) | Led + |
| 16 | Backlight Ground (0V) | LED - |

### 5.2.8 Gas Sensors

Features of the sensors used are given in table below

***Table 5-3*: Features of MQ-5, MQ-7 Gas Sensors**

| **GAS SENSOR** | **FEATURES** |
|---|---|
| MQ-5 LPG/ Methane sensor | High sensitivity to CH4, Natural gas and LPG<br>Fast response<br>Stable and long life<br>Simple drive circuit[40] |
| MQ-7 Carbon-monoxide sensor | High sensitivity to carbon-monoxide<br>Stable and long life[41] |

## 5.3 Summary

To summarize, this chapter contains the description of the components like microcontroller, voltage regulator, Relay, LCD, sensors and keypad.

*Chapter: 6*

# GSM

## 6.1 Introduction

In this chapter basic functional components of GSM network structure are discussed, which are used for communication in Smart Nose.

## 6.2 GSM (Global System for Mobile Communications)

GSM is a standard sets developed by the European Telecommunication Standard Institutes (ETSI) to explain technologies for second generations (or "2G") network.. In this project we use GSM Module SIM 900 for the transmission of SMS to the desired destination.

### 6.2.1 GSM Carrier frequencies

GSM organize works in various different bearer reoccurring ranges (isolated into GSM reoccurring ranges for 2G and UMTS recurrence groups for 3G), GSM digitize and pack information and utilizations it claim timeslot for the transmission of the information as two streams. It works at two recurrence groups 900 MHz or 1800 MHz. In atypical cases the 400 and450 MHz groups are dispense in couple of nations. This band is separated in timeslots, particular for each telephone associated. The schedule vacancy arrange is called ordinary burst and conveys client information activity, different blasts designs are utilized for control flagging. Limit in kbps of a full rate movement direct in GSM .Each activity channel gets one space for each casing and 24 outlines for each 120ms .The subsequent information rate is114 (bits/opening) X 24 (spaces/multi-outline)/120 ms/multi-outline = 22.8 kbps

### 6.2.2 Network Structure

GSM architecture is divided into four main portions, discussed as below:

#### 6.2.2.1 Mobile Station (MS)

MS which is versatile station is that piece of the GSM arrange which is aused at the client end and is otherwise called Client Hardware (UE) Another further favorable position is the time between charges has essentially expanded. Portable station conveys crosswise over Um interface (air interface) with base handset station (BTS) in same cell as versatile unit

- Mobile hardware (ME) – physical terminal, for example, a phone ME incorporates radio handset, advanced flag processors and supporter character module (SIM) IMEI (Worldwide Portable Gear Personality)Identity
- GSM supporter units are nonexclusive as long as the SIM isn't embedded and some vital shortenings are
  - SIMs perform the function of roaming ,it is not necessary that the subscriber device does
  - MSISDN (Mobile Subscriber ISDN Number)
  - IMSI (International Mobile Subscriber Identity )
  - TMSI (Temporary Mobile Subscriber Identity)

The SIM or Subscriber Identity Module contains the information that provides the identity of the user to the network.

#### 6.2.2.2 Base Station Subsystem (BSS)

The Base Station Subsystem (BSS) is the component which is has the task for the communication of information with the versatile user. It consists of two elements:

##### 6.2.2.2.1 Base Transceiver Station (BTS)

The BTS of the GSM arrange is comprised of radio handsets and receiving wires for correspondence from the user having device and the network. Air interface is the interface which is used in between the user and the network for communication. This the main air interface utilized as a part of the system. This interface which is used for communication is known as Um interface.

##### 6.2.2.2.2 Base Station Controller (BSC)

The following segment in the GSM organize is the BSC after the BTs and it is associated with numerous BTSs. It controls a gathering of BTSs, and is frequently co-situated with one of the BTSs in its gathering the fundamental capacity of the BSc is to BSC saves radio frequencies, oversees handoff of portable unit starting with one cell then onto the next inside BSS, and controls paging. It likewise dispenses channels and speaks with the BTS over the Abis interface.

