DEVELOPMENT OF LOW COST AIR POLLUTION DETECTOR USING ARDUINO

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Abstract: We are going to make an low cost air pollution detector using arduino in which we will monitor the Air Quality and monitor it and it will trigger the alarm when the quality of air goes down beyond certain level, that means when there are the sufficient amount of harmful gases present in the atmosphere sulfur dioxide (SO2), carbon monoxide (CO), carbon dioxide (CO2), nitrogen oxide (NO). It will show the air quality in PPM on the LCD. Quality Assessment will be performed by low cost smart sensors that will be able to collect accurately several quality parameters such as temperature, Physical and chemical etc.

The traditional method of testing is to collect samples manually and then send them to laboratory for analysis. However, it has been unable to meet the demands of the quality monitoring today. So, a system of Monitoring quality will be developed. The system consists of Temperature sensor of quality testing, single-chip microcontroller data acquisition module, monitoring center and other accessories. Air quality & Temperature of are automatically detected under the control of single chip microcontroller all day. Then processes and analyzes them. If the quality is abnormal, it will alert the public through SMS ALERT at the same time. It is convenient for management to take corresponding measures timely and be able to detect real-time situation of air quality. The main focus is on to construct a low-cost sensor system for real time monitoring of the air quality in environment.

Previously we have built the LPG detector using MQ6 sensor and Smoke detector using MQ2 sensor but this time we have used MQ9 sensor which is the best choice for monitoring of the Air Quality as it can detects the most harmful gases and also measure the amount accurately. In this project, you can monitor the pollution level from anywhere using your computer or mobile. We can install this system anywhere as per our requirement and can also trigger some device when pollution goes beyond some level, like it can switch on the Exhaust fan or send SMS alert to the users.

Keywords: *Low Cost Sensor, Air Pollution Monitoring, Sensors, GSM SIM Module.*

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I INTRODUCTION

The Environment is full fill by the Air and it is one of the basic requirement for human. The Earth is surrounded by the atmosphere and the Air is the essential part of it. Air contains Nitrogen, Oxygen, Carbon Monoxide and many other gases. Human needs an atmosphere of air for living which should be free from contaminants .This is very beneficial for human and health. If there is any change in the atmosphere or natural composition of the air that may affects the human life as well as the animal life. The air pollution is measured in parts per million (ppm) or ug/m^3. The pollutants which are known as the primary pollutants are directly released into the atmosphere and when the primary pollutants reacts with the atmospheric chemicals they are known as the secondary pollutants .The air quality affects the human health. The polluted air or the atmosphere give rise to the human health problems such as difficulty in breathing, coughing, aggregation of asthma and emphysema. The polluted air or the atmosphere give rise to the visual problems to the human as well as animals. Due to air pollution the numbers of death are 7 million persons worldwide each year or 1 in 8 premature death yearly. And around 570000 children under the age of 5 years by every from the disease of respiratory infection which is linked to the indoor or outdoor pollution or the second hand smoke. The children's which are exposed to the air pollution have a high risk of developing the chronic respiratory problems or the disease such as asthma. For monitoring the air pollution several research from the world wide have developed the models to monitor air pollution or the pollution gages such as sulfur dioxide (SO$_2$),

carbon monoxide(CO), carbon dioxide(CO_2), nitrogen oxide(NO) and many other gases. This paper will focus on the design and the implementation and Development of low cost air pollution monitoring system using arduino. It will discuss the how the level of pollutants in the atmosphere can be monitored by using the gas sensors.

1.1. Embedded Systems

Embedded systems are the electronic devices that incorporate microprocessors with in the implementations. The main purposes of the microprocessor is to simplify the system design and to provide flexibility. By having a microprocessor in the device means that removing the bugs, making modifications, or adding new features are only matters of rewriting the software to controls the device. We can also say that the embedded computer systems are electronic systems that include a microcomputer to perform the specific application. The computer is hidden inside these chip. Embedded systems are ubiquitous. Every week millions of the small computer chips come out of the factories finding their way into our everyday products.

Embedded systems are self-contained programs which are embedded within a piece of hardware. Whereas the regular computer has many different applications and software that can be applied to different tasks, embedded systems are usually set to a particular task that cannot be altered without physically manipulating the circuitry. Another way to think of an embedded system is as a computer system that is created with minimum efficiency, thereby allowing it to complete specific functions as early as possible.

