IOT BASED AIR POLLUTION DETECTOR FOR MINING AREA

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CHAPTER 1

INTRODUCTION

PROJECT GOAL

Air pollution is one of the major problems that today's world is facing. We all are aware of the fact how dangerous it could be working at the mines. Hours of work at the mine could lead the workers life to danger. Mining involves various activities like drilling, blasting, hauling, etc. This could lead to the exposure of various harmful gases like carbon dioxide, carbon monoxide, methane, sulphur dioxide, etc. A survey conducted says that Lakhs of people die every year due to the harmful gases released in the mining sectors.

Inhalation of these gases can lead to chronic diseases' like asthma, Pneumoconiosis, silicosis etc.during the mining process it is not possible to predict where and when which gas will be released . How much amount of the gas is present in the air. The purpose of Iot based air pollution detector is to have continuous monitoring of the gases released in the mining area so that the person monitoring the system is aware of the type of gas released and its concentration. This will help the workers to take safety precautions in advance.

AIR POLLUTION

Air pollution occurs when harmful or excessive quantities of substances are introduced into Earth's atmosphere. Sources of air pollution include gases such as ammonia, carbon monoxide, sulfurdioxide, nitrousoxides, methane and chlorofluorocarbons, particulates (both organic and inorganic), and biological molecules. It may cause diseases, allergies and even death to humans; it may also cause harm to other living organisms such as animals and food crops, and may damage the natural or built environment.

Air pollution is a significant risk factor for a number of pollution-related diseases, including respiratory infections, COPD, stroke and lung cancer'. Individual reactions to air pollutants depend on the type of pollutant a person is exposed to, the degree of exposure, and the individual's health status and genetics. Overall, air pollution causes the deaths of around 7 million people worldwide each year, and is the world's largest single environmental health risk.

The World Health Organization estimated in 2014 that every year air pollution causes the premature death of some 7 million people worldwide India has the highest death rate due to air pollution. India also has more deaths from asthma than any other nation according to the World Health Organization.

MINING

- Mining is the process of digging things out of the ground. Any material that cannot be grown must be mined. Mining things from the ground is called extraction. Mining can include extraction of metals and minerals, like coal, diamond, gold, silver, platinum, copper, tin and iron. Mining can also include other things like oil and natural gas. Some mining is done by scraping away the soil (dirt) from the top of the ground. This is called surface mining. Some mining is done by going deep underground into a mine shaft. This is called underground mining.

- Some mining, such as gold mining, is done in other ways. Gold can be mined by searching in the bed of a river or other stream of water to remove the flakes of gold. This is called panning or placer mining.
- Underground mining is a dangerous job for the miners. Many mines have accidents. Hundreds of miners die every year from accidents, mostly in poor countries. Safety rules and special safety equipment is used to try and protect miners from accidents. Underground coal mining is especially dangerous because coal can give off poisonous and .explosive gases.


IMAGES OF SURFACE MINING


IMAGES OF UNDERGROUND MINING

TYPES OF MINING

There are four main types of mining

- **Underground**

Underground mines are more expensive and are often used to reach deeper deposits.

- **Open surface**

Surface mines are typically used for more shallow and less valuable deposits

- **Placer**

Placer mining is used to sift out valuable metals from sediments in river channels, beach sands, or other environments.

- **In-situ mining**

In-situ which is primarily used in mining uranium involves dissolving the mineral recourse in place then processing it at the surface without moving rock from the ground.

COAL MINES

Coal mining can result in a number of adverse effects on the environment. Coal mining is the process of extracting coal from the ground. Coal can be extracted from the earth either by surface mining or underground mining. If coal is less than 61 meters (200 feet) underground, it can be extracted through surface mining. In surface mining, workers simply remove any overlying sediment, vegetation, and rock, called overburden According to the MSHA, they include exposure to: Dust: Very fine mineral dust particles from blasting and drilling can accumulate in the lungs, causing a disease called pneumoconiosis. Black lung disease, which can strike coal miners, is another form. Pneumoconiosis can cause scarring of the lungs called fibrosis. Coal production is a major contributor to global warming: burning coal generates large quantities of carbon dioxide and mining operations can release methane, a known greenhouse gas, into the atmosphere.


IMAGES OF COAL MINES

IRON MINES

Iron ores are rocks and minerals from which metallic iron can be economically extracted. The ores are usually rich in iron oxides and vary in color from dark grey, bright yellow, or deep purple to rusty red. The iron is usually found in the form of magnetite, hematite, goethite, limonite or siderite. Sulfur dioxide is produced when iron pyrite burns in gob fires or by blasting sulfide ores. It is also found in diesel exhaust. Sulfur dioxide has the same effect on the body as nitrogen dioxide, except that sulfuric acid is created in the lungs. It is a non-flammable gas.


IMAGES OF IRON ORE MINE

EFFECT OF MINING ON MINERS

Respiratory complications

Respiratory problems such as pneumoconiosis, asbestosis, and silicosis. A coal mine produces lots of dust which if inhaled, can lead to the black lung disease among the miners and other people living within the surrounding region.

Due to blasting and drilling, the fine mineral particles of dust are inhaled and accumulate in the lung causing pneumoconiosis. And when miner inhales excessive amounts of quartz or crystalline silica, he or she is likely to suffer an irreversible disease called the silicosis. Chronic exposure to welding fumes can also cause lung irritation and poisoning,

Injuries and fatalities

There are reports of people injured by the rails that transport them to and From ground. Others have had rocks collapsing on them as they mine. Some mining activities are associated with a lot of heavy lifting and shoveling which can cause back injuries. Studies indicate that 25 percent of the total injuries reported in mining are due to slips and falls.

Cancers due to radioactive material exposure

People in industries that mine radioactive elements or in fields that generate hazardous gases such as Radon are in danger of having terminal diseases, especially cancers.

Poisoning and organ damage due to heavy metals exposure

Mining activities ordinarily generate high concentrations of metals and metalloids. When these metals leach they can reach the groundwater and surface water and find a way into the food chain and even climb up the food chain through bioaccumulation. If a metal such as mercury is ingested it can lead to poisoning, organ damage, and even death in high concentrations.

Mining blasts

The main toxic gases in mines are carbon monoxide (CO) and carbon dioxide (CO_2); the flammable gases are methane (CH_4), CO, and hydrogen (H_2); the suffocating gases are CO_2, nitrogen (N_20), and CH_4; and the toxic gases are CO, nitrogen oxides (NOx), and hydrogen sulphide (H_2S).

CHAPTER 2

LITERATURE SURVEY

Human security from death defying gases using an intelligent sensor system

Kumar Visvam, Devadoss Ambeth

Computer science and Engineering, Panimalar Engineering College, Chennai 600123, India

Year January 2016

A b s t r a c t: Hazardous gas contamination causes threat to human life. In many developing countries, the sewers are s t i l l cleaned by unskilled labourers. Situations may arise where harmful gases may get emitted via sewage and can potentially endanger life. Furthermore, in coal mining, there is a possibility of hitting a source of natural gas which cannot be determined unless or until a sensor is utilized. To prevent such hazardous situations, this new gas detection system detects those types of gases, analyzes them for us and provides essential details about it. Our system is designed to track the presence of hazardous gases, identify the safety limit and calculate the level in that situation, thereby preventing hazards to human life. It allows detection of carbon monoxide and methane at the given time, along with their accurate concentration values in ppm. The system also provides a threat detection alert so that the person immediately evacuates that area, thereby preventing any possible dangers. The alert messages are broadcast using GSM technology and hence, can be used to notify other rescue workers about the potential hazard the worker is facing at the moment.

IOT Based LPG Gas Leakage Detector

Prof. Pranay Meshram, Nancy Shukla, StutiMendhekar, Renuka Gadgeshivani Kanaskar

ComputerScience&Engineering, Priyadarshini J .L .College of Engineering, Nagpur, Maharashtra, India

Year: 2019

ABSTRACT: Gas leakage is a major problem in the industrial sector, in residential locations etc. One of the preventive methods to stop the incident related to the gas leak is to install a gas leak detection kit at vulnerable locations. The goal of this paper is to propose a system that can detect, alert and automatically control gas leaks. In a particular, gas sensor has been used which has a high sensitivity to gases such as Propane and butane together with LPG. There is an alarm that is triggered once the LPG has been detected. The gas leakage system. Consists of a Wi-Fi module that alerts the user by sending an SMS message.

DesignandImplementationofaWearableGasSensorNetworkforOilandGasIndustryWorkers

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Computer Engineering Department, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.

Department of Computer Science, Effat University, Jeddah, Saudi Arabia

Year: 2017

Abstract: Industrial environment usually involves some types of hazardous substances including toxic and/or flammable gases. Accidental gas leakage can cause potential dangers to a plant, its employees and surrounding neighbourhoods. Around 64% of accidents that happen in the oil fields are due to combustibles and/or toxic

gases. The safety plan of most industries includes measures to reduce risk to humans and plants by incorporating early-warning devices, such as gas detectors. Most existing tools for monitoring gases are stationary and incapable of accurately measuring individual exposures that depend on personal lifestyles and environment. This paper provides a design and implementation of a wearable gas sensor network by building sensor nodes with wireless communication modules which communicate their data along the network. The system is designed to be flexible, low cost, low maintenance and with accurate performance to detect toxic gases in a timely fashion to warn employees before an existence of a disaster.

A COMPREHENSIVE REVIEW OF SEMICONDUCTOR-TYPE GAS SENSORS FOR ENVIRONMENTAL MONITORING

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G.N.D.U- Regional Campus, Jalandhar

Faculty of Information Technology, Haiphong University, Haiphong, Vietnam

Year: 2016

ABSTRACT: In this paper a review of different semiconductor-type gas sensors is presented. The different types of gas sensors from various companies like Hanwei, Libelium, Sandbox Electronics and Sensor Tech SGX are discussed along with their technical specifications. Environment is surrounded by various sorts of gases cum pollutants and it is utmost necessary to keep a efficient check on them as these gases can cause trouble to the health of human beings and pollute environment drastically. The main objective of this research paper is to present all sorts of gas sensors which are based on semiconductors and to generate awareness regarding which sensor is best for which detection. However, for more improved sensitivity and selectivity for these sensors, future trends and outlook for researchers is also suggested. The paper can also act as base for researchers to get hold of these sensors to develop a market ready product like drone or robot for Environmental Gas Detection.

The Analysis of Fruit Ripening Level from Diffusion of Gases by using Data Mining Techniques

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College of Information and Communication Technology, Rangsit University.

Year: 2018

Abstract: The purpose of this research aims to analyze fruit ripening level from diffusion of gas by data mining techniques. Due to the fact that Ethylene is associated with fruit ripening level. A tool, Arduino board connected with MQ3, MQ6 and MQ8 detection sensors, has been developed for the assessment. These sensors are substituted for Ethylene one which is quite expensive. After collecting 160 data by this tool, data mining procedures are mainly used for data clustering and classification. The experimental result demonstrates that K-Means clustering algorithm classify Durian ripening level into 4 types; 1) unripe, pre-ripe, 3) ripe, 4) overripe. When it comes to classification, various types of algorithm, for instance, Decision Tree, K Nearest Neighbours (KNN), Neural Network, Naive Bayes and Support Vector Machine

(SVM), have been compared by accuracy rate of their performance through cross validation procedure. It has been found that Support Vector Machine and Neural Network algorithm are similarly the most accurate. However, the accuracy of all algorithm in this experimental closely to 100%, these algorithms can be further developed to analyze fruit ripening level from diffusion of gas analysis.

Hazardous Gas Detection using Gas Sensors Arrays and Fuzzy-Based Classification

Rajina R. Mohamed, M A Mohamed, WahidahHashim, Abd.Rahim, M. SyamilFuad

Year: 2019

Abstract*:* This paper presents hazardous gas detection using gas sensors arrays and fuzzy-based classification. This research is an automation of hazardous gas detection using electronic nose. Gases surround us could either hazard or benefit our health. Gas detection is an important issue, as humans should not breathe in hazardous gases in order to maintain their health. Hence, there must be an indicator to show the hazardous level of certain gases so that people can avoid and minimize the impact on their health. In this paper, hazardous gas detection is implemented by using gas sensor arrays and fuzzy-based classification. A classification for the electronic nose (e-nose) is developed in order to classify gases and determine the level of hazard of gases. The results found that e-nose system is able to differentiate hazardous level of chosen gases which are LP gas and CO gas.

Review Paper on IOT based Design System for Checking Atmospheric Habitability

Navneet Kumar Gautam, Kumar Saurabh, SuyashJohri, TarunChaudhary

Degree of Bachelor's of Technology, Dept. of Computer Science & Engineering IMSEC, Ghaziabad, U.P., India

Year: 2017

Abstract: Problem of air pollution is increasing each and every second and day by day. To measure the level of air pollution, we were planning to design an IOT based system for cheating atmospheric habitability i.e. Air quality Monitoring System. The main objective is to prevent the harmful effects of pollutants present in air so that healthy surroundings can be maintained using telemetry. Air quality index were sensed gases like PM10, PM2.5, CO etc. and displayed each and every calculation in the LCD display. If these gases exceed the normal level then an alarm is generated immediately. Aim of this paper is to highlight some technology which can monitor air pollution.

Characterization of MQ-Series Gas Sensor Behaviour

NORTHERN ILLINOIS U NIVERSITY

Author: Alec F IS H E R

Year: sept 2016

ABSTRACT: There are a wide variety of circumstances in which knowing of the presence of various potentially toxic gases in the local atmosphere is desirable. For many cases, such as for average household

use, inexpensive alarms or detectors are readily available for specific gases. Common examples of these are carbon monoxide detectors and smoke alarms. However, for some applications, a higher degree of precision and detail about the prop- erties of the local environment is desired. Unfortunately, commercial solutions to this problem are prohibitively expensive for many cases. The purpose of this project was to study the behaviour of MQ-series gas sensors. These are metal oxide semiconductor gas sensors which are inexpensive and readily available from internet retailers which make them seemingly ideal for the entrepreneur or hobbyist looking to work with gas sensors. However, the sensors are not internally calibrated, so characterizing their behaviour is necessary before they can used to collect quantitative data. While there are others available, the models tested for this experiment were the MQ2 (flammable gas and smoke), MQ4 (methane), MQ6 (isobutane/propane/LPG), MQ7 (carbon monoxide), and the MQ9 (car- bon monoxide/flammable gas). The primary goal was to find a relationship describing the sensor signal as a function of gas concentration and the sensitivity resistance. To accomplish this, a testing apparatus was created such that a controlled mixture of a gas to which the sensor is sensitive (propane, referred to generally as the" active" gas) and an inert gas (nitrogen, generally referred to as the ''inactive" gas) could be passed over the sensor surfaces. Different combinations of active gas concentration and sensitivity resistor values were explored to develop the desired functional relationship. Upon examination of the results of over one-hundred trials, it was concluded (in accordance with equations derived analytically) that there was a strong relationship between sensor value and active gas concentration resembling a logistic function. Additionally, it was found that the resistance across the sensor itself is strongly dependent on the voltage drop across it and its reference atmosphere, though the nature of said relationships were not determined due to the multitude of potentially influential factors regarding which either little information was available or studying would be prohibitively difficult.

Toxic Gas Detection using Low PowerController with Alert System

Karthika S, Vanitha U, RejinaParvin J, SuprajaArasu T, Sampritha R V, Srinithi K

Year: 2019

Abstract: The main idea of gas leakage detection is to implement the security system for detection of gas leakage in closed environment. In present scenario, there are many criteria which are related to gas leakage which affects an innocent people lives and property damage. Implementation of this alert system can be useful for companies, houses, which can save lives of people. In this work, SIM900 (GSM module) is used to perform the chosen task by interfacing Gas sensor (MQ5), Buzzer, Arduino UNO, Stepper Motor(5V) and LCD to display. Initially when there is a leak, the Gas sensor detects it using MQ5 and sound alarm is produced automatically and the leakage of gas is controlled. Also, an SMS based system is setup using GSM Module which sends 3 alerts (messages) to the specified mobile number. Not only detection of gas leakage but also stopping the leakage is equally essential to detection. This project provides an effective in cost and highly accuracy, which not only detect gas leakage but also alerting the people (sound alarm) and turn off main power and gas supplies, and send an SMS. In despite to provide high accuracy, gas sensor MQ-5 has been used and this can be used in application of chemical and hazardous industries where there is a consecutive monitoring of gas leaks. By using different types of gas sensors for various gas, used to identify leaks for every kind of gases. Thus, on designing this project our ultimate aim is to automatically detect and stop leakage in vulnerable premises. Index Terms: Arduino Uno, Gas Sensor, MQ5.