#### 6.2.2.3 Network Switching Subsystem (NSS)

The GSM organize subsystem contains a wide range of components, and is frequently named the center system. Principle interfacing and control for the entire GSM arrange is given by the NSS. The significant components inside the center system include:

##### 6.2.2.3.1 Mobile Switching Service Centre (MSC)

It is the primary component of the GSM pecking order and it shapes the center system of the framework. It performs exchanging based on PSTN and ISDN number yet it has different capacities too which bolster the portable necessities. Its significant capacities incorporate the procedures of enlistment, verification, call area, between MSC handovers and routingof calls to the versatile supporters. It fills in as an interface keeping in mind the end goal to associate calls approaching from the PSTN to the particular BSS of the endorser.

##### 6.2.2.3.2 Home Location Register (HLR)

Home location register (HLR) database stores data about every endorser that has a place with it alongside the last known area of the supporter. Henceforth calls are then steered to the client with the assistance of the area said in the HLR of that particular MSC. There are one HLR per each system however there can be numerous of these disseminated all through the system also for different reasons identified with its activity. The HLR makes the client passage upon effective enrollment method after which calls can be directed fittingly.

#### 6.2.2.3.3 Visitor Location Register (VLR)

Visitor location register (VLR) database keeps up data about supporters as of now physically in the locale. Along these lines get to is made speedier and more helpful. It is a piece of the MSC bu it can likewise be taken as a different module of the GSM structure.

#### 6.2.2.3.4 Equipment Identity Register (EIR)

Equipment identity register (EIR) monitors the kind of hardware that exists at the versatile station (white, dim and boycotts). Every portable gear has a number known as the Universal Versatile Hardware Personality. The IMEI number is introduced in each gadget and amid the procedure of registration it is checked by the EIR also. Subordinate upon the data held in the EIR, the versatile might be allotted one of three states - permitted onto the system, banned access, or checked in the event that its issues.

#### 6.2.2.3.5 Authentication Centre (AuC)

Authentication centre (AuC) is used for verifying activities and it also holds the encryption keys to provide confidentiality.

#### 6.2.2.3.6 Gateway Mobile Switching Centre (GMSC)

The GMSC is for short messages being sent to an ME. The use of SMSIWMSC is more when short messages are to be originated by a mobile station within the network. The SMS-IWMSC provides the feature of Short Message Service Centers to be turned in to fixed centers while the role of SMS-GMSC is similar to that of the GMSC.

#### 6.2.2.4 Operation and Support Subsystem (OSS)

It is associated with all gear in the MSC and BSC. It plays out the support of the HLR and furthermore performs regulatory capacities, for instance, charging.

The elements of the OSS incorporate the checking of the GSM general structure and to likewise convey the movement stack in like manner. As the no. of BS is expanded, a portion of the task of maintenance of the OSS are given to the BTS which spares the cost of framework possession.

## 6.3 Summary

To summarize, this chapter discusses the basic GSM architecture and its functional components.

# SIMULATIONS AND RESULTS

## 7.1 Introduction

In this chapter, the images of proteus circuits and the images of project in running condition are shown. The project was implemented on hardware and the screenshots of results are displayed.

## 7.2 Proteus Simulations

The following figure shows the Proteus circuit of transmitter part of Smart Nose which contains Arduino interfaced with GSM, LCD, buzzer, LED, gas sensors and NRF24L01 module.