Embedded systems designers usually have a significant knowledge of hardware technologies. They used specific programming languages and software to develop the embedded systems and manipulate the equipment. When searching online, companies offer embedded systems development kits and other embedded systems tools for use by engineers, businesses and as per the requirement of the use.

Embedded systems technologies are usually fairly expensive due to the necessary development time and built in efficiencies, but they are also highly valued in specific industries. Smaller businesses may wish to hire a consultant to determine the sort of embedded systems will add value to your organization.

1.2 ARDUINO

What is Arduino?

Arduino is a device for making computers that can sense and control the physical world from your computer. It's the open-source for the physical computing platform which is based on simple microcontroller board and developed the environment for writing software on the board.

Arduino can also be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of devices and other physical outputs. Arduino projects can be stand-alone, or they can be communicate with software running on the computer. The boards can be assembled by own hands or purchased pre-assembled; the open-source IDE can be downloaded for free.

The Arduino programming language is an implementation of writing, a similar physical computing platform, which is based on the Processing of the multimedia program for the environment.

Why to use Arduino?

Parallax Basic Stamp, Net-media's BX-24, MIT's Handy board, and many others offer similar functionality. All of these tools take the messy details of micro-controller programming and wrap up to an easy-to-use package. Arduino also simplifies and process the working with micro-controllers, but it will offer some advantage for the teachers, students, and interested amateurs over other systems:

In-expensive - Arduino boards are cheap as compared to other micro-controller platform. The low cost version of the Arduino can be assembled by hand, and even the pre-assembled Arduino modules and it will be easily affordable.

Simple programming environment - The Arduino programming environment is easy-to-use for the beginners, and yet flexible enough for advanced users to take advantage. For teachers, it's conveniently based on the Processing programming environment, so students can learn to program in that environment and will be familiar to the look and feel of Arduino

Open source and extensible software- The Arduino software is published as open source tools and available for the extension by the experienced programmers. As well as the language can be expanded through C++ libraries, and people required to understand the technical details and can make the leap from Arduino to the AVR C program language on which it's based. Similarly, you can add AVR-C code directly in-to Arduino programs if you required.

Cross-platform - The Arduino software runs on Windows, Macintosh OSX, and Linux operating system. Most of the microcontroller systems which are limited to Windows.

1.3. GSM

A GSM is a special type of modem which accepts a SIM card, and also operate by the mobile operator, just similar to mobile phone. From the mobile operator perspective, a GSM the modem is just similar to a mobile phone. When a GSM modem is connected to a computer, it will allows the computer to use the

GSM modem to communicate over the mobile network. While these GSM modems are most frequently used to provide the mobile internet connectivity, most of them can also be used for sending and receiving SMS and MMS messages. A GSM modem is might be a modem device with a serial, Bluetooth or USB connection, or it can be a mobile phone that provides GSM modem capabilities.

A GSM modem exposes an interface that allows applications such as SMS to receive and send messages over the modem interface. The mobile operator charged for this message sending and receiving as if it was performed directly from the mobile phone. To perform all these tasks, a GSM modem must be support an "extended antenna set" for receiving/sending SMS messages.


Fig. No. 1: GSM

GSM modems is the efficient and quick way to get started with SMS, because a special subscription to an SMS service provider is not required. In most parts of the world, GSM modems are the cost effective for receiving SMS messages, because the sender are paying for the message to delivery.