Hazardous Gas Detection using Gas Sensors Arrays and Fuzzy-Based Classification

Rajina R. Mohamed, M A Mohamed, WahidahHashim, Abd. Rahim, M. SyamilFuad

Year: 2019

International Journal of Recent Technology and Engineering (IJRTE)

Abstract: This paper presents hazardous gas detection using gas sensors arrays and fuzzy-based classification. This research is an automation of hazardous gas detection using electronic nose. Gases surround us could either hazard or benefit our health. Gas detection is an important issue, as humans should not breathe in hazardous gases in order to maintain their health. Hence, there must be an indicator to show the hazardous level of certain gases so that people can avoid and minimize the impact on their health. In this paper, hazardous gas detection is implemented by using gas sensor arrays and fuzzy-based classification. A classification for the electronic nose (e-nose) is developed in order to classify gases and determine the level of hazard of gases. The results found that e-nose system is able to differentiate hazardous level of chosen gases which are LP gas and CO gas.

Air Quality Monitoring System For City

Pradeep D. Landge, R. R. Harne

Government College of Engineering, Amravati, Maharashtra, India . Assistant professor, dept. of Electronics, GCOEA, Maharashtra, India

Year: June 2018

Abstract - An Objective of this paper is to design and implement a system for air quality monitoring using Internet of Things called as IoT. The model initiates from sensor devices that can sense, compute, and communicate data in a network. This study measures real-time PM2.5, temperature, humidity, Air Quality Index. Monitored data is wireless transmitted via Wi-Fi module to a server. When the sensor node reads pollutant gases composition, temperature and humidity, it will be displayed on the website. The monitored data with date and time can be retrieved as a tabular data for future analysis. With implementation of this work, precautionary alerts can be given to public on the designed website to wear anti-pollution mask, change paths while transporting where there is high air pollution ensuring high reliability. It promotes the public awareness about state of air pollution and how much important it is to reduce it. There will be news, surveys regarding pollution in different countries, different ways to reduce air pollution on the website.

IOT BASED AIR QUALITY MONITORING SYSTEM USING MQ135 AND MQ7 WITH MACHINE LEARNING ANALYSIS

KINNERA BHARATH KUMAR SAI, SOMULA RAMASUBBAREDDY, AND ASHISH KR. LUHACH

The Papua New Guinea University of Technology and VIT University

Year: December 2019

Abstract. This paper deals with measuring the Air Quality using MQ135 sensor along with Carbon Monoxide CO using MQ7 sensor. Measuring Air Quality is an important element for bringing awareness to

take care of the future generations and for a healthier life. Based on this, Government of India has already taken certain measures to ban Single Stroke and Two Stroke Engine based motorcycles which are emitting high pollution. We are trying to implement a system using IoT platforms like Thingspeak or Cayenne in order to bring awareness to every individual about the harm we are doing to our environment. Already, New Delhi is remarked as the most pollution city in the world recording Air Quality above 300 PPM. We have used easiest platform like Thingspeak and set the dashboard to public such that everyone can come to know the Air Quality at the location where the system is installed. Machine Learning analysis brings us a lot of depth in understanding the information that we obtained from the data. Moreover, we are proving a reducement of the cost of components versus the state of the art.

Smart Pollution Monitoring System

International journal of recent technology and engineering

Stanly Wilson, Tony Manuel, Peter Augustin D

Year: March 2019

Abstract: The world has travelled a long way through the industrial revolution. One of the consequences that the industries and its different forms gave to humanity is pollution. The environment that we live is being polluted in different ways. Different parts of the world are already experiencing air pollution as a matter of concern. The increasing amount of industries and the emission of gas by the vehicles cause much damage to the air. We are in a situation where we need to monitor the amount of pollution in our areas of living and working. In order to monitor pollution, the paper proposes an efficient and low-cost method with the help of the internet of things (IoT). The system is designed to monitor the levels of CO, CO_2, smoke, alcohol, NH_3, temperature and humidity. The various alarms and notification are arranged in such a way that the information is given when there is any sign of threat. The remote monitoring is made possible with dedicated website and mobile app. Index Terms: Air Quality Monitor, Cloud Server, Pollution, Prototype, Sensors, and Toxic Gases.

Air Quality Monitoring: The Use of Arduino and Android

Ashish M. Husain, Tazrin Hassan Rini , Mohammed Ikramul Haque and Md. Rakibul Alam

Journal of Modern Science and Technology

Abstract: In this paper a cost efficient, portable, easily manageable Arduino based device has been presented to monitor air quality. The device works by collecting data of quantity of specific harmful gases and the amount of dust present in the air. This device can be located at any place and the data can be transferred to an Android phone via Bluetooth or simply by connecting the device to a PC/laptop. Data collected by the device from different places can be later examined to make further decisions and analysis about the state of air quality; furthermore, it can also help concerned individuals to act upon it.

An IoT Based Automated Noise and Air Pollution Monitoring System

Palaghat Yaswanth Sai

Department of Computer Science and Engineering, Narayana Engineering College Gudur, India

Year: March 2017

Abstract: In the present era, air and noise pollution is the growing hazardous issue. It is necessary to monitor air quality and keep it under control for a better future and healthy living for all. Here we propose an air quality as well as sound pollution monitoring system that allows us to monitor and check live air quality as well as sound pollution in particular areas through IOT. System uses air sensors to sense presence of harmful gases/compounds in the air and constantly transmit this data to microcontroller. Also system keeps measuring sound level and reports it to the online server over IOT. The sensors interact with microcontroller which processes this data and transmits it over internet. This allows authorities to monitor air pollution in different areas and take action against it. Also authorities can keep a watch on the noise pollution near schools, hospitals and no honking areas, and if system detects air quality and noise issues it alerts authorities so they can take measures to control the issue.

Estimating Gas Concentration using Artificial Neural Network for Electronic Nose

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Year: November 2017

Abstract: E-nose is a sensor used to detect the existence of gas in the air. Some types of sensor has the ability to detect certain gas and also has different datasheet. Slope deflection is the method to determine the suitable sensor for the experiment. E-nose with MQ Family produces the ratio of existing air and base line air resistance, and it is usually equipped with a datasheet containing the consecration of detected gas in a certain value of the sensor to convert the output to the concentration of detected gas. The ratio is used to estimate the concentration of a gas. In this paper, artificial neural network is used to estimate the concentration of a gas in the air based on the ratio. Providing the accurate calculation of the ratio is very important to increase the Electronic nose performance, and the result of this experiment showed that the artificial neural network method achieves a good performance with smaller RMSE of 0.0433 compared with the existing methods.

LPG Gas Leakage Monitoring and Alert System using Arduino

Faculty, Dept. of CSE, World University of Bangladesh (WUB), Bangladesh MSc. in CSE, Daffodil International University (DIU), Bangladesh

Ayesha Siddika, Imam Hossain

Year: 2018

Abstract: The explosion due to gas leakage has become a serious problem in our country's daily activities. Now the world is evolving with technology, so it is necessary to use technology if possible in every case. LPG gas to resolve the accident occurred we can prevent it through technology. The system is based on a microcontroller, which uses gas sensors as well as GSM, display and buzzer. It is designed for LPG Gas

Leakage Monitoring and Alert System using Arduino Mega with MQ135 sensor. This circuit contains MQ135 gas sensor, microcontroller, buzzer, display and GSM. The sensor will detect the gas leakage and transmit the information to the microcontroller. On the basis of that information, the microcontroller makes a decision and then displays a warning message on the display and the message will be sent to the user via GSM. The uses of the Arduino microcontroller with Arduino provide a suitable platform for implementing an embedded control system and it is possible to modify it to meet our future requirements easily and quickly.

Real Time Monitoring System for Mine Safety using Wireless Sensor Network

(Multi-Gas Detector)

Department of mining engineering National institute of technology Rourkela

Sumit Kumar Srivastava

Year: 2015

Abstract: Today safety of miners is a major challenge. Miner's health and life is vulnerable to several critical issues, which includes not only the working environment, but also the after effect of it. Mining activities release harmful and toxic gases in turn exposing the associated workers into the danger of survival. This puts a lot of pressure on the mining industry. To increase the productivity and reduce the cost of mining along with consideration of the safety of workers, an innovative approach is required.

Miner's health is in danger mainly because of the toxic gases which are very often released in underground mines. These gases cannot be detected easily by human senses. This thesis investigates the presence of toxic gases in critical regions and their effects on miners. A real time monitoring system using wireless sensor network, which includes multiple sensors, is developed. This system monitors surrounding environmental parameters such as temperature, humidity and multiple toxic gases. This system also provides an early warning, which will be helpful to all miners present inside the mine to save their life before any casualty occurs. The system uses Zigbee technology to establish wireless sensor network. It is wireless networking standard IEEE 802.15.4, which is suitable for operation in harsh environment.

AIR QUALITY SENSING AND MONITORING

DEPARTMENT OF APPLIED ELECTRONICS & INSTRUMENTATION ENGINEERING, RCC INSTITUTE OF INFORMATION TECHNOLOGY, CANAL SOUTH ROAD, BELIAGHATA, KOLKATA

Arpan Chakraborty, Prajukti Das, Shovan Karmakar

Year: Nov 2017

Abstract: Continued exposure to environments with poor air quality is a major public health concern in developed and developing countries. It is estimated that the pollutants responsible for poor air quality cause nearly 2.5 million premature deaths per year world-wide. Significantly, around 1.5 million of these deaths are due to polluted indoor air, and it is suggested that poor indoor air quality may pose a significant health risk to more than half of the world's population. Due to its link with industrialisation, societal health problems associated with poor air quality disproportionately affects developed and developing nations – it is estimated that air pollution is responsible for the premature deaths. Remedial action to improve air quality is

often easy to implement once airborne pollutants have been detected. This project provides a combination of process of sensing several gas levels in the air and also the ambient temperature and humidity, thus sensing the quality of the air. The levels of the gases and the temperature is displayed in a LCD display panel , which continuously shows the real time output values of the gas sensors , temperature and humidity sensor.

A smart sensor system for air quality monitoring and massive data collection

Published in: Information and Communication Technology Convergence (ICTC), 2015 International Conference

Yonggao Yang, Lin Li

Year: 2015

(Department of Computer Science, Prairie View A&M University, Prairie View, TX 77446, U.S.A)

Air pollution has been a global challenge for environment protection. Effectively collecting and scientifically visualizing the air quality data can better help us monitor the environment and address related issues. This article presents a smart sensor system for air quality monitoring which consists of three units: the smart sensor unit, the Smartphone, and a server.

A real-time ambient air quality monitoring wireless sensor network for schools in smart cities:-

Published in: Smart Cities Conference (ISC2), 2015 IEEE First International

H. Ali, J. K. Soe, Steven. R. Wel

Year: 2015

(School of Electrical Engineering & Computer Science, the University of Newcastle, Callaghan, NSW 2308, Australia)

In this paper, a low-cost solar-powered air quality monitoring system based on ZigBee wireless network system technology is presented. The solar powered network sensor nodes can be deployed by schools to collect and report real-time data on carbon monoxide (CO), nitrogen dioxide (NO_2), dust particles, temperature, and relative humidity. The proposed system allows schools to monitor air quality conditions on a desktop/laptop computer through an application designed using Lab VIEW and provides an alert if the air quality characteristics exceed acceptable levels. They tested the sensor network successfully at the Singapore campus of the University of Newcastle, Australia. The experimental results obtained by them demonstrated that the sensor network can provide high-quality air quality measurements over a wide range of CO, NO_2 and dust concentrations.

An embedded system model for air quality monitoring:-

Published in: Computing for Sustainable Global Development (INDIACom), 2016 3rd International Conference

Sneha Jangid, Sandeep Sharma (School of ICT, Gautam Buddha University, Greater Noida, India)

Year: 2016

Abstract: Objective of the paper is to present a system model which can facilitate the assessment of health impacts caused due to indoor air pollutant as well as outdoor and can intimate the human prior about the risk he/she going to have, here we are focusing our work in context to allergic patients as they will be informed by this tool such that they can secure themselves without actually experiencing the risk factors, here a sensing network based microcontroller equipped with gas sensors, optical dust particle sensor, humidity and temperature sensor has been used for air quality monitoring. The design included various units mainly: sensing unit, processing unit, power unit, display unit, communication unit. This work will apply the techniques of electrical engineering with the knowledge of environmental engineering by using sensor networks to measure Air Quality Parameters.

A wireless system for indoor air quality monitoring

Published in: Industrial Electronics Society, IECON 2016 - 42nd Annual Conference of the IEEE

R du Plessis, A Kumar, GP Hancke

Year: 2016

(Department of Electrical, Electronic and Computer Engineering, University of Pretoria, South Africa)

This paper describes the development of a wireless monitoring system which can be deployed in a building. The system measures carbon dioxide, carbon monoxide and temperature. The system developed in this paper can serve as the monitoring component of a HVAC control system and function as an indoor air quality monitor independently.

IoT enabled proactive indoor air quality monitoring system for sustainable health management:-

Published in: Computing and Communications Technologies (ICCCT), 2017 2nd International Conference

M.F.M Firdhous, B.H Sudantha, P.M Karunaratne (Dept. of Information Technology, University of Moratuwa, Sri Lanka)

Year: 2017

Abstract: This paper proposes an IoT based indoor air quality monitoring system for tracking the ozone concentrations near a photocopy machine. The experimental system with a semiconductor sensor capable of monitoring ozone concentrations was installed near a high volume photocopier. The IoT device has been programmed to collect and transmit data at an interval of five minutes over blue tooth connection to a gateway node that in turn communicates with the processing node via the WiFi local area network. The sensor was calibrated using the standard calibration methods. As an additional capability, the proposed air pollution monitoring system can generate warnings when the pollution level exceeds beyond a predetermined threshold value.

A WiFi-enabled indoor air quality monitoring and control system:-

Published in: Control & Automation (ICCA), 2017 13th IEEE International Conference

Xiaoke Yang, Lingyu Yang, Jing Zhang

(School of Automation Science and Electrical Engineering, Beihang University, Beijing, 100191, China**)**

Year: 2017

Abstract: This paper proposes an open platform of a WiFi-enabled indoor air quality monitoring and control system, which could be incorporated into such a 'smart building' structure. The complete software and hardware design of this system is presented, along with a series of control experiments. The proposed system operates over an existing WiFi wireless network utilizing the MQTT protocol. It is capable of monitoring the indoor air quality as well as controlling an air purifier to regulate the particulate matters concentration. Experiment results under a real world office environment demonstrate the effectiveness of the proposed design.

A Review on IoT Based Air Pollution Monitoring System

Dept. Of E&TC Engg. GF's Godavari College of Engineering, Jalgaon,425003, India, Dept. of E&TC Engg. SSGB College of Engineering ,Bhusawal, Jalgaon,425003.

Chetan N. Badgujar[1], Paresh S. Patil[2], Kumudini Gawande[3], S. K. Chaudhari[4], H. T. Ingale

Year: 2019

Abstract: -. Evidence shows that Smart Cities are starting to materialise in our lives through the gradual introduction of the Internet of Things (IoT) paradigm. In this scope, crowd sensing emerges as a powerful solution to address environmental monitoring, allowing to control air pollution levels in crowded urban areas in a distributed, collaborative, inexpensive and accurate manner. However, even though technology is already available, such environmental sensing devices have not yet reached consumers. In this paper, we present an analysis of candidate technologies for crowd sensing architectures, along with the requirements for empowering users with air monitoring capabilities. Specifically, we start by providing an overview of the most relevant IoT architectures and protocols. Then, we present the general design of an off-the-shelf mobile environmental sensor able to cope with air quality monitoring requirements; we explore different hardware options to develop the desired sensing unit using readily available devices, discussing the main technical issues associated with each option, thereby opening new opportunities in terms of environmental monitoring programs.

Coal Mine Robot for Detection of Hazardous Gas

M. E Student, Dept. of Electronics & Telecommunication, Govt. College of Engg. Aurangabad, India

Assistant Prof, Dept. of Electronics & Telecommunication , Govt. College of Engg., Aurangabad, Maharashtra, India

S. D. Mitragotri, Dr. A. R. Karwankar

Year: April 2016

Abstract: Safety of human life is an important factor .So improve life safety, many system have been developed. While working environment such coal mine safety is an important factor because coal mine is an underground tunnel. In previous work environment in coal mine different accident take place due to gas explosion, fire, and low percentage oxygen gas (O_2) content layer, excess amount of carbon monoxide gas (CO), carbon dioxide gas (CO_2), methane gas (CH_4) so that , in that accident many worker's injured and died. This system helps people who were working in coal mine by using coal mine robot. A control system uses microcontroller and a Zigbee communication system to transfer the coal mine environment data acquired through the MQ 135 and temperature sensor. Robot enters and moves in coal mine and detect hazardous gas and provide safety against fire explosion, poisoned gases like CO, CO2, CH_4 and alert people in tunnel. So using coal mine robot probability of accident reduced.