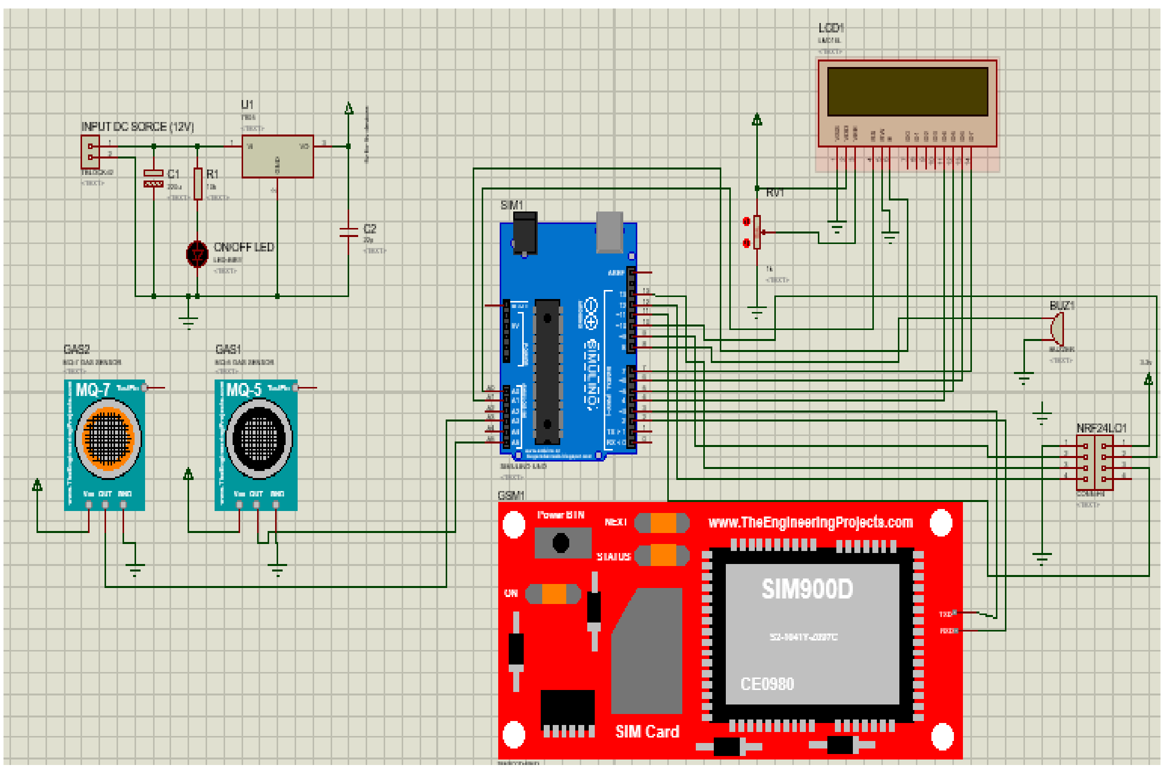



***Figure 7-1:*** **Proteus circuit of transmitter**

The following figure shows the proteus circuit of receiver part in which NRF24L01 module and gas and electric supplies are interfaced. Relays and opto-couplers are also used for switching and insulating purposes.