1.4 Breadboard

The most important tools for electrical prototyping is the **breadboard**. It's not a piece of bread that you stick electronics into, it's a piece of plastic with holes to place wires into and copper connecting to the holes so electricity can get to all the pieces you are working with. But not all the holes are connected! Following diagram and explanation of how a **breadboard** works as well as examples of series and parallel circuits. The important thing is learn how to use the **breadboard** so you can play with some electronics.
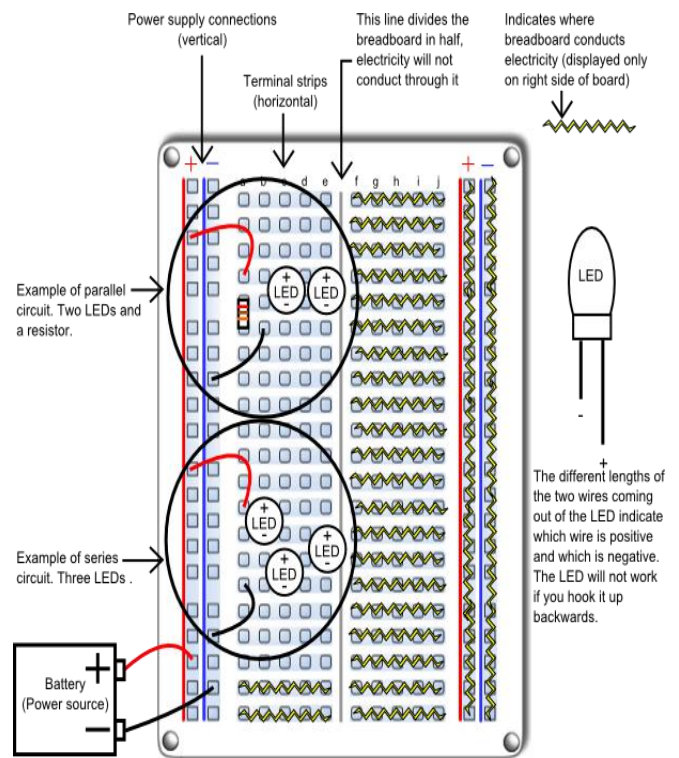
Fig. No. 2: Breadboard

In the right side of **breadboard** shows that which holes are connected and allow the electricity to flow between them without any connection between them. This is possible due to strips of copper on the underside of the board. **Power** supply connections have a + and − indicating how to hook up your power source. The connections for the **power** supply run up and down. The **terminal of the** strips are labeled with "a" through "j", these connections run across the board, but are broken down in the middle. This cuts the connection across the entire **terminal** area in two equal halves, giving you two unconnected sections to work with.

1.5. SENSORS

LM35:

Features

-Calibrated directly in ° Celsius

- Linear + 10.0 mV/°C scale factor

- 0.5°C accuracy guarantee able (at +25°C)

- Rated for full −55° to +150°C range

- Suitable for remote applications

- Low cost due to wafer-level trimming

- Operates from 4 to 30 volts

- Less than 60 µA current drain

- Low self-heating, 0.08°C in still air

- Nonlinearity only ±1⁄4°C typical

- Low impedance output, 0.1mA

General Description: The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 μA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

1.6. MQ6 SENSOR

TECHNICAL DATA MQ-6 GAS SENSOR

FEATURES

 High sensitivity to LPG, iso-butane, propane

 Little sensitivity to alcohol, smoke.

 Fast response, Stable and long life, Simple drive circuit

APPLICATION

They are used in gas leakage detecting equipment's at home and industry and are suitable for detecting the Liquid Petroleum Gas (LPG), iso-butane, propane, LNG, avoid the noise of alcohol and cooking fumes and cigarette smoke.

1.7. MQ9 SENSOR

MQ-9 Semiconductor Sensor for CO/Combustible Gas

MQ-9 gas sensor has a sensitive material of is SnO_2, it has the lower conductivity in clean air. It makes Detection by the method of cycle high and low temperature, and detect of CO when there is the low temperature (heated by 1.5V). The sensor's conductivity is high along as the gas concentration rises. When there is high temperature (heated by 5.0V), it detects Methane,

Propane etc. and other combustible gas and clean and other gases are adsorbed under low temperature. By the use of simple electro circuit, it Convert change of conductivity to correspond output signal of gas concentration.

MQ-9 gas sensor has high sensitivity to Methane, Carbon Monoxide and Liquid Petroleum Gas (LPG). The sensor is also used to detect different gases contains Carbon Oxide and combustible gases, it has the low cost and suitable for different purpose.