Survey Paper on "IoT Based Air and Sound Pollution Monitoring System"

Department of Electronics & Communication Engineering' S.B.Patil College of Engg., Vangali, Maharashtra, India.

Shrotika Ankush Shinde, Namrata Bhauso Ghayal, Prajakta Pradip Gaikwad, Vrushali Vivek Deshmukh

Year: April 2018

Abstract*:* In this project, to monitoring atmospheric conditions of environment like, air pollution and sound pollution an effective implementation for Internet of Things is used. This project presents a conceptual architecture for a versatile, flexible and cost efficient for monitoring the air and sound quality of a particular site. In the description about this integrated network architecture and the connected mechanisms for reliable and accurate measurement of parameters by sensors and transfer of information or data is done with the help of internet. This system is able to provide a mechanism for the operations of the devices to do better in monitoring stage. This monitored data can be obtained from remote location without actually visiting it due to the access of internet. The framework of this monitoring system is based on combination or collaboration of affective distributed sensing units and information system for data composition.

GAS AND SMOKE DETECTION IN INDUSTRIES USING Node MCU

Department of Computer Science and Engineering, Undergraduate Student, Branch of Computer Science and Engineering, SRM institute of Science and Technology, India

B. Amutha, C. Rajeshbabu, Ch. Neehar, E. Sumanth

Year: 2020

Abstract: Industrial automation has been quite prevalent these days due to its unique significant advantages. This is done by utilizing local communication protocols and remote control and tracking of industrial system constraints utilizing Raspberry Pi and Integrated Web Server Technologies. In this paper, we suggest wireless data gathering frameworks that enable each detector node to track the variability in its atmosphere whilst at the same time minimizing its power consumption. In the proposed device, the temperature detector and the gas detector are used to determine the environment and the undesirable gas

within the manufacturing plant. Gauged details can be connected to the web. In addition, our research findings demonstrated substantial energy efficiency and high-precision data analysis relative to conventional protection device strategies.

Hazardous Gas Monitoring System In Industries And Washrooms

International journal of engineering and advanced technology (IJEAT)

Divya.R, Latchaprabhu.P, Nishashree.R, Nivetha N.J, R. Kavitha

Year: December 2018

Abstract: A gas detector is a vital device in industries that detects the presence of hazardous gases often as part of a safety system. This type of equipment is used to detect a gas leak or other emissions and provide signal and alarm giving the employees the opportunity to evacuate. The main idea of this project is to apply gas monitoring system in washroom and industry. In India most of the washrooms are not clean regularly which leads to lots of hygienic problem and restricts the usage of public. The main gases in the washroom are hydrogen sulphide, methane, ammonia, carbon monoxide and nitrogen oxides. This project is proposed to initiate the use of public washrooms in India without any hesitation. The gases are detected using sensors MQ-4, TGS-2602andMQ-136 respectively and GSM will send a message to the server GSM, which will indicate washroom should be cleaned.

Air Quality Monitoring System based on Arduino Microcontroller

International journal of innovative research in science engineering and technology

Navreetinder Kaur, Rita Mahajan,, Deepak Bagai, P.G. Student, Dept. of Electronics and Communication, PEC University of Technology, Chandigarh, India.

Year: June 2016

Abstract: The level of pollution has increased with times by lot of factors like the increase in population, increased vehicle use, industrialization and urbanization which results in harmful effects on human wellbeing by directly affecting health of population exposed to it. In order to monitor quality of air, a Wireless sensor network (WSN) based new framework is proposed which is based on data acquisition and transmission. The parameters of the environment to be monitored are chosen as temperature, humidity, volume of CO, volume of CO2, detection of leakage of any gas - smoke, alcohol, LPG. The values of these parameters are transmitted by using Zigbee Pro (S-2) to a base station where they are being monitored. The value of temperature and humidity are transmitted over Bluetooth also so that every person in the range of the system can check it over their smart phones and laptops as these parameters hold importance to everyone. CO, a dangerous parameter is monitored with an extra precaution. A text message is sent to the base station through GSM module whenever its volume exceeds a particular safe limit intended for a particular application.

Research paper on IOT based Air and Sound Pollution Monitoring System

International journal of computer applications

Lalit Mohan Joshi

Year: November 2017

Abstract: In infrastructure and industrial plants the rapid growth creating environmental issues like pollution (Air, Water, Noise), climate change, malfunctioning and has greatly consequence for the requirement of an, operationally adaptable, efficient, cheap and smart monitoring systems. In this context where combination of many challenges of computer science, wireless communication and electronics; the Smart Sensor Networks are an emerging field of research. In this paper a solution to monitor the air and noise pollution levels in industrial environment or by using wireless embedded computing system a particular area of interest is proposed. The technology like Internet of Things (IoT) is included in the form of solution which is outcome of merged field of computer science and electronics. For monitoring the fluctuation of parameters like noise and air pollution levels from their normal levels in this case the sensing devices are connected to the embedded computing system. For the requirement of continuous monitoring, controlling and behavior analysis this model is adaptable and distributive for any infrastructural environment. The working appearance of the proposed model is evaluated using prototype implementation, consisting of AVR UNO board, sensor devices and MATLAB with AVR hardware support package. For two or three parameters like noise, CO and radiation levels the implementation is tested with respect to the normal behavior levels or given specifications which provide a monitoring over the pollution control to make the environment smart and ecofriendly. The basic mission of the Air Quality Planning and Standards is to preserve quality of air .The level of pollution in air can be measured by measuring the pollutants such as humidity level, temperature level, dust level, CO level, smoke level etc present in the air of that area. Here we propose an air quality pollution monitoring system that allows us to monitor and check live air quality in particular areas through IoT.

With the fast growing technology, it would be great to get to know about our surrounding weather parameters in this widely connected environment of internet when one can easily access the rarest and the farthest information at one's own fingertips. This project is based on IoT (Internet of Things), which is an emerging field in which all the devices are connected to a channel made by self (private channel). The channel is used to view the weather parameters with unique API key of channel of a particular user. Every channel has both Read and Write API keys to get the access. Wi-Fi module, temperature, humidity, gas, and dust sensors are interfaced with the Xmega 2560. The user is prompted to provide the API key of channel. ESP8266-01 reads the key and sends it to the Xmega 2560. If the key is matched, then the data transmission can be carried out between the channel and the microcontroller. The module is connected to the Wi-Fi through some AT Commands.

IOT ENABLED CARBON DIOXIDE AND CARBON MONOXIDE MONITORING AND CONTROL TO REDUCE AIR DETERIORATION FROM VEHICLES

Dr.T. Thimmaiah Institute of Technology, Oorgaum, KGF.

Ashwini.R, Balaji.R, Naveen.R, Sweeta.S, Dr.Palaniswamy , Electronics & Communication Engineering Department.

Year: 2019

Abstract: Due to the increase in the amount of heat trapping gases, the earth is getting Warm day by day, thus leads to global warming. CO and CO_2 are the main types greenhouse gases. The main goal of this paper is to reduce the greenhouse effect by real time monitoring and controlling of CO2 and CO emitted by vehicles and industries using IOT. The Internet of Things (IoT) provides internet connectivity to a various devices and everyday things that use embedded technology to communicate and interact with the outside environment. In this paper, here the CO2 and CO detector intelligent is used to save the CO2 and CO levels in different areas. The model is cost effective and can be easily manufactured and installation is possible where ever it is necessary.

IOT BASED AIR AND SOUND POLLUTION MONITORING SYSTEM

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY WAKNAGHAT, SOLAN – 173234

HIMACHAL PRADESH, INDIA

Nipun Aggarwal, Shashi Shekhar Shukla, Raaj

Year: 2017

Abstract: Pollution of air and sound is increasing abruptly. To bring it under control its monitoring is majorly recommended. To overcome this issue, we are introducing a system through which the level of sound and the existence of the harmful gases in the surroundings can be detected. The growing pollution at such an alarming rate has started creating trouble for the living beings, may it be high decibels or toxic gases present in the environment leaves a harmful effect on human's health and thus needs a special attention.

The main objective of IOT Air & Sound Monitoring System is that the Air and sound pollution is getting larger these days. It is necessary to detect air quality and keep it under control for a better future and healthy living for all. Therefore we initiate an air and sound pollution system that allows us to assess and examine live air quality as well as sound pollution in an area through Internet of Things. Model uses air sensor to recognise presence of harmful gases present in the atmosphere and repeatedly convey the data. Also, system keeps measuring sound level and reports it. This allows authorities to monitor air pollution in different areas and act against it. Therefore officials can keep a watch on the noise pollution near schools, hospitals and areas where noise is not allowed, and if system detects air quality and noise issues it alerts authorities so they can take measures to control the issue.

Air Quality Monitoring System

School of Computer Science and Engineering (SCOPE), Vellore Institute of Technology, Gorbachev Road, Vellore, Tamil Nadu 632014, India.

Ramik Rawal

Year: 2019

Abstract: This paper deals with measuring Air Quality using MQ135 sensor along with Carbon Monoxide CO using MQ7 sensor. Measuring Air Quality is an important element for bringing lot of awareness in the people to take care of the future generations a healthier life. Based on this, Government of India has already

taken certain measures to ban ‘Single Stroke’ and ‘Two Stroke’ Engine based motorcycles which are emitting high pollutions comparatively. We are trying to implement the same system using IoT platforms like Thingspeak or Cayenne, we can bring awareness to every individual about the harm we are doing to our environment. Already, New Delhi is remarked as the most pollution city in the world recording Air Quality above 300PPM. We have corrected the other papers where they have wrongly calibrated the sensor and wrongly projecting the PPM values. We have also used easiest platform like Thingspeak and set the dashboard to public such that everyone can come to know the Air Qualityat the location where the system is installed. Also, we have reduced the cost of components used on comparing with the papers referred.

Pollution Based Traffic Control System using Internet of Things

International journal of innovative technology and exploring engineering (IJITEE)

N V V N J Sri Lakshmi, K Durga Bhavani, O Tejaswi, K Swapna Bhanu, N Aswini, K Mahima

Year: May 2019

Abstract: Traffic congestion is the extreme concerned problem in enormous cities around the world. As the traffic increases at the signal zone area, automatically the area is polluted with harmful gases. The architecture of our proposed design is implemented on the traffic signaling junction point. In the signaling area, the road junctions are fully cooperated with the gas sensor. This gas sensor is interfaced with the ESP8266 Micro controller, which observes the traffic density and increase the time delay by traffic congestion. The circulation method of signaling system is further implemented by the extension of adding the MQ series gas sensor. By using the Wi-Fi microcontroller, the pollution data from the gas sensor is uploaded in the cloud with the service ‘ubidots’ using Internet of Things (IoT) technology. The Application programming interface (API) in the cloud will store the values of the MQ sensor data. This data will be continuous visualized in the dashboard for the incoming status of the road junction pollution. By observing the pollution at the signal area, the time interval is increased to clear the traffic. Thus, heavy traffic movement thickness is reduced and allows the citizens to flow the traffic easily.

ImplementationofanIoTBasedHomeAutomation System Using Real Time Sensors

Department of Computer Science and Engineering BRAC University, Dhaka - 1212,Bangladesh

Dipta Mandal Md. Sowad Hassan Janet Santa Joydhar

Year: December 2018

Abstract: The research aims towards a full implementation of an IoT based home automation system through data processing so that the system can take suitable action based on the circumstances without human supervision. The goal of our research is to implement the prototype system so it can detect the presence of harmful gas as well as measure temperature and humidity. The research suggests that the system will require MQ-4, MQ-9, MQ-135 gas sensors, DHT11 temperature and humidity sensor, Arduino Uno, NodeMCU ESP8266 and Arduino Nano micro-controller. After the acquisition of the data from sensors, the system will go through several steps to determine the decision. This research proposes a two stage approach that

includes the pre-processing stage and decision stage. The pre-processing stage involves acquiring and processing the data while the decision stage involves controlling the components of the home and operations of voice control using IFTTT. Moreover, for further research purpose, decision data of temperature and humidity are being stored on the cloud server.

An Arduino UNO Based Environment Monitoring System

Anas Tukur Balarabe, Abdurrashid Sani, Zahriya Lawal Hassan

(Department of Computer Science, Sokoto State University, Sokoto-Nigeria)

Year: Mar- Apr. 2019

Abstract: This paper converses a system for measuring, monitoring and estimation of some environment's parameters like temperature, humidity, and volume of CO_2. The system was developed using Arduino Uno micro-controller and its platforms. It has high level scalability and is cost-effective, which makes it suitable for other environment monitoring applications. The paper contains elaborate explanations of the overall system architecture as well as hardware and software requirements of the system. Viability of the system has also been demonstrated through presentation of some results obtained.

Pollution Monitoring & Intelligent Information Exchange System for Traffic Congestion

Faculty, Department of Electronics Engineering, PDEA's College of Engineering Manjari(Bk), Pune, India.

Prof.S.M.Banka, Abhijeet Deshmukh, Shrirang Shewale, Ashvini Deshmukh

Year: March 2016

Abstract: Today's major environmental & public issue is air pollution & traffic congestion. According to the report of World Health Organization (WHO), air pollution is significant risk factor for multiple health conditions including skin & eye infection, irritation of nose, throat & eyes. It also causes serious conditions like heart disease, lung cancer difficulty in breathing & many. Traffic congestion is also main public issue in most of metropolitan cities and that is also the reason of many problems. The main objective of project is by using various sensors, GSM module, VB & android app to design an efficient and remote system to monitoring the level of various pollutants causing pollution and to minimize the effect of these parameters without affecting the natural environment and provide live updates of traffic to avoid the traffic jams in any particular area.

Alerting and Detection of Toxic Gases in Industries using the Internet of Things

PG Student, Dept. of Electronics and Communication Engineering, Marri Laxman Reddy Institute of Technology and Management, Hyderabad, India.

Bichinapally Sruthi, E Sreenivasulu

Year: 2018

Abstract: Industries disasters are the purpose for the increasing unreliability in the human life particularly to the workers. To decrease these industries disasters, we developed a gadget that might recognize the poisonous gas and other physical condition utilizing the Internet of things (IoT). This project planned to avoided industries accident and checking the contamination control board. A central microcontroller is joined with sensors like shoot sensor, temperature, gas sensor. Sensors would be used to get the information from the environment at the leakage time. This will be utilized with single or multi dangerous gasses leakage that provides the fast resultant response time is also high. An alarm may be used to generate a sound signal

alert by industries to the nearby area living humans. If assume the level of the gasses and temperature goes above the average level than the indicated values than the alert will be provided for utilizing the internet of the web page and the android app which is created. Firstly, when the framework is developed we make one web page and an android app. Several numbers of clients who have a security ID (password) might see the information about temperature and gases leakages is an included principle advantage. This information of the sensors is stored on the internet in the equivalent website that could make utilized for future and further processing, and this will be good begin for industries to secure the humans in the surroundings and guarantee them a secured existence.

IOT ENABLED AIR POLLUTION METER WITH DIGITAL DASHBOARD ON SMART-PHONE FOR VEHICLES USING AURDINO

School of Electronics and Communication Engineering, Reva University, Bangalore, (India)

Jyoti Alagawadi, Jayashree Awati, Kirankumar Narayanpur, Vinay N.A

Year: April 2018

Abstract: Nowadays air pollution has turned out to be one of the significant issues because of increment in the quantity of vehicles and during the time spent industrialization and urbanization. This expansion in the level of contamination brings about destructive consequences for prosperity. For the most part, vehicles discharge unsafe gases like Carbon Monoxide (CO), carbon dioxide (CO2) and so on which are the significant purposes behind contamination. Thus in this paper, we are proposing a model where a gadget will be joined to silencer of vehicles. In the event that contamination produced by that vehicle is more than edge esteem proprietor will be given an implication through a sensor. On the off chance that he doesn't make any move even after two insinuations vehicle will be bolted by the gadget after 10 km and send points of interest of vehicles to RTO office.

IOT Based Pollution and Temperature Monitoring System

Department of E&TC, Parikrama College of Engineering, Kashti, Maharashtra, India.