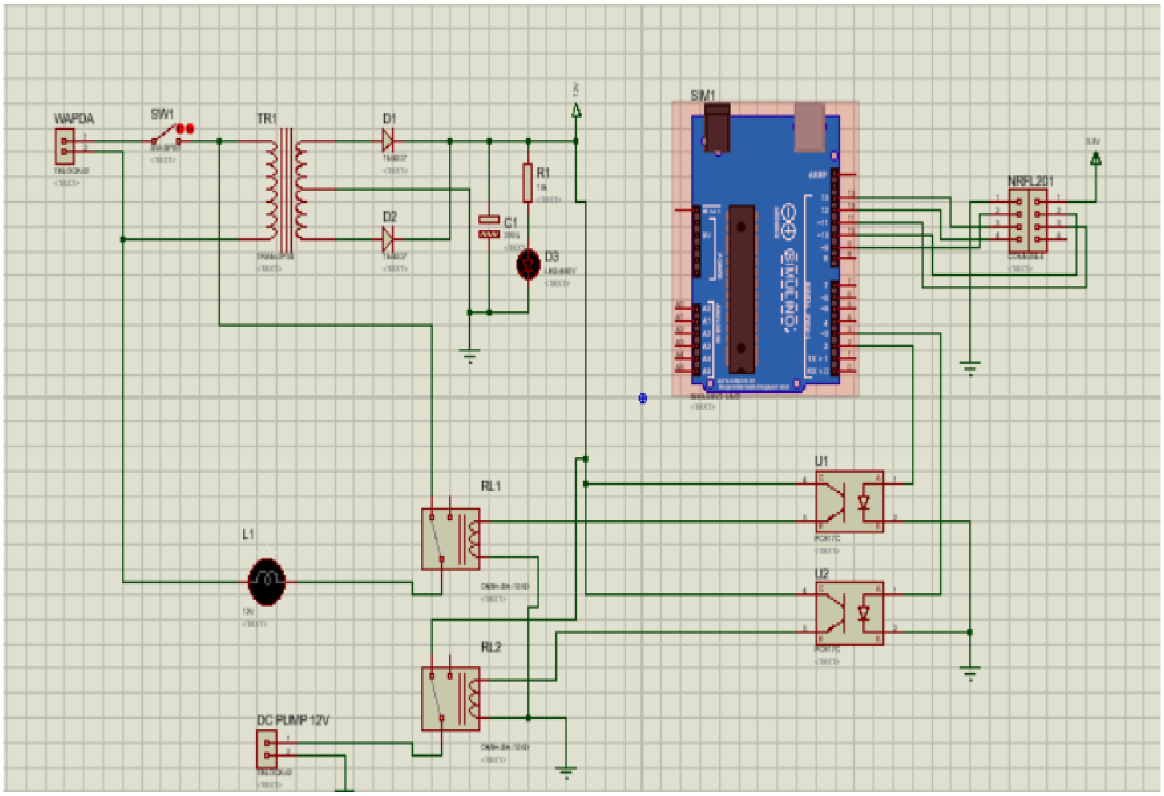


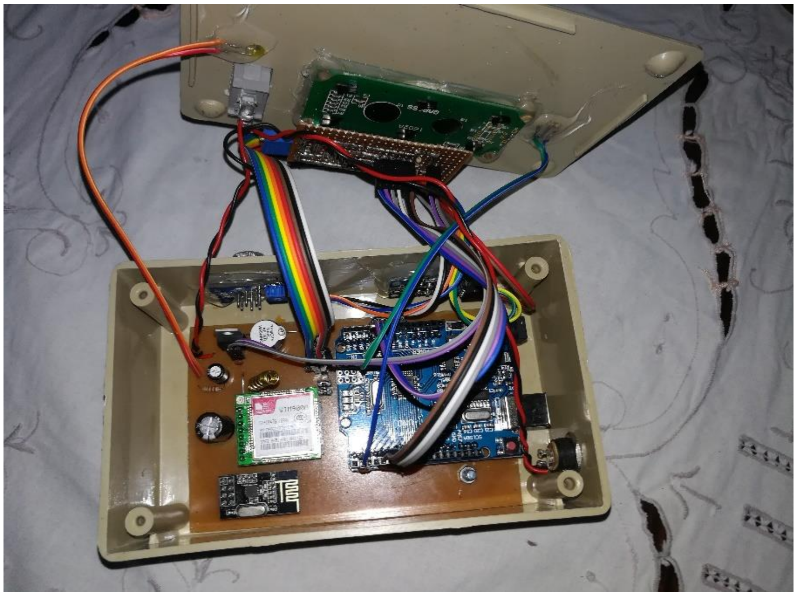

***Figure 7-2:*** **Proteus circuit of receiver part**

## 7.3 Practical Results

### 7.3.1 Complete image of Smart Nose

Below are the complete pictures of transmitter and receiver part after converting it Into product form:

Below is inside view of transmitter box:



### 7.3.2 When project is turned on

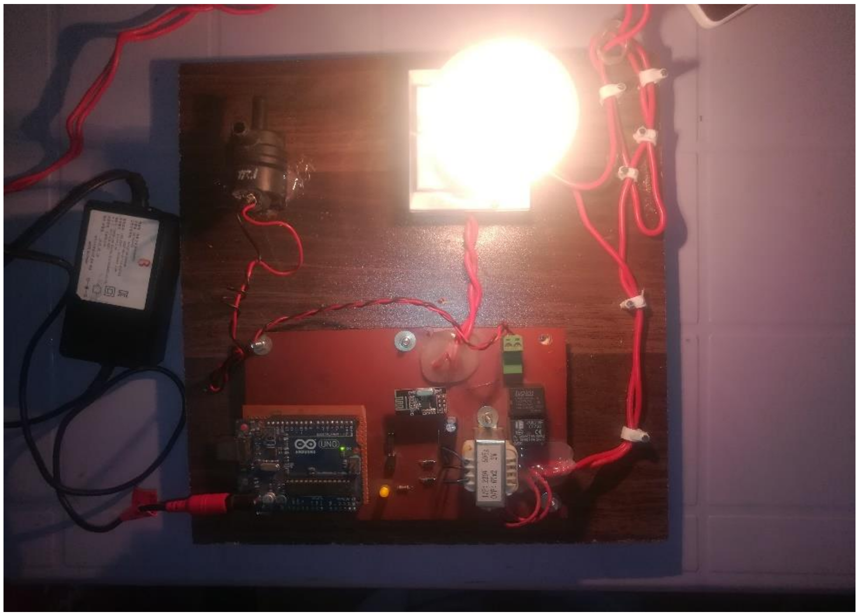
When project is turned on then transmitter Arduino starts to calibrate the sensors and LCD and status LED are turned on.


Transmitter Arduino has now calibrated the sensors and value of Ro is displayed on the LCD.

### 7.3.3 When no gas is detected

LCD displays 0 ppm because there is no leakage.

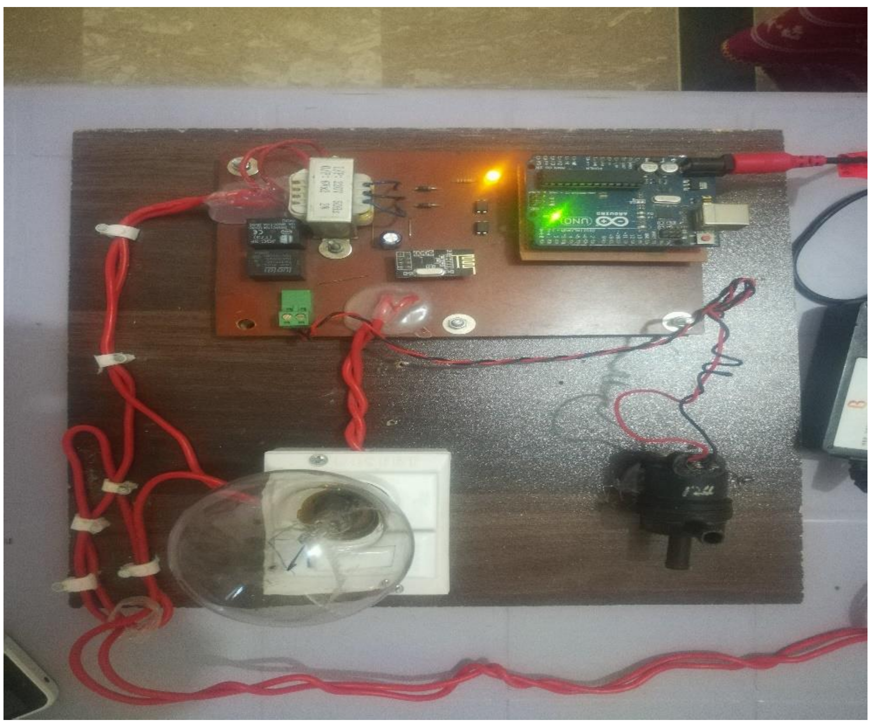

Both gas and electric supplies are on.