Character Configuration

 Good sensitivity to Carbon Oxide/Combustible gas

 High sensitivity to Methane, Propane

 Long life and low cost

Simple drive circuit

Application

 Domestic gas leakage detector

 Industrial gas detector

 Portable gas detector

1.7. LIQUID CRYSTAL DISLAY (LCD)

Liquid crystal display a type of displays which are commonly used in the digital watches and many portable computers. LCD displays consist of two sheets of polarizing material with the liquid crystal solution between them. When the electric current passes through the liquid then the crystals comes to align so that light cannot pass through them. Therefore each crystal act like a shutter, by allowing light to pass through it or blocking the light. LCDs have become very popular over past few years by providing the information display in many smart appliances. Commonly they are controlled by microcontrollers. They make complicated equipment too easier to operate. LCDs are usually comes in many shapes and sizes but the most common size is the 20 character x 4 line display with no backlight. It requires only 11 connections – eight bits for data (which can also be reduced to four if necessary) and three control lines (we have only used two here). It runs on a 5V DC supply and only needs about 1mA of current. The display contrast can be varied by changing in the voltage into 3 pin of the display, usually with a trim pot.
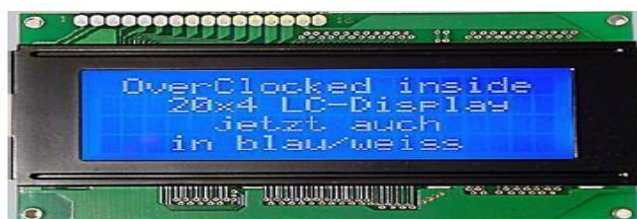

Fig. No. 3: Liquid Cristal Display (LCD)

LCD seems a lot to our application in terms by providing the useful interface for the user, debugging an application or just giving it a "Professional" look. The most common type of LCD is the Hitachi 44780, which provides a simple interface between a processor and an LCD.

Light Emitting Diode (LED)

A light-emitting diode (LED) is a semiconductor diode that emits incoherent narrow spectrum light when electrically biased in the forward direction of the pn-junction, as in the common LED circuit. This effect is a form of electroluminescence

While sending a message in the form of bits such as 1,the data is sent to the receiver side correspondingly the LED glows representing the data is being received simultaneously when we send 8 as a data the LED gets off .
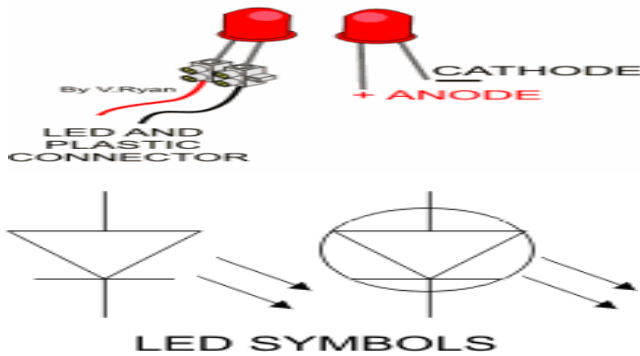
Fig. No. 4: LED

Color Coding:

| Color	Potential Difference
Infrared	1.6 V
Red	1.8 V to 2.1 V
Orange	2.2 V
Yellow	2.4 V
Green	2.6 V
Blue	3.0 V to 3.5 V
White	3.0 V to 3.5 V
Ultraviolet	3.5V