Shaikh Ittesam R., Shirke Shital B., Tade Shruti K., Prof. Date Archana R

Year: 2018

Abstract: In this article we have discussed and analyze Internet of Things (IOT) based pollution and temperature monitoring system. This system monitoring start from traditional way to the most sophisticated computer has been used to monitor the pollution as well as temperature quality, however the fresh air,

preferable sound and temperature is necessary for all human body, for that various technology has been used and some of this technology is really useful in order to provide a real time air, sound quality and temperature data. The aim of this paper is to highlight some technology which is used for air and sound pollution monitoring and identify the important research in this important area**.**

Design and Development of a Wireless Communication Network Based Ambient Air Quality Monitoring System for Metropolitan Cities

Renuka Naik, Naganada SN and Anusha Vadde

Department of Electrical Engineering, MS Ramaiah University of Applied Sciences, Bengaluru, India

Year: 2018

Abstract: Air pollution poses a severe threat to humans and the natural environment. High levels of air pollution are linked to respiratory problems, mental illness, skin diseases etc. Monitoring air pollution to report, study and take appropriate actions to curb it is an important agenda on many civic and government institutions. This work aims to develop a capable system to cover these grounds. The system is cost effective, portable, and accurate for providing warnings in case life threatening levels of pollutants is discovered. These specifications were responsible in the selection of ATmega32 processor with Arduino UNO development board for the main air pollution monitoring unit. It is a low power controller and can be powered by solar panels. The sensors are capable of detecting CO, CO_2, Methane, dust of PM 1.0, PM10.0 and temperature and humidity are passed through a conditioning circuit and are then interfaced to the main control unit. The signals are calibrated initially to reduce erroneous detections. Short messaging service or SMS is used to wirelessly transmit data to a base station which is capable of alerting in case of a hazard. Wireless networks eliminate many limitations posed by wired networks, mainly costs related to wiring infrastructure.

Air Quality Monitoring: The Use of Arduino and Android

Journal of Modern Science and Technology

Ashish M. Husain, Tazrin Hassan Rini , Mohammed Ikramul Haque and Md. Rakibul Alam

Year: September 2016

Abstract: In this paper a cost efficient, portable, easily manageable Arduino based device has been presented to monitor air quality. The device works by collecting data of quantity of specific harmful gases and the amount of dust present in the air. This device can be located at any place and the data can be transferred to an Android phone via Bluetooth or simply by connecting the device to a PC/laptop. Data collected by the device from different places can be later examined to make further decisions and analysis about the state of air quality; furthermore, it can also help concerned individuals to act upon.

A SURVEY ON TOXIC ENVIRONMENT MONITORING USING SENSORS

Department of Electronics and Communication Engineering IFET College of Engineering, Villupuram, Tamilnadu, India.

R.Rajalakshmi, J.Vidhya, PG Scholar, Associate Professor

Year: December 2018

Abstract*:* The level of contamination has increased with times by lot of factors like the increase in population, increased vehicle use, industrialization and urbanization which results in harmful effects on human wellbeing by directly influencing health of population exposed to it. Poor environmental conditions can lead to severe health problems. Nowadays people are affected by harmful gases in perilous environment. The important of this paper is observing harmful environmental conditions for safety applications. In this paper we detailed a survey on toxic environment monitoring based on different technologies using sensors.

ONLINE MONITORING AND TRANSFERING OF GEOLOGICAL GASES DATA THROUGH ZIGBEE

Student, Department of Electronics & Instrumentation Engineering, Vignan Institute of Technology & Science, Deshmukh, Andhra Pradesh, India.

N DINESH KUMAR, B. BHAVANI & V. ANAND

Year: June 2014

Abstract: Global warming is making all the Scientists, Engineers and Doctors to think and act in each and every movement. A predictable rise on the Earth's temperature is mainly due to the carbon dioxide levels exceeding the pre-industrial threshold levels, which in turn is effecting the global climate atmospheric concentrations. The monitoring of these gases is very important for effective control of the atmosphere pollution levels to a permissible limit. The data obtained from the sensors are transferred to the receiver side through Zigbee communication. The main purpose of this paper is to implement a control system which will keep a track of the concentration of different gases, and would alert the higher authorities or control engineers in case the concentration goes above the set threshold levels. Sensor's resistance would change depending upon the concentration of the gas, which will change the voltage. This change can be tracked by the microcontroller to convert the analog data into digital data, and transfer it wirelessly to the base module.

SMOKE DETECTION USING INTERNET OF THINGS

Department of Computer Science and Engineering, K L University, Green Fields, Vaddeswaram,

Guntur, Andhra Pradesh, India..

V Rama Krishna, Ch.Maanv, pappula Ramya,Yavara Anusha

Abstract: Environmental associated issues and parameters are of maximum significance to man, and is critical to his life and impact and as a result he always seeks for a stepped forward system that would be capable of seizing and screen the changes in environmental parameters irrespective of time and area with a purpose to provide for measures so that it will forestall abnormalities and cater for emergencies. This paper provides studies paintings on a device this is capable of imparting real-time far away wildfire tracking and

SMS alert. The work aimed at the layout and implementation of a low fee, however, green and bendy wildfire monitoring and alert gadget using GSM generation. It became designed in the sort of way that the monitoring of wildfire might be executed with the use of LED and smoke sensors coupled with a manipulate unit and transmitter module all of which might be battery powered. Fireplace and smoke are sensed and measured with the aid of the sensors which ship the alerts to the manipulate unit for right processing and determination of the smoke charge. This is displayed on an LCD screen, then an alert is dispatched to the cell phone of the environmental employees via SMS whilst concurrently triggering an alarm in control room. Consequently, this system presents a continuous, actual time, remote, secure and accurate monitoring of wildfires and smoke fee, therefore ensuring the conservation and renovation of the natural world, herbal habitats, and the atmosphere, and at the same time, supporting to curb high impact human, commercial and environmental damage.

Intelligent LPG Gas Leak Detection Tool with SMS Notification

Computer Technology, Politeknik LP3I Medan, Indonesia, Industrial Engineering, Politeknik LP3I Medan, Indonesia

Muhammad Siddik Hasibuan, Syafriwel, Iswandi Idris

Year: 2019

Abstract: Gas is a molecule that is not bound, formless, and invisible and can turn into search or solid at certain temperature pressures. LPG gas is one of the needs for industry and household needs, namely for cooking. LPG gas in Indonesia is the cause of many fires; a factor that often causes LPG gas fires is a damaged gas regulator. Therefore prevention and security are needed to minimize fires. Seeing this and given the technological developments, an intelligent Arduino-based device was created that was able to overcome this problem. This tool is equipped with MQ-2, SIM800L, and buzzer gas sensors. In an embedded device the system that can convert input data received from the sensor Mq-2 sensor works to detect propane and butane gas, then the system will send the actual data in the form of short messages (SMS) to the mobile number that has been registered into the system. Besides being able to send SMS the system also emits a sound that is generated from the buzzer.

Initial Development and Testing of Microcontroller-MQ2 Gas Sensor for University Air Quality Monitoring

Electronics Engineering Department, College of Engineering and Architecture, and Faculty, Department of Physics, College of Science and Mathematics, University of Science and Technology of Southern Philippines, 9000 Philippines

Brawner Brian L. Heyasa and Van Ryan Kristopher R. Galarpe

Year: June 2017

Abstract: Typical air quality monitoring system involved the use of expensive instruments often accessed through the Philippines Department of Environment and Natural Resources (DENR), leading to limited

locale based air quality monitoring system. To address the need this study was conducted utilizing microcontroller (arduino-Uno)-MQ2 gas sensor. The initial stage included preliminary development of premade devices, coding, and testing on site. The testing was conducted in the University of Science and Technology of Southern Philippines (USTP)-Science complex on March, 2017 with preselected dates. Result showed Rs/Ro ratio within the appreciable range for air quality. Overall, the study served as neo monitoring system for air quality locally and potential use can be maximized. However, it is preliminary in nature and needing improvement.

Poisonous Gas Detector with Electrochemical Nose

Department of Electrical and Electronics Engineering, GKM college of Engineering and Technology, Tamilnadu, India.

Dr.Thangalakshmi.S , Kathiravan.A.R

Year: April 2016

Abstract: Poisonous Gas Detector is used to detect the harmful gases in an area for safety purposes. The proposed device is used to detect the various poisonous gas leakages and alert people so that they can be evacuated immediately to save the life. This device uses the electrochemical sensor which is sensitive to poisonous and flammable gases such as CH_4 (Methane), CO (carbon monoxide), H2S (Hydrogen sulphide), C_3H_8 (Propane), LPG (Liquefied Petroleum Gas). Already there are devices existing in the market for the same purpose but they are costly. Also they fail to detect many gases. The proposed model in this paper is cost effective and efficient. Moreover, the rate of response is high. Hence this device may be used as a multi gas detection apparatus. The proposed device is designed and controlled with the help of Atmel Atmega 328p_pu micro controller. It is programmed and tested with Atmel ICE and Arduino IDE. The circuit is tested with LPG gas which resulted in quick response. This device is used to detect the poisonous gases in sewage, LPG leakage in home, leakage of poisonous gas in industries, formation of poisonous gas in Mines, and cleaning the hazardous leftovers. A DC motor is connected to the device which is used into the sewage manhole to detect gases at different level thereby avoiding human usage in manholes.

A REAL TIME GAS MONITORING SYSTEM- A SURVEY

Department of Electronics and Communication Engineering Saveetha School of Engineering, Saveetha University, Chennai.

V.Kameshwaran, D.Nareshkumar, K.Rampatel, Radhika Baskar, P.C.Kishore Raja

Year: September 2016

Abstract: The main aim of this paper is to survey the different kinds of gas monitoring systems implemented in various applications to prevent from dangers. The gas monitoring system is based on both wired and wireless sensor technology. Leakage of gases may cause fatal fire accidents and hazardous condition is the major issue nowadays. The leakage of every gas is monitored through gas monitoring system to avoid such condition. This type of monitoring system can be helpful in hospitals, homes, hotels and many commercial places.

Android Based Real-Time Industrial Emission Monitoring System Using IoT Technology

Malayan Colleges Laguna, Pulo Diezmo Road, Cabuyao City, Laguna 4025, Philippines

Dennis A. Martillano, Joshua Miguel R. Dita, Christian G. Cruz, and Kunal S. Sadhra

Year: November 2017

Abstract*:* The need to industrialize to compete with global standards is a complete requisite to realize a booming economy. However, there is no question that it has wreaked havoc on the environment caused industrial emissions of dangerous chemicals. This study aimed to create a system that will allow Industrial plants and factories to monitor the emission of the smoke stacks held in a manufacturing company anytime, anywhere using IoT or Internet of Things Technology. IoT is a system of physical things embedded with different sensors, software, electronics and connectivity to allow it to perform better by exchanging information with other connected devices. This will help companies in maintaining the machine and provide them emission data of gaseous elements such as carbon monoxide, particulate matter, sulphur and nitrogen dioxide that will help them in complying with the environmental standards of industrial emission. Enabling manufacturing companies to gather plot and interpret data using the system which could be used to further improve emission output and make necessary decisions and corrective actions while imposing cleaner air will benefit the company, the people and the environment.

Design of Iot Based Coal Mine Safety System Using NodeMCU

International journal of innovative technology and exploring engineering (IJITEE)

Boddapati Venkata Sai Phani Gopal, Pakirabad Akash, P.S.G.Aruna Sri

Year: April 2019

Abstract: In this paper, a coal mine safety system is implemented using a Thinger Io platform as a medium to transmit the data. The system is implemented to monitor and control various parameters in the coal mines such as light detection, leakage of gas, temperature and humidity conditions, Fire detection in the coal mine. These all sensors are together considered as one unit and are placed in the coal mines. All the esteems of the sensors are continuously uploaded to the thinger for analysis. Here the gas is continuously monitored if any uncertainties in the level of gas arise, then buzzer is used to alert the workers. In this system LDR sensor is utilized to detect the presence of light. Automatically light gets one and can be controlled using the LED button. In case if any fire occurs in the coal mine, then an alert notification is sent to the mail of the authorized person. Temperature and humidity values are also continuously monitored and displayed on the serial monitor and also in the thinger platform. The developed system is mainly implemented to improve the working condition inside the coal mines and also to ensure workers safety.

IoT Based Coal Mining Safety for Workers using Arduino

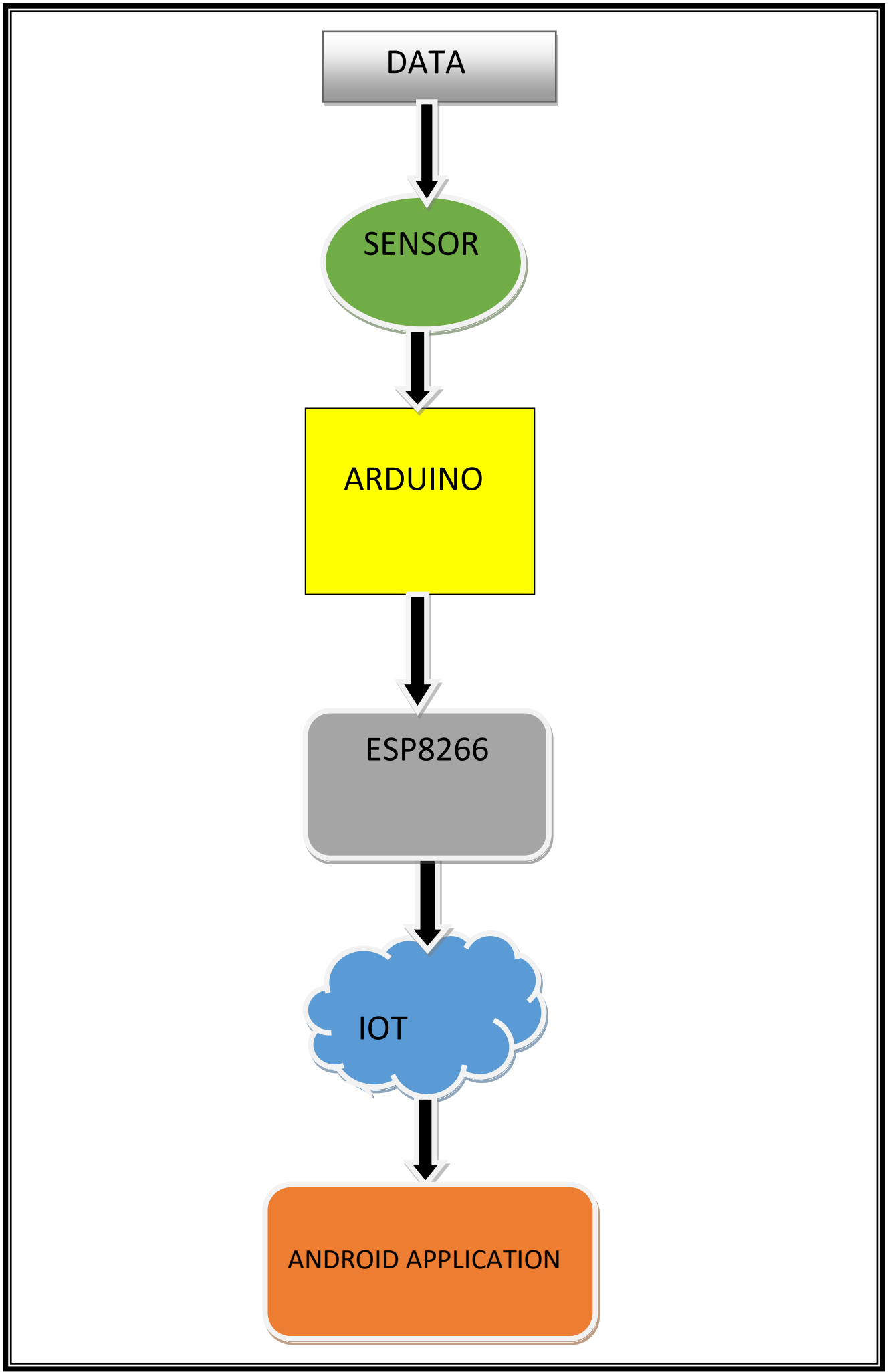
Department of Computer Science and Engineering SRM Institute of Science and Technology, Chennai, India.

D. Prabhu, V. Naga Nikhil, J. Shiva Kumar

Year: 2019

Abstract: Mines are the world's most dangerous place to work because in the mines, explosion often happens and thousand people are dying. And a recent report states that in such mine accidents an average of around 12,000 people have died. This plan will be useful to them in remote locations during the crisis. In this paper given an overview of IoT based coal mining safety for workers using IoT and Arduino. Apart from this, it consists of LDR, Gas sensor, Temperature and Humidity sensor which are used to monitor the underground hazards. In this paper, we mainly focused on the hazards monitoring, all the sensor values compared with the received data from the sensor with safety limits and if any hazards detected, and the ground section will be given the necessary alert.