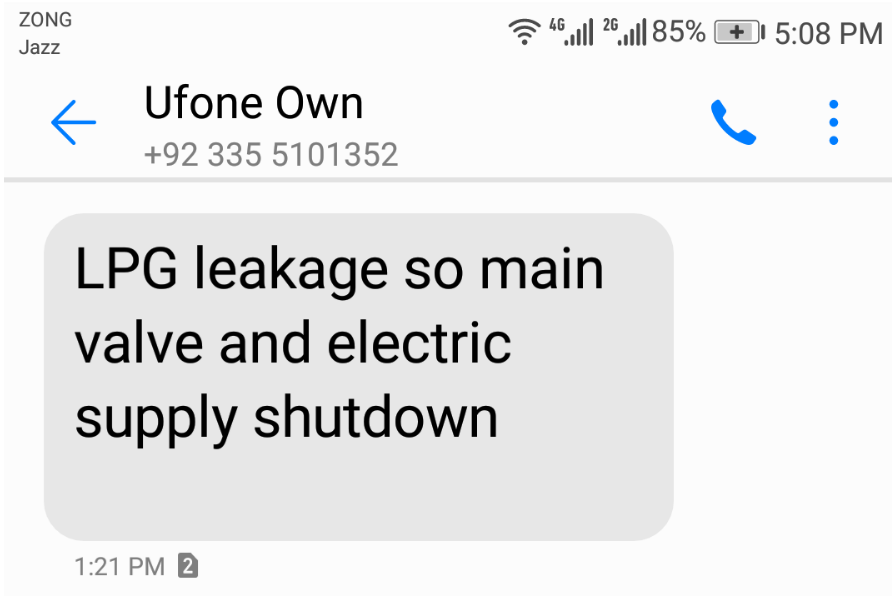
### 7.3.4 When LPG gas is detected

Warning displayed by LCD, buzzer, both supplies are cut off and message is sent.


Both supplies are cutoff.



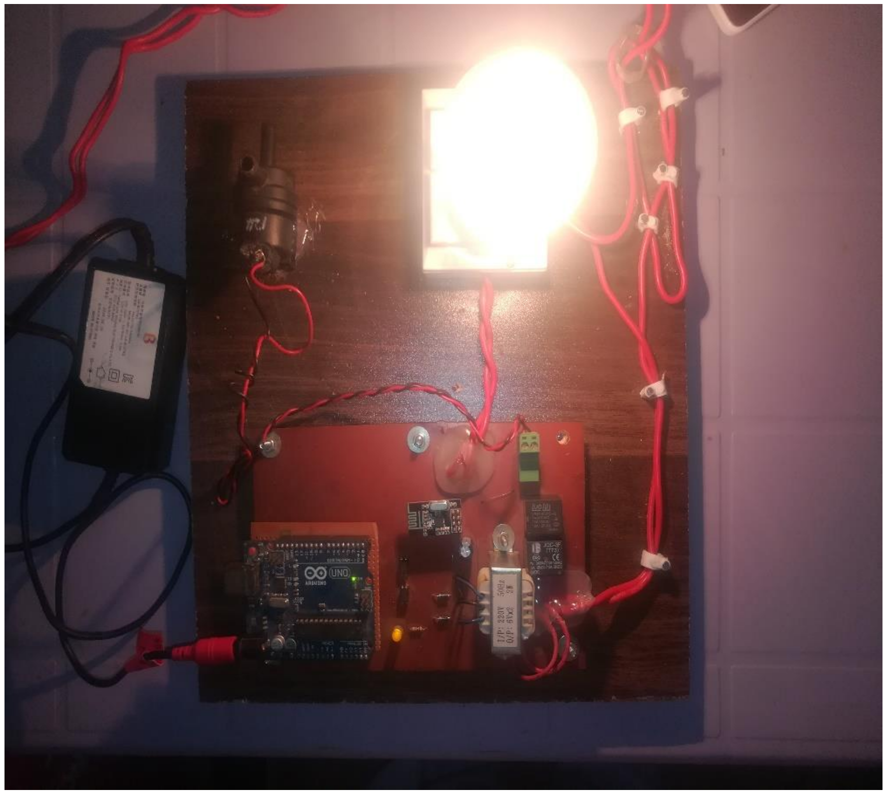
Message is sent to user’s mobile.