Table No. 1

II METHODOLOGY

This model is designed by using an Arduino Uno microcontroller which is also known as the processing chip. The model includes functions such as SIM 800L GPRS which provides the data network to consumers like sending SMS as wireless connection. MQ-9 sensor works as Semiconductor Sensor for CO/Combustible Gas. When there is high temperature (heated by 5.0V), it detects Methane, Propane etc. MQ-9 gas sensor has high sensitivity towards Methane, Carbon Monoxide and Liquid Petroleum Gas (LPG). MQ-6 sensor working principle is to detect leakages of Liquid Petroleum Gas (LPG), iso-butane, propane, LNG, avoid the noise of alcohol and cooking fumes and cigarette smoke at home or industries etc. The LM-35 is the temperature detected equipment used to show the temperature directly in ° Celsius. The LCD (Liquid Crystal Display) screen dimension of 16 by 2 provides all the data relates to temperature and gas sensors surrounding. The most important function of breadboard is used to distribute the power supply equally.
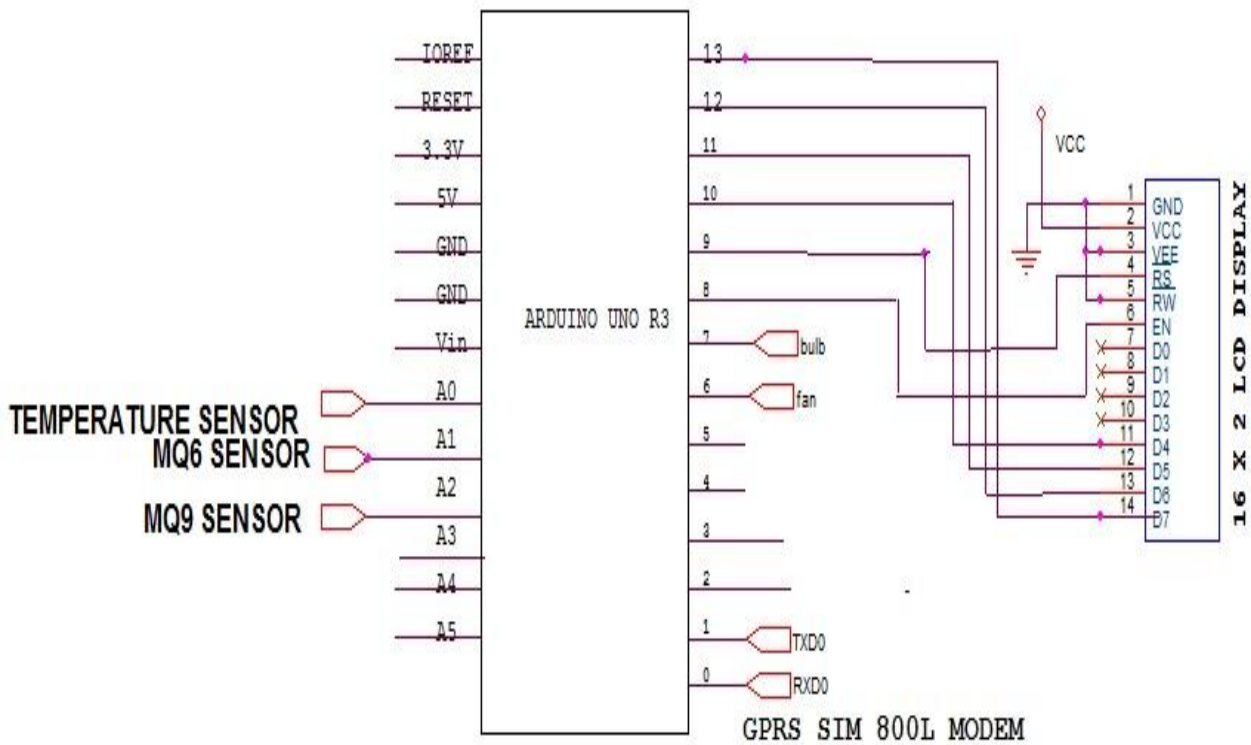
The Design Specification

Sr. No.	Components	Quantity
1	Arduino	1
2	Breadboard	3
3	MQ-9	1
4	MQ-6	1
5	GPRS SIM	1
6	LM-35	1
7	Motor and Fan	1
8	Bulb	1
9	Power Adaptor output	1
10	Relay	1