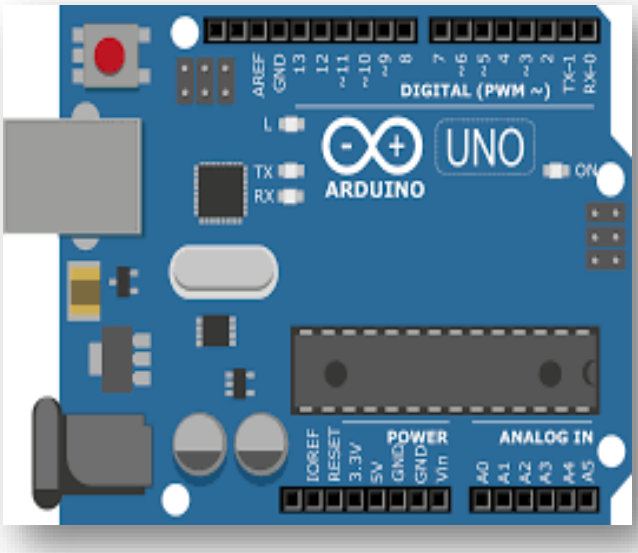
CHAPTER 3
BLOCK DIAGRAM


DATA
SENSOR
ARDUINO
ESP8266
IOT
ANDROID APPLICATION

(I) MQ135 GAS SENSOR

The MQ-135 Gas sensors are used in air quality control equipments and are suitable for detecting or measuring of NH3, NOx, Alcohol, Benzene, Smoke, CO2 etc. The MQ-135 sensor module 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. If you need to measure the gases in PPM the analog pin need to be used. The analog pin is TTL driven and works on 5V and so can be used with most common microcontrollers.

(2) ARDUINO UNO BOARD



The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

ESP832

The ESP32 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

(3)IOT

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The Internet of things (Iot) is a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. The definition of the Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems.

ANDROID APPLICATION

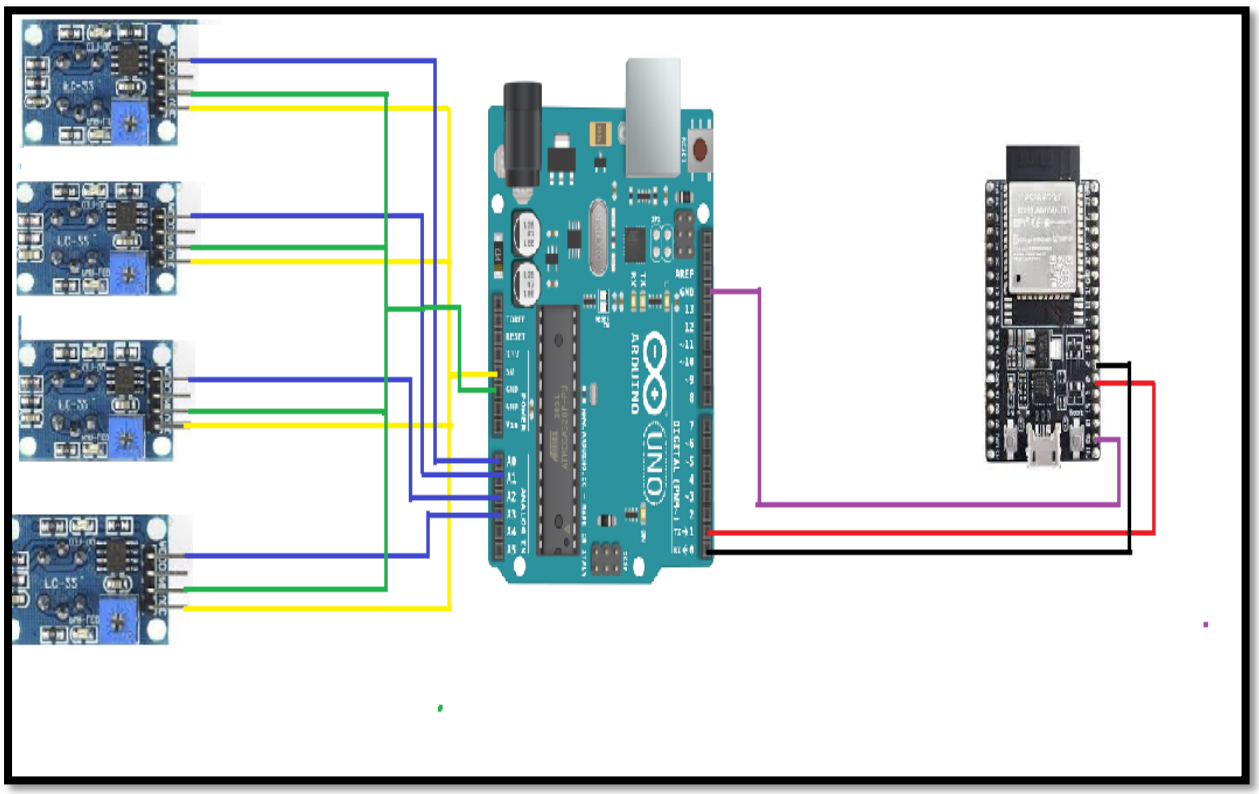
The android is a powerful operating system and it supports large number of applications in Smartphone's. These applications are more comfortable and advanced for the users. Mobile apps can be used to increase customer loyalty because it allows businesses to communicate directly with their customers via In-app purchases, ads, promotions, and notifications sent to customers' phone via mobile apps.

(ii) BLOCK DIAGRAM EXPLINATION

- In the above system the sensor will detect the gas and send the data to the arduino board which is connected to it.
- Later the arduino Uno board will send the data to esp32 which will upload it to the cloud
- The data will be uploaded on the thingspeak
- Later the user can access the data on their mobile phone through an app

CHAPTER 4

CIRCUIT DIAGRAM



CIRCUIT DIAGRAM

- In the above circuit diagram the mq135 sensors are connected in parallel to the arduino Uno board
- A0 of sensor 1 is given to the A0 of arduino board
- A0 of second sensor is given to the A1 of arduino board
- A0 of third sensor is given to the A2 of arduino board
- A0 of fourth sensor is given to the A3 of arduino board
- The ground of ESP32 board is connected to the ground of arduino board
- The TX of arduino board is connected to the RX of ESP32 board
- The RX of arduino board is connected to the TX of ESP32 board

CHAPTER 5

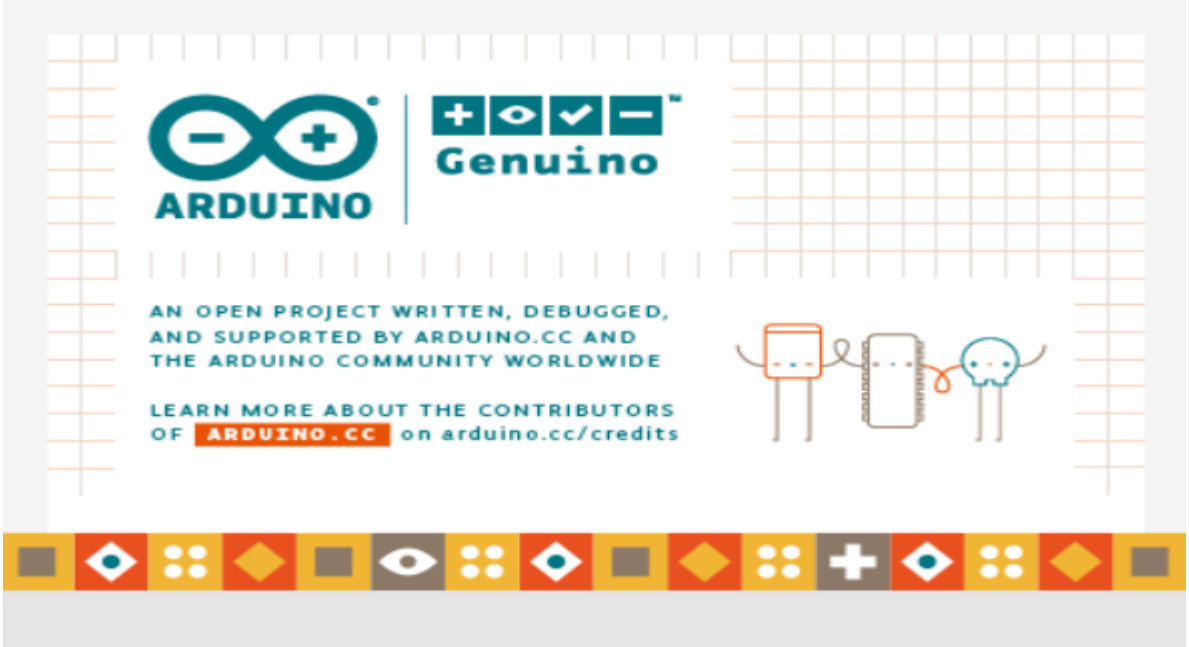
METHODOLOGY

Methodology

The proposed device consists of four sensors that were used to monitor the air quality. MQ-135 gas sensors were used to detect the type of gases present in the air. The sensors are connected to Arduino Uno board and when the Arduino is powered on, the sensors start to generate data continuously in real time. The data is transferred to the Iot with the help of Esp8266 device later creating an account on thingspeak. For transferring data to an Android device, the user would simply have to download the blynk app. The data mainly consists of air pollutant intensity values. Higher values indicate higher air pollutants and vice versa. The block diagram of the whole system is shown below.

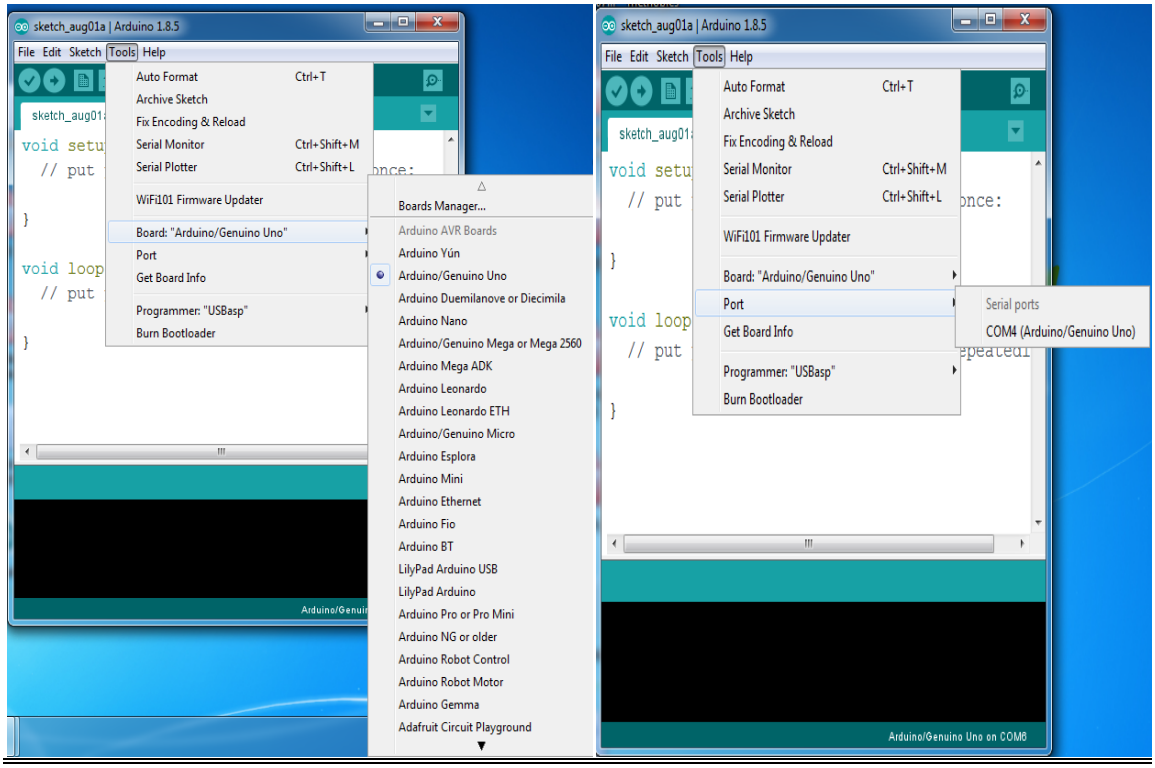
SOFTWARE USED

- The programming for this project is done by using Arduino IDE software.
- It is open source software which can be used by many boards.
- It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.



- Download the arduino IDEE software
- Install the software

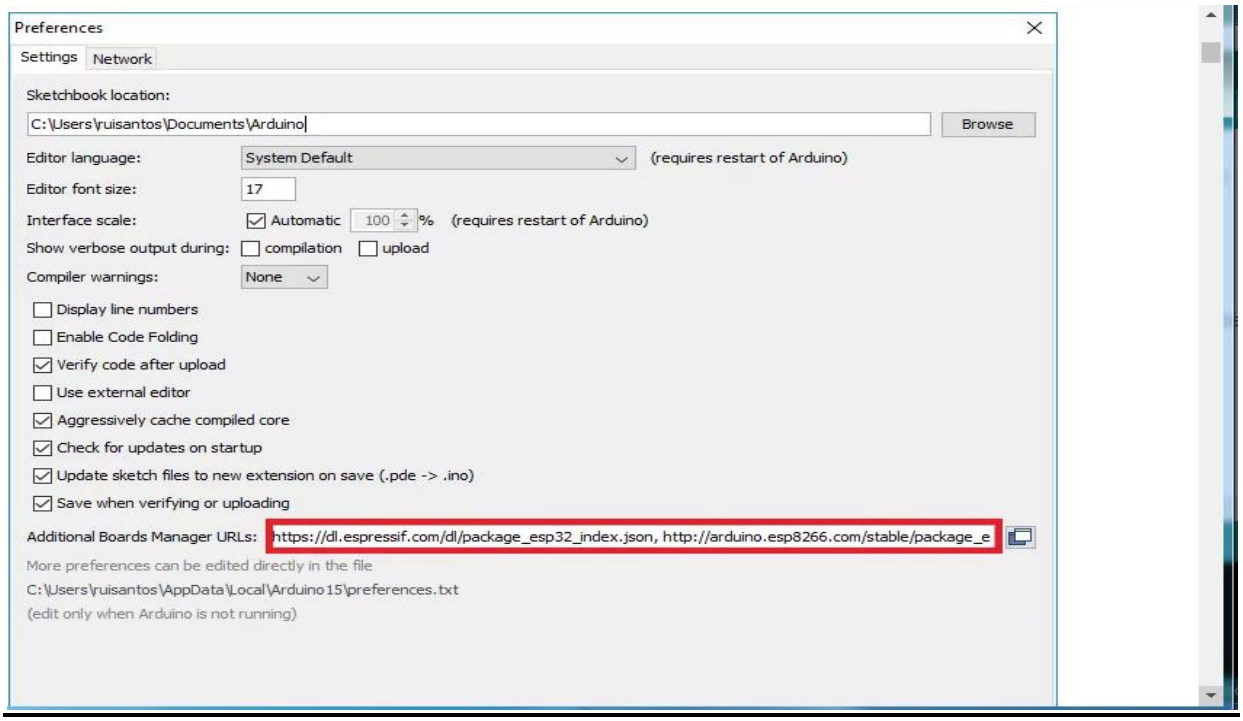
Step 1



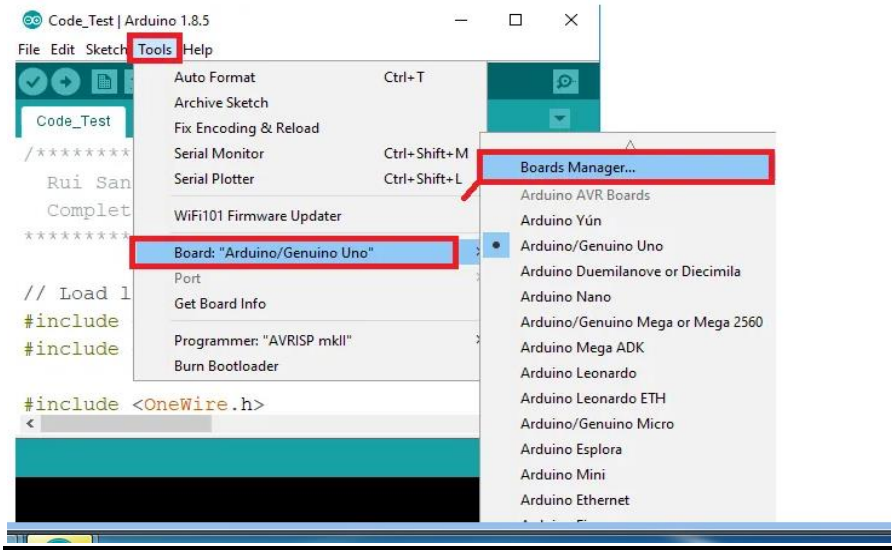
- Connect the arduino Uno board to the PC
- Click on file new
- Then go to tools and select the arduino genuine Uno board
- Then click on port and select the COM port.
- Go back to file and paste your code there and save the file
- Then go to tools select the Arduino Uno board then select the com port
- Run the program and upload it on the arduino Uno board