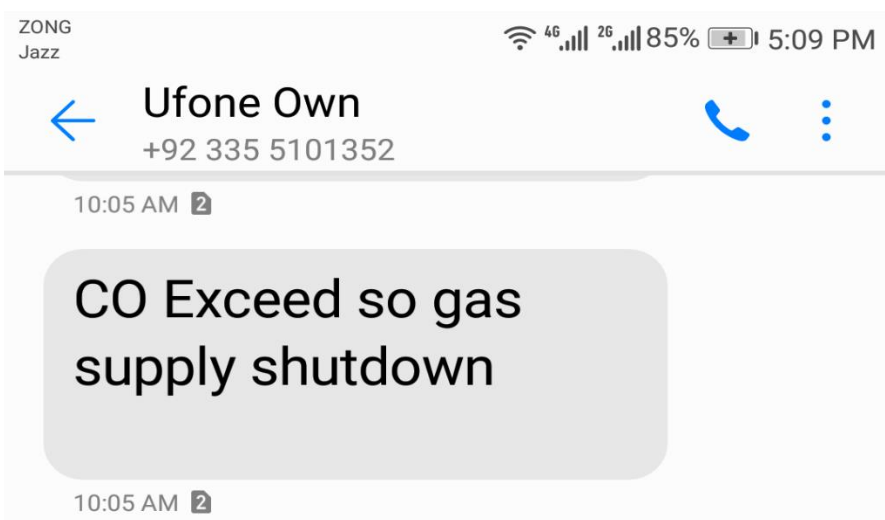

### 7.3.5 When CO gas is detected

When CO gas is detected than warning is displayed on LCD, buzzer and LED. Only gas supply is cutoff and message is sent to user.

Only gas supply is cutoff.



Message is sent to user's mobile.




## 7.4 Summary

In this chapter, results simulated on proteus and practical results of implemented circuits was shown.

*Chapter: 8*

# FUTURE WORK AND APPLICATIONS

## 8.1 Introduction

This chapter includes the work that can be done later for the advancement of Smart Nose. And the applications of Smart Nose to a different types of mercantile industries, including the agricultural, military, domestic use, and various other scientific research fields.

## 8.2 Future work

The smart nose as FYP was designed at domestic level keeping in mind the modern airtight structure of houses. A single unit device was developed to be placed centrally in a house. Bigger houses with multiple compartments will require more than 1 device.

Industrialization:

For industries, it can be advanced by using:

- Different Gas Sensors
- Multiple Microcontrollers
- Complex Coding
- External Memory

The central device can be placed in any management room and can be controlled from there. Specific gas sensors for detecting specific gases and calibrated to required measurement threshold of these gases. Multiple Arduino Uno's can be wirelessly linked by using RF modules to each other for gas detection and loss prevention. Similarly this can also be done for residential building like flats and also in hotels.

## 8.3 Applications

Smart nose finds its application wherever hazardous gases exist or produced, we have designed it for home and domestic use but with some improvements it can be commercialized and used on industrial level. Below are the areas in which Smart Nose can be used for gas detection and loss prevention.