Table No. 2
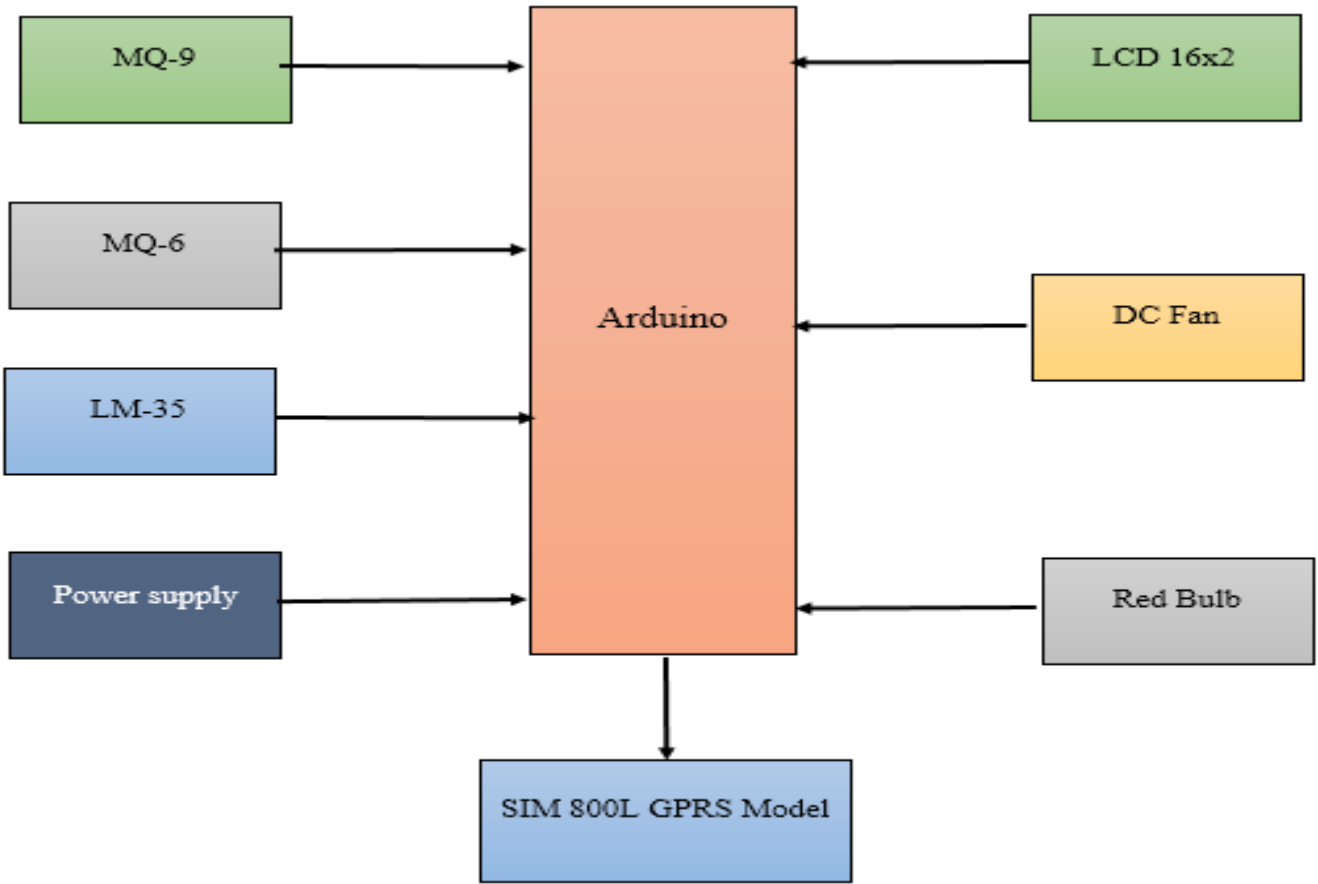
Figure 5: Circuit Module

Working principle of proposed model

As shown in the figure the arduino is loaded with the program and it is ready and message will be sent to the Liquid Cristal Display (LCD), the air quality data which was collected by using the MQ-6, and MQ-9 gas sensors and the temperature is sent by using LM35 it is a temperature sensor. It is the calibrated sensor made with the analog output voltage which is proportional to the concentration of polluting gases in Parts per Million (ppm). First of all the data will be shown on the LCD display and if the values are gone above the permissible limits or below the permissible limits then the message will be sent to the user using the GPRS SIM module 800L. And simultaneously it will trigger the exhaust fan to remove the harmful gas from its surrounding.

Mathematical Analysis for the Proposed Model

The level of concentration of the pollutants which is present in the atmosphere is measured in parts per million (ppm) or percentage.

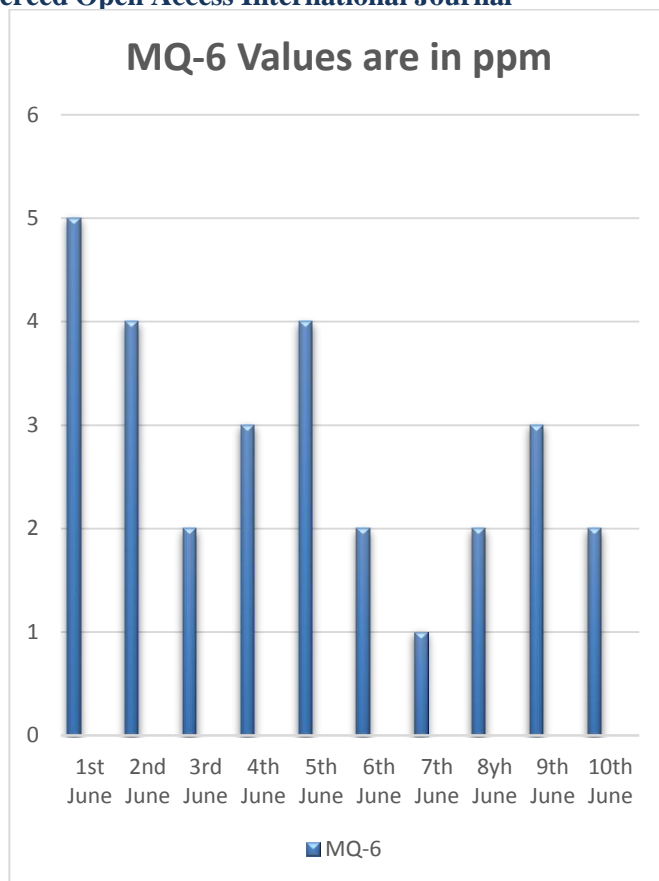For the conversion following factors are include.