Install the ESP32 Library on arduino IDE

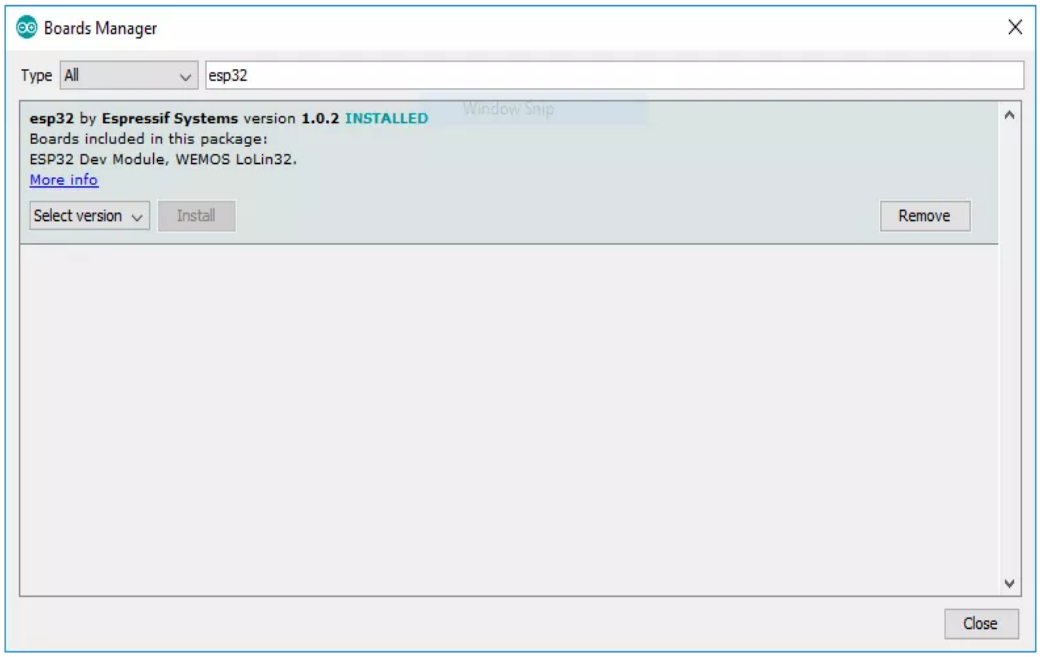
- Open Arduino IDE go to file > preferences
- Enter the given URL and click ok.



- Open the board manager >tools>board>board manager.



- Search for ESP32 and press install button for the ESP32 by espressif system.



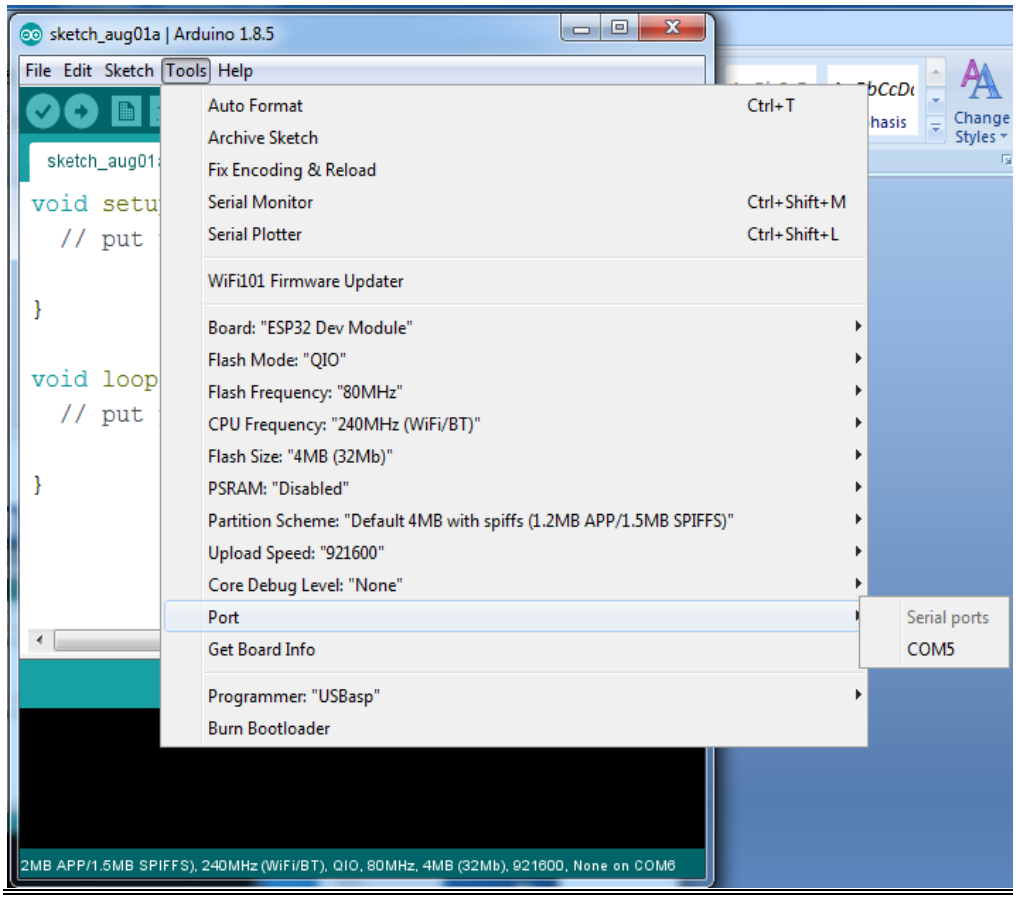
- ESP32 will be installed
- Now click on file new> tools> select ESP32 DEVKIT VI>select com port
- Now paste the arduino code in the code given below
- Remove the mqtt lines and paste the code here and run it.

```
#include <WiFi.h>
#include <PubSubClient.h>
#include <ArduinoJson.h>

// Update these with values suitable for your network.
const char* ssid = "ENTER-SSID";
const char* password = "ENTER-PASSKEY";
const char* mqtt_server = "ENTER-IP-ADDRESS";
#define mqtt_port 1883
#define MQTT_USER "surgemq"
#define MQTT_PASSWORD "verysecret"
#define MQTT_SERIAL_PUBLISH_CH "send"
#define MQTT_SERIAL_RECEIVER_CH "rec"
#define ID_MAP_LENGTH 5


//GPIO Config
/* LED pin */
byte ledPin = 14;
/* pin that is attached to interrupt */
byte interruptPin = 12;
/* hold the state of LED when toggling */
volatile byte state = LOW;


WiFiClient wifiClient;
/*id - GPIO
 * 1 - 4
```

```
/*id - GPIO
 * 1 - 4
 * 2 - 5
 * 3 - 16
 * 4 - 17
 */
int iomap[ID_MAP_LENGTH]={0,4,5,16,17};

PubSubClient client(wifiClient);

void setup_wifi() {
    delay(10);
    // We start by connecting to a WiFi network
    Serial.println();
    Serial.print("Connecting to ");
    Serial.println(ssid);
    WiFi.begin(ssid, password);
    while (WiFi.status() != WL_CONNECTED) {
      delay(500);
      Serial.print(".");
    }
    randomSeed(micros());
    Serial.println("");
    Serial.println("WiFi connected");
    Serial.println("IP address: ");
    Serial.println(WiFi.localIP());
}

void reconnect() {
```

The code mentioned above is the Code for ESP32

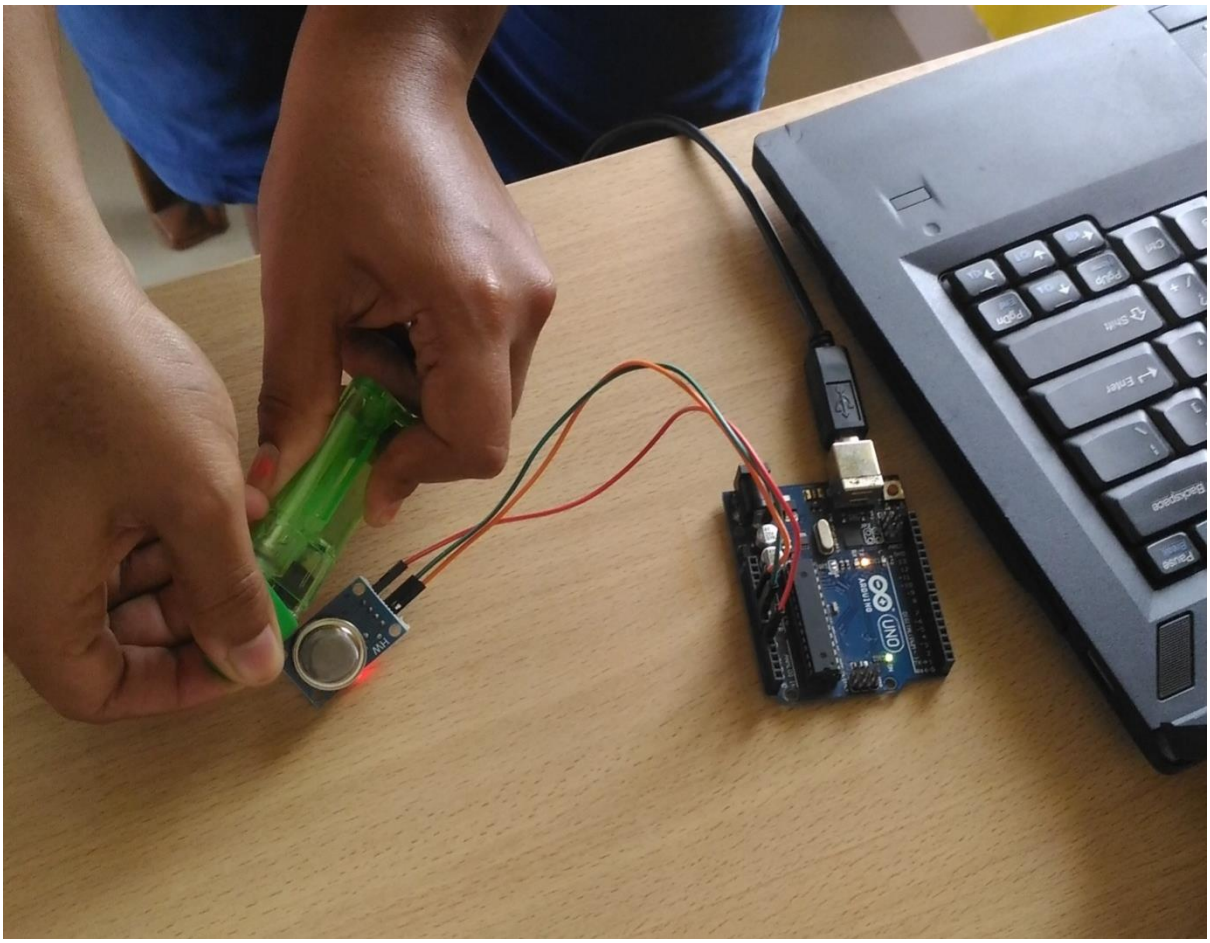
Step 2



- Now go to file new
- Then click on tools and select the ESP32 board
- Select the com port
- Run the program and upload it.

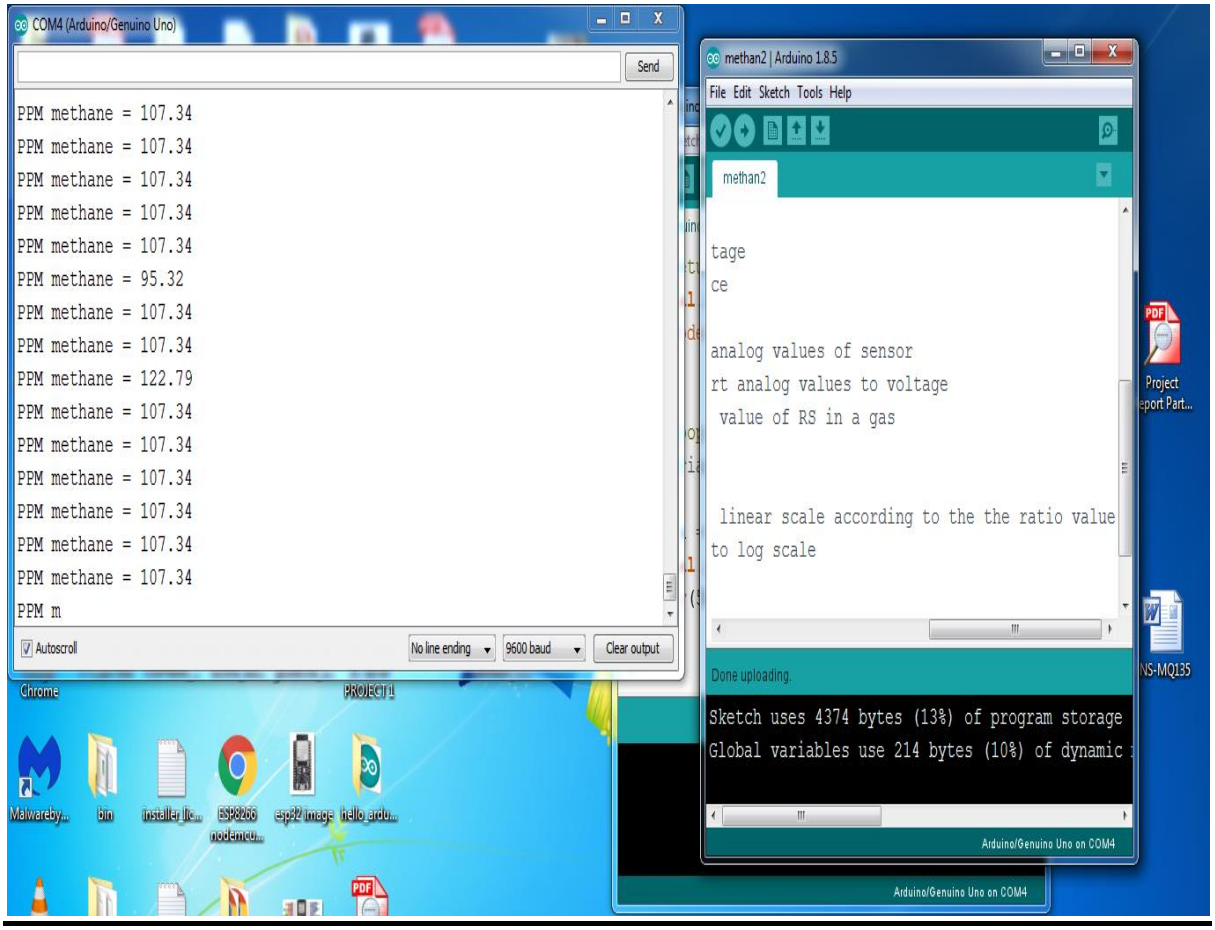
Step 3

For detecting a single gas at a time



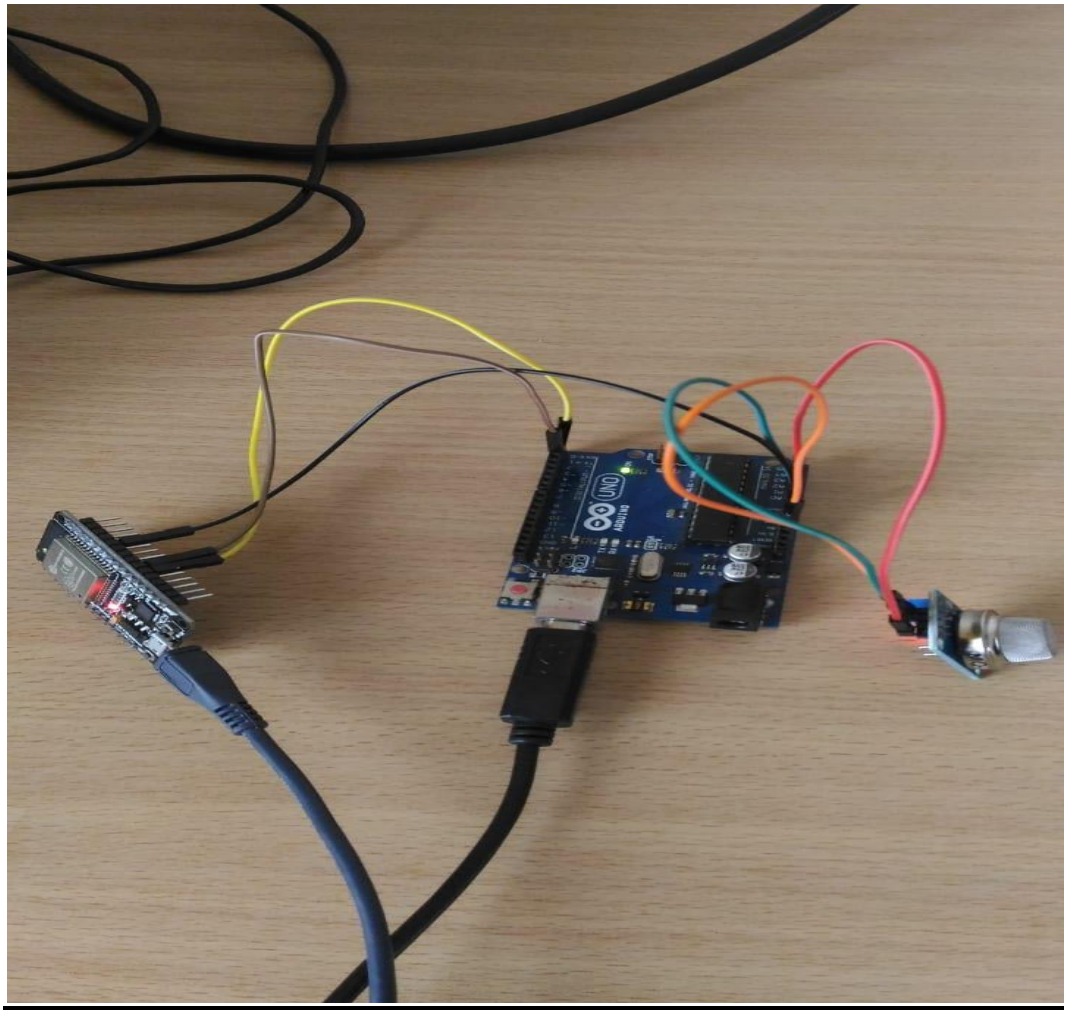
- Connect the mq135 gas sensor with arduino Uno board.
- Connect the pins of the sensor to arduino Uno board.
- The AO of the sensor should be connected to the AO of the arduino Uno board
- The Vcc pin of the sensor should be connected to the 5V pin of the Arduino board
- The GND of the sensor should be connected to the ground of the Arduino board.
- Open arduino IDE go to file, new. Then paste the code here, save it and run the code.
- Then get the methane gas close to the sensor.
- You can observe that the sensor is detecting the methane gas.

Step 4



- The above figure shows the ppm concentration of methane gas.
- Its different values are obtained depending on the gas concentration.
- At the initial stage the sensor showed a random value of 90ppm
- As it was exposed to the gas the ppm level started increasing.

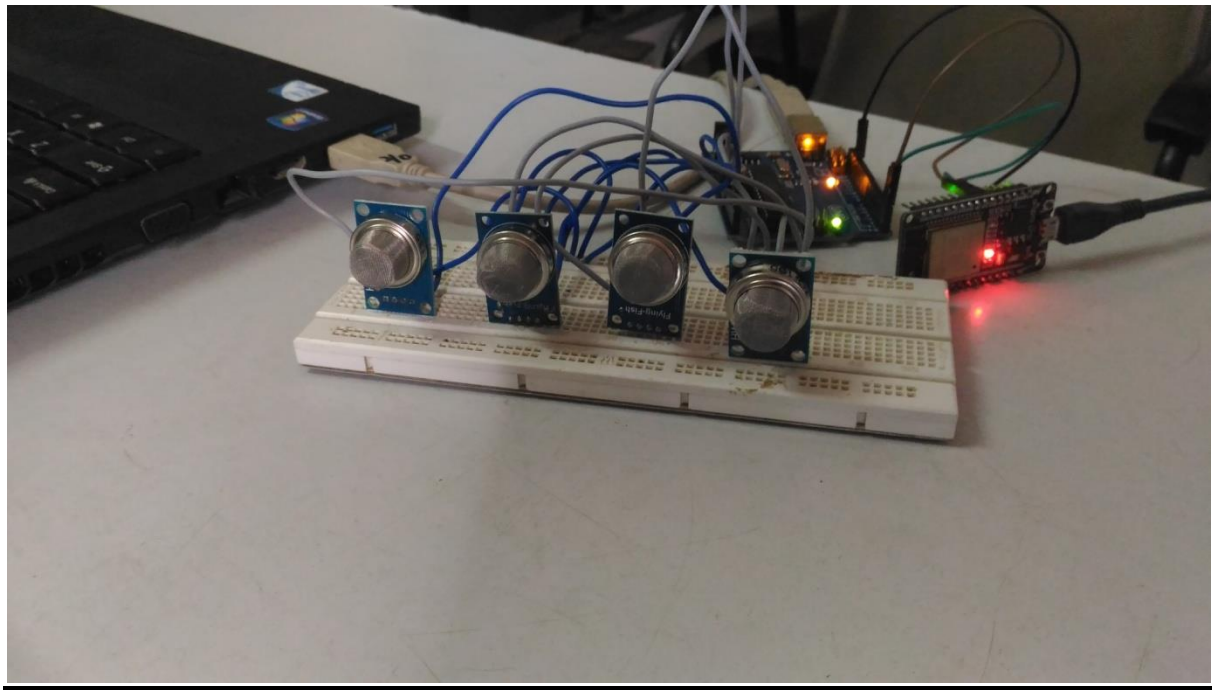
Step 5



Connecting Arduino Uno to ESP32

- This data will be uploaded on things peak cloud with the help of ESP8266 wifi module.
- This wifi module uploads data on the cloud by getting connected on internet using mobile hotspot server.
- The thingspeak API keys are needed for uploading the data on the cloud.

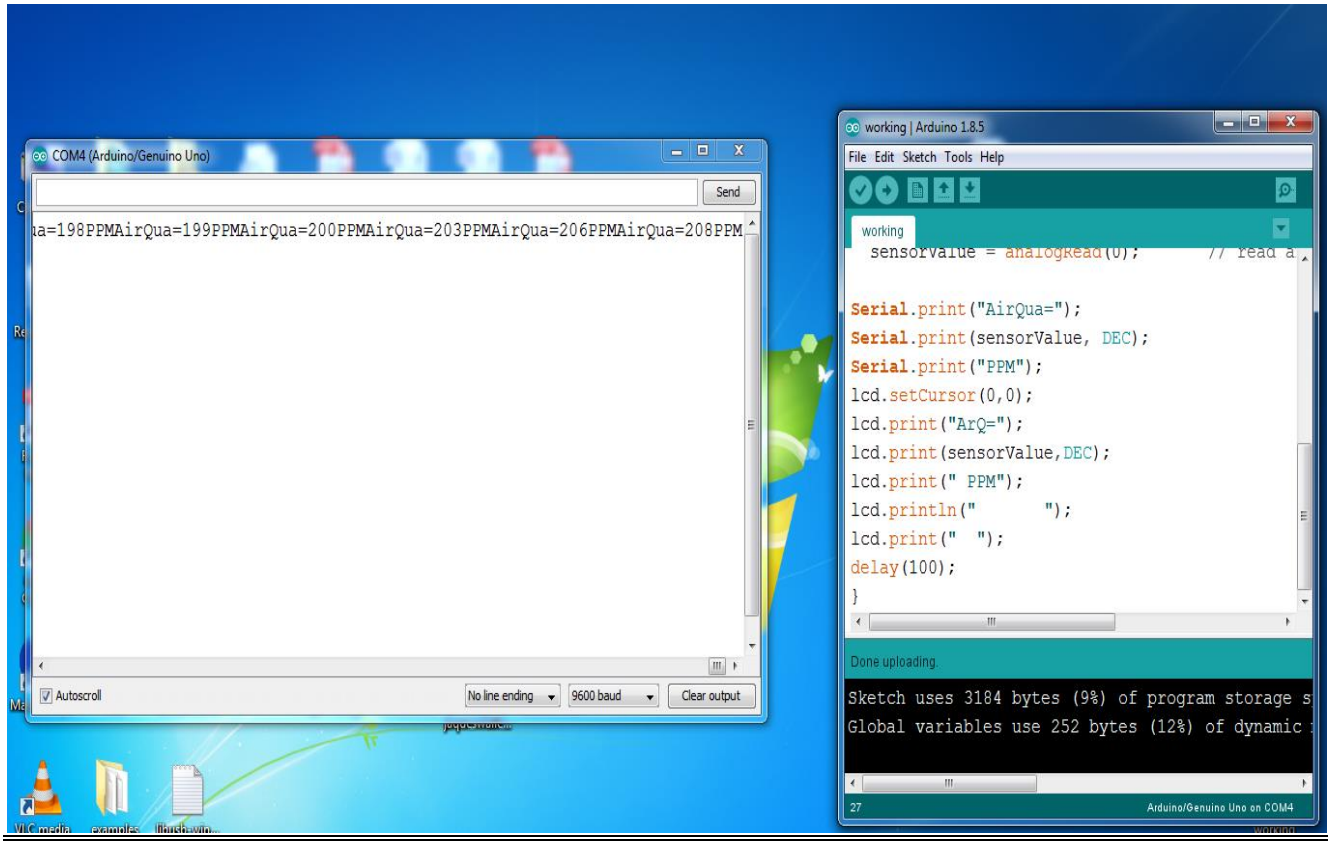
Step 6



Connecting mq135 sensors together for the detection of different gases

- Connect the mq135 sensors in parallel
- The GND of all the sensors is given to the GND of Arduino Uno board
- The VCC pins of all the sensors is given to the 5V pin of Arduino Uno board
- The AO pin of one sensor is given to the AO pin of Arduino
- The AO pin of second sensor is given to the A1 pin of Arduino
- The AO pin of third sensor is given to the A2 pin of Arduino
- The AO pin of fourth sensor is given to the A3 pin of Arduino
- The TX pin of the Arduino board is connected to the RX of ESP32
- The RX pin of Arduino board is connected to the TX of ESP32
- The GND of Arduino board is connected to the RX of ESP32

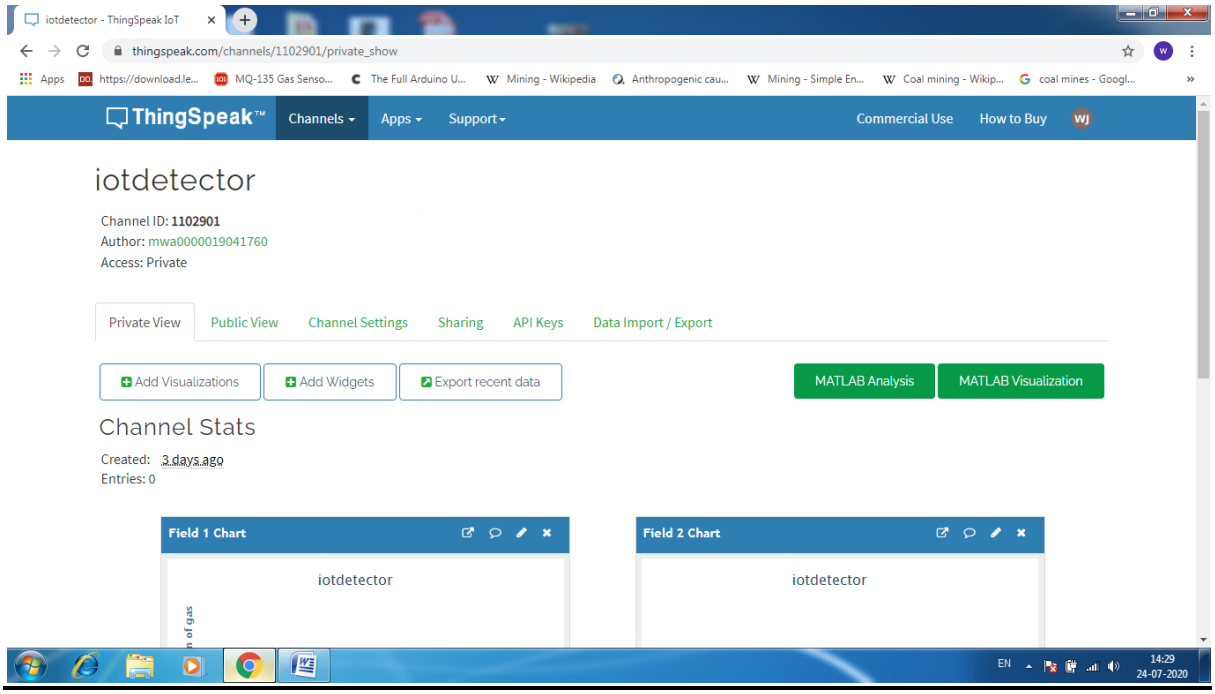
Step 7



- Here the ppm level of methane gas was obtained
- The ppm level was increasing depending upon the concentration of the gas
- At the initial stage the sensor showed a random value of 180 ppm.
- As it was exposed to the gas the ppm level started increasing.

Step 8

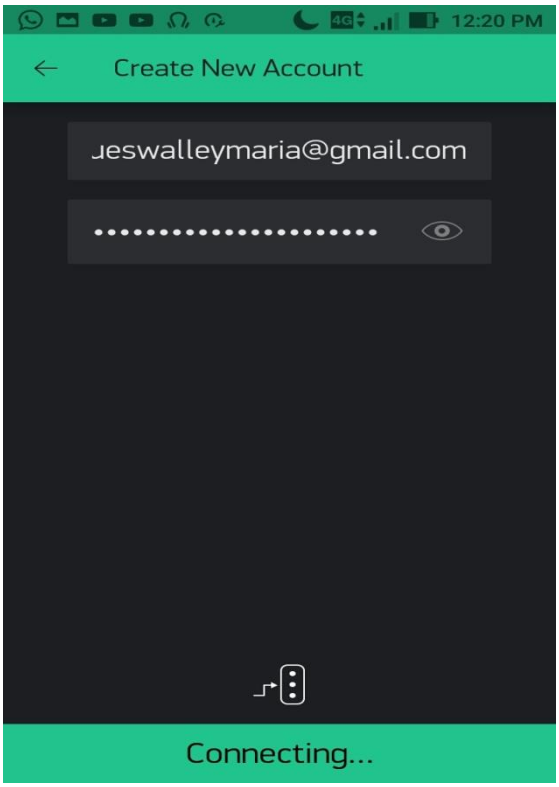
Creating account on thingspeak

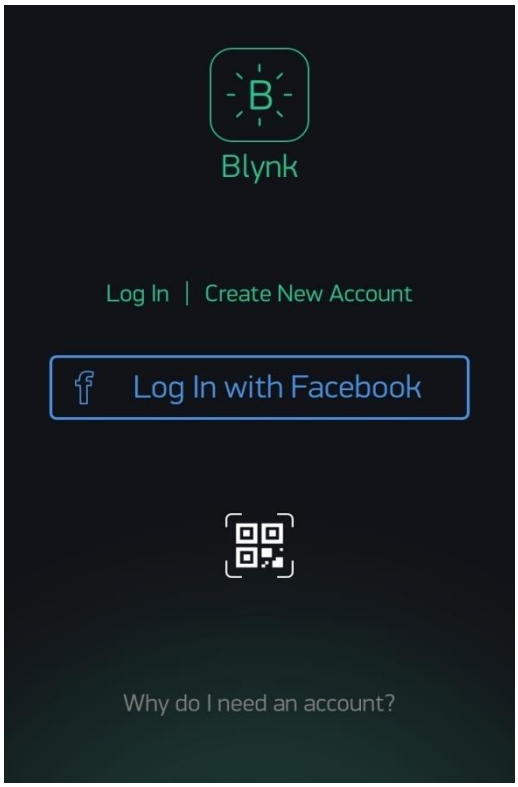


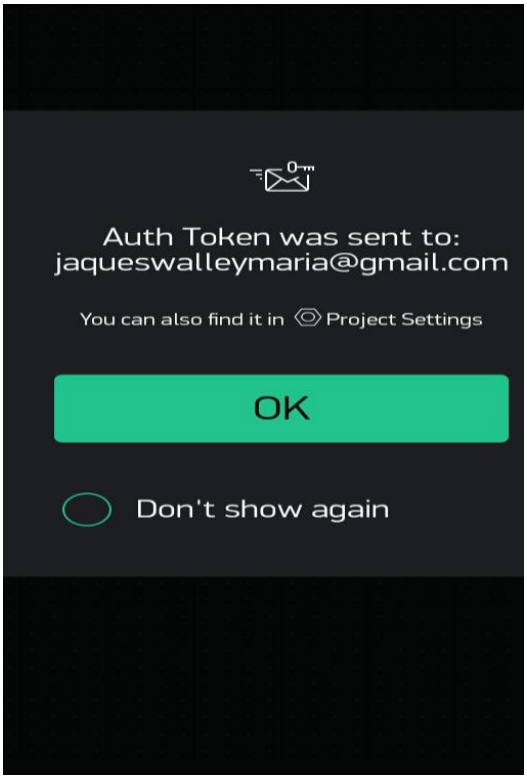
- Thingspeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP and MQTT protocol over the Internet or via a Local Area Network.
- Thingspeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates.
- Once we create account on thingspeak two API keys will be generated
- Which have to be added in the code
- Later the data will available on the thingspeak.

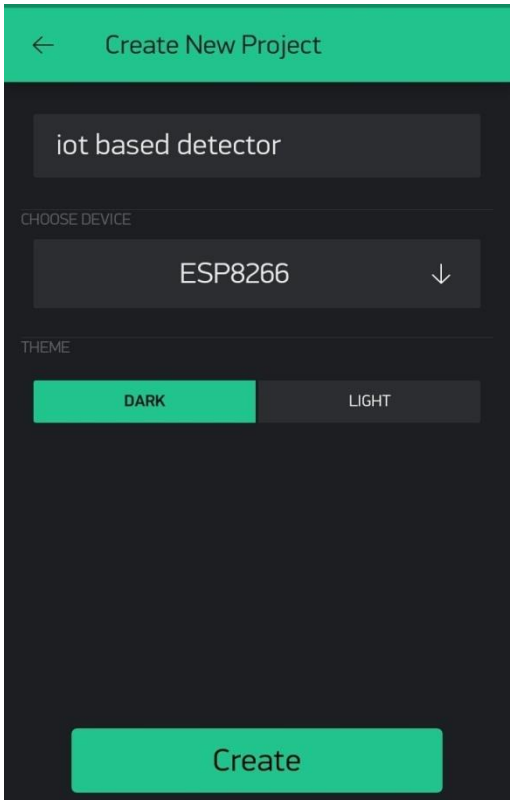
Step 9

Create account on blink









- Download the blink app on your android device and login
- Create an account here we will get a link which has to be pasted in our code.
- click on create project and name the project and select the board
- there are different tools available depending on which you can create your layout

CHAPTER 6

TEST RESULTS AND ANALYSIS

At the initial stage the sensor value was 90.55 as soon as methane gas was released the ppm level started increasing and reached a maximum of 107.33. Later after the gas concentration was decreased it was observed that the ppm levels were also decreasing

GAS	**PPM**
Methane	90.55
Methane	90.55
Methane	91.88
Methane	92.77
Methane	92.77
Methane	93.88
Methane	94.22
Methane	97.99
Methane	98.33
Methane	99.11
Methane	101.88
Methane	102.33
Methane	103.99
Methane	105.66
Methane	105.99
Methane	106.66
Methane	106.88
Methane	107.33
Methane	107.33

When the sensors were connected in parallel methane gas was released the sensor detected the gas and it was observed that the ppm level of the gas went on increasing .at the initial stage the ppm was 180 and later the ppm level was above 200 and as the gas concentration decreased it was observed that the ppm levels were also decreasing.

GAS	PPM
Methane	180.44
Methane	180.44
Methane	190
Methane	190
Methane	190
Methane	191
Methane	191
Methane	192
Methane	192
Methane	193
Methane	195
Methane	196
Methane	198
Methane	201

CHAPTER 7

CONCLUSION

Methane gas was detected using the mq135 gas sensors module. For methane ppm levels were obtained. When connected in parallel the sensor was detecting the type of gas present in its surrounding and the ppm levels of the gas were obtained. From this we can conclude that mq135 gas sensor can be used for different gas monitoring purposes.

CHAPTER 8

APPLICATIONS

- It can be used in industries, mining areas, chemical factories, research labs etc.
- This device can be used in any field to detect pollution levels are high and when a particular gas is to be known.
- This device can be used to detect the presence of gases in an area, often as part of a safety system.
- This type of equipment is used to detect a gas leak or other emissions and can also be interface with a control system so a process can be automatically shut down.
- A gas detector can sound an alarm or an alert sms to operators in the area where the leak is occurring, giving them the opportunity to leave.
- Array sensors have got a wide application in detecting signals.
- . Another application of array sensor is to estimate the direction of arrival of impinging electromagnetic waves.

CHAPTER 9

CODE FOR ARDUINO

Code for Arduino

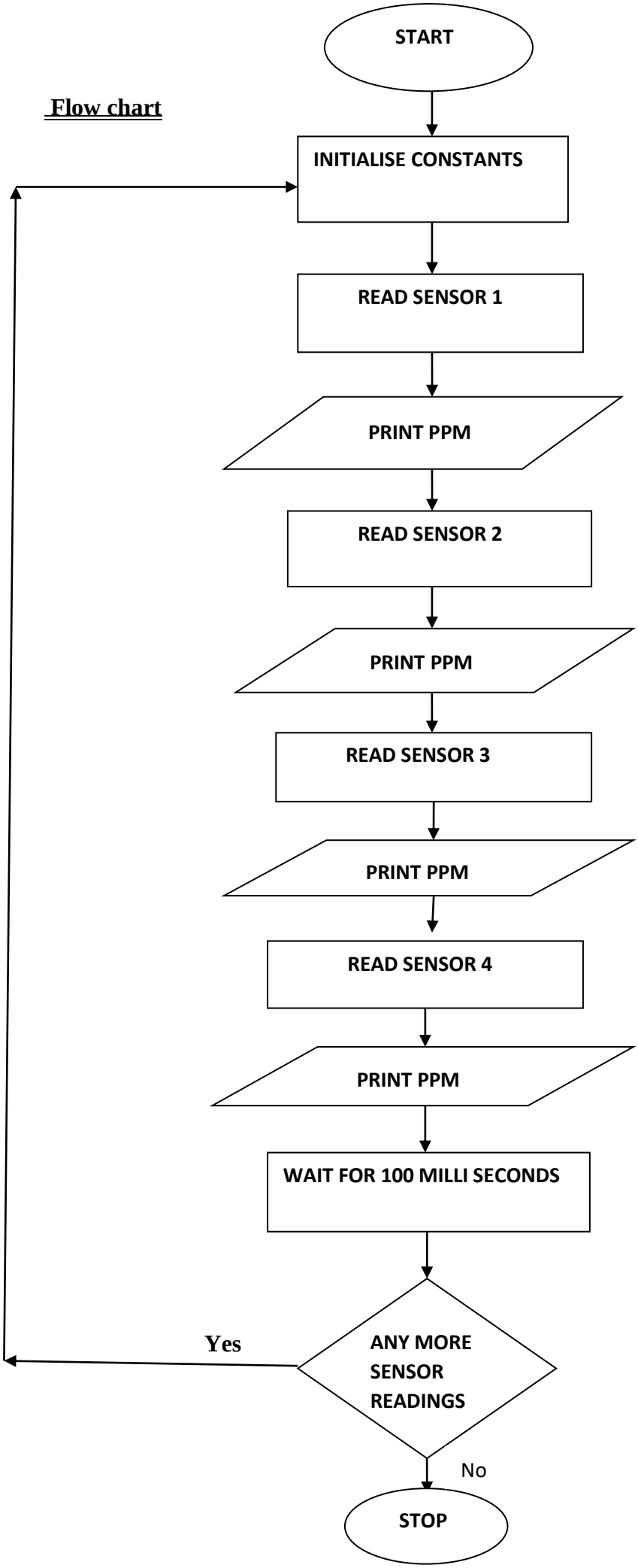
```
#include <LiquidCrystal.h>
int Sv0,Sv1,Sv2,Sv3;
constintrs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystallcd(rs, en, d4, d5, d6, d7);

void setup()
{
lcd.begin(16, 2);
Serial.begin(9600);
}
                    // sets the serial port to 9600

void loop()
{
  Sv0= analogRead(0);
Sv1=analogRead(1);
  Sv2=analogRead(2);
Sv3=analogRead(3)
// read analog input pin 0,1,2,3

Serial.print("AirQua=");
Serial.print(Sv0, DEC);              // prints the value read
Serial.print("PPM");
Serial.print(“parameter2”);
Serial.print(Sv1,DEC);
Serial.print(“SI unit”);
Serial.print(“parameter3”);
Serial.print(Sv2,DEC);
Serial.print(“SI unit”);
Serial.print(“parameter4”);
```

```
Serial.print(Sv3,DEC);
Serial.print(“SI unit”);
lcd.setCursor(0,0);
lcd.print("ArQ=");
lcd.print(sensorValue,DEC);
lcd.print(" PPM");
lcd.println("      ");
lcd.print("  ");
delay(100);                          // wait 100ms for next reading
}
```

CHAPTER 10

FLOW CHART

Flow chart


START
INITIALISE CONSTANTS
READ SENSOR 1
PRINT PPM
READ SENSOR 2
PRINT PPM
READ SENSOR 3
PRINT PPM
READ SENSOR 4
PRINT PPM
WAIT FOR 100 MILLI SECONDS
ANY MORE SENSOR READINGS
Yes
No
STOP

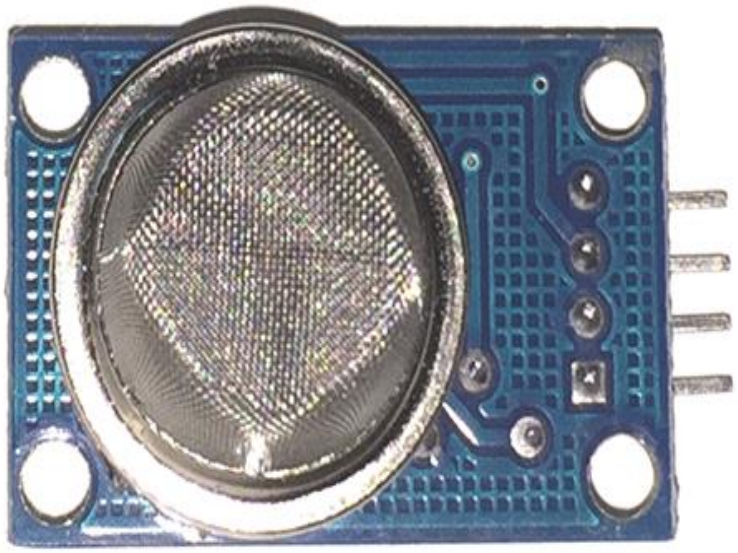
CHAPTER: 11

APPENDIX

THE MAIN BLOCKS OF THE SYSTEM ARE

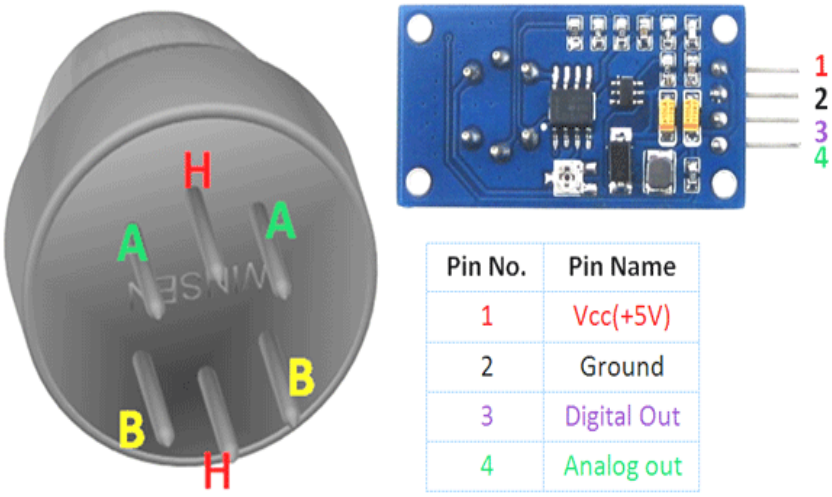
- MQ135GAS SENSOR
- Arduino Uno board
- Wi-Fi Module ESP 8266
- Iot
- Android application

MQ135 GAS SENSOR



MQ-135 Gas Sensor/Module

MQ135 Air quality sensor is used for detecting a wide range of gases, including NH3, NOx, alcohol, benzene, smoke and CO2. Ideal for use in office or factory. MQ135 gas sensor has high sensitivity to Ammonia, Sulphide and Benzene steam, also sensitive to smoke and other harmful gases.



MQ-135 Gas Sensor Pin out

Pin Configuration:

Pin No:	Pin Name:	Description
For Module		
1	Vcc	Used to power the sensor, Generally 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.
For Sensor		
1	H –Pins	Out of the two H pins, one pin is connected to supply and the other to ground
2	A-Pins	The A pins and B pins are interchangeable. These pins will be tied to the Supply voltage.

3	B-Pins	13031. A pins and B pins are interchangeable. One pin will act as output while the other will be pulled to ground.

MQ-135 Sensor Features

- Wide detecting scope
- Fast response and High sensitivity
- Stable and long life
- Operating Voltage is +5V
- Detect/Measure NH3, NOx, alcohol, Benzene, smoke, CO2, etc.
- 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

How to use MQ-135 Sensors to detect gases

You can either use the digital pin or the analog pin to do this. Simply power the module with 5V and you should notice the power LED on the module to glow and when no gas it detected the output LED will remain turned off meaning the digital output pin will be 0V. Remember that these sensors have to be kept on for pre-heating time (mentioned in features above) before you can actually work with it. Now, introduce the sensor to the gas you want to detect and you should see the output LED to go high along with the digital pin, if not use the potentiometer until the output gets high. Now every time your sensor gets introduced to this gas at this particular concentration the digital pin will go high (5V) else will remain low (0V).

we can also use the analog pin to achieve the same thing. Read the analog values (0-5V) using a microcontroller, this value will be directly proportional to the concentration of the gas to which the sensor detects. We can experiment with this values and check how the sensor reacts to different concentration of gas and develop your program accordingly.

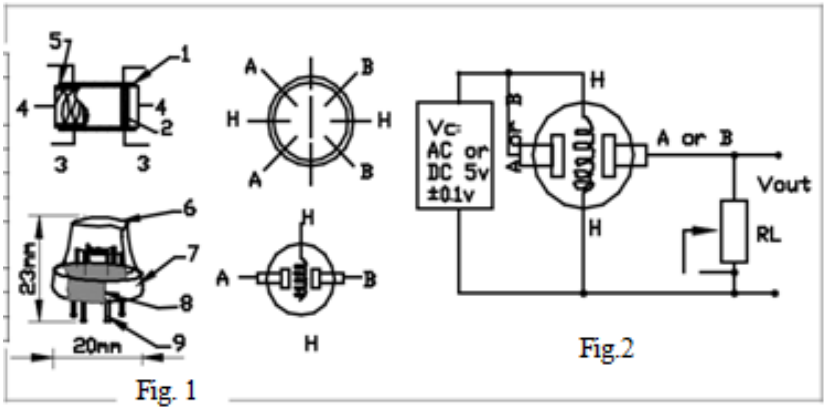
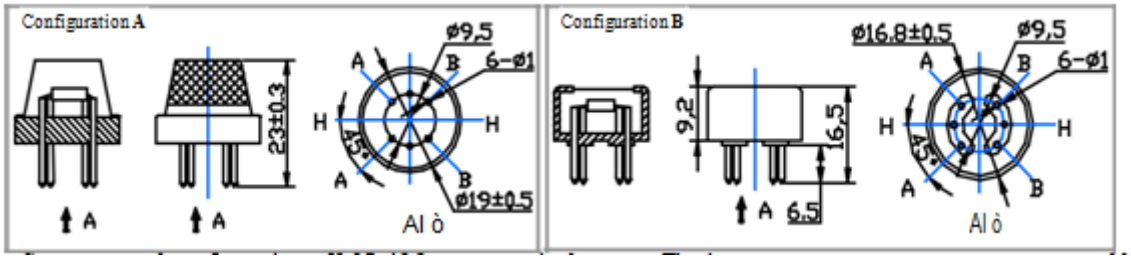


Fig. 1 Fig.2

	PARTS	MATERIALS
1	Gas sensing layer	SnO_2
2	Electrode	Au