1. In industries many dangerous gases like carbon dioxide and carbon monoxide are produced which are life threatening for the people working there and hence they need to be detected and loss can be prevented by using Smart Nose which can help maintain good air quality and alarm about the gases.
2. Smart Nose can be used in houses to detect CO gas which is produced by heaters/stoves due to incomplete combustion, LPG/methane gas which is used for cooking purposes, hydrogen gas and hydrogen sulphide gas produced in washrooms. Ventilation system can be attached with Smart Nose to clean air.

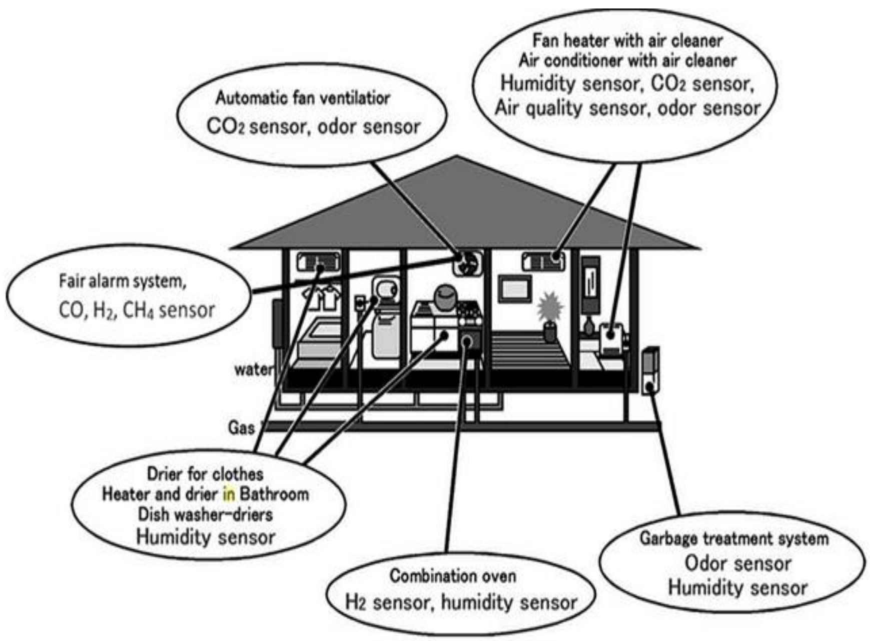



***Figure 8-1:*** **Gases present in our homes that require sensor for detection**

3. In underground tunnels and car parking gasoline vapors are present which are dangerous hence Smart Nose can be used for ventilation of these and for the detection of gasoline vapors.
4. It can be used to check quality and freshness of foods, vegetables, milk and meat by changing gas sensors with other sensors.
5. It can be used to diagnose the pathological problems by doing chemical analysis of blood, sweat, urine and skin etc.
6. It can be used in coal mines to provide ventilation and detect carbon monoxide and other dangerous gases produced.

7. It finds its application in agriculture too for checking soil minerals and quality of plants and crops.
8. It can be used in automobiles for checking air quality.

## 8.4 Summary

To summarize, development and utilization of many new electronic-nose applications in the healthcare and biomedical fields have continued to rapidly accelerate and improve over the past 20 years. This chapter includes the applications of Smart Nose in various industries.

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# APPENDIX A

**USER MANUAL**

1. Insert SIM Card in the GSM device.
2. Connect one power supply to the jack of transmitter box and then it's switch in the socket. LED and LCD display will be turned on. Let the device be, it will take some time to calibrate the gas sensors.
3. After approximately one minute, sensors will be calibrate and value of resistance will be displayed on screen.
4. Now connect the other power supply to the jack of Arduino of receiver part and it's switch to the socket, LED will turn on.
5. Plug in any gas excavating or security devices you want to control with Smart Nose.
6. Now Smart Nose is ready to detect gases, place the device at eye level on any wall in a central area of your accommodation area so that its alarm can be audible easily in case of any emergency.

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