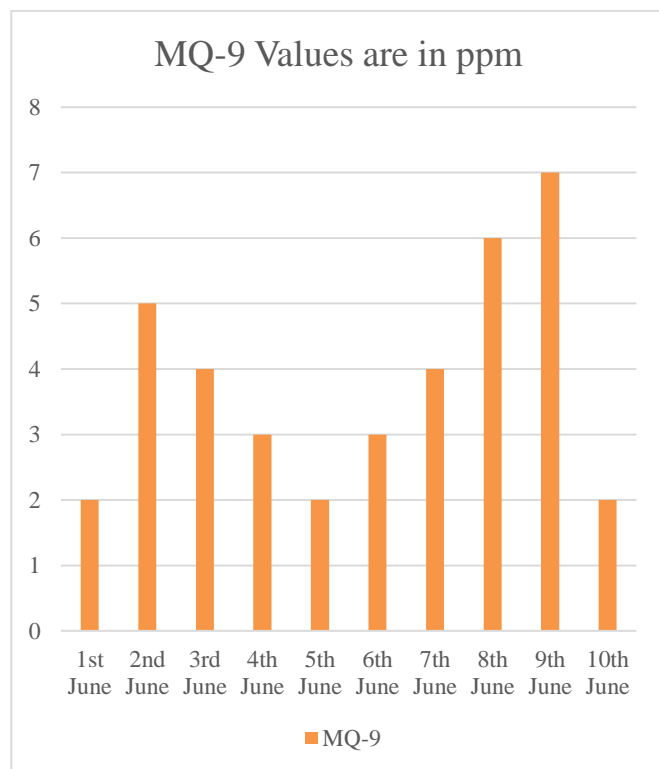1 ppm = 1.145 mg/m^3

1 mg/m^3 =0.873ppm

1 ppm = 1/1000000

1 ppm = 0.000%

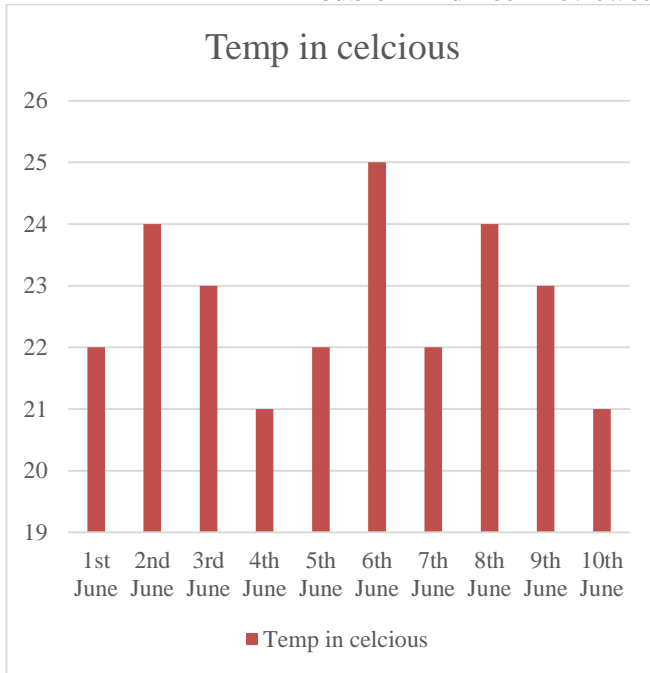| Parts Per Million (ppm)	Percentage %
0	0
5	0.0005
50	0.005
500	0.05
1000	0.1

Table No. 3

Graph 1: MQ-6 Sensor

Graph 2: MQ-9 Sensor

III RESULT

Graph 3: LM35 Temperature Sensor

IV CONCLUSION

This research paper proposed a Development of low cost air pollution detector using arduino. System that constantly keeps monitor or air quality in an area and displays air quality measure on an LCD screen. It also send the monitored data to the user by SMS. This system also activate the devices like exhaust fan. This system helps create awareness of quality of air that each and every one breathes daily. This monitoring devices delivers the real time data.

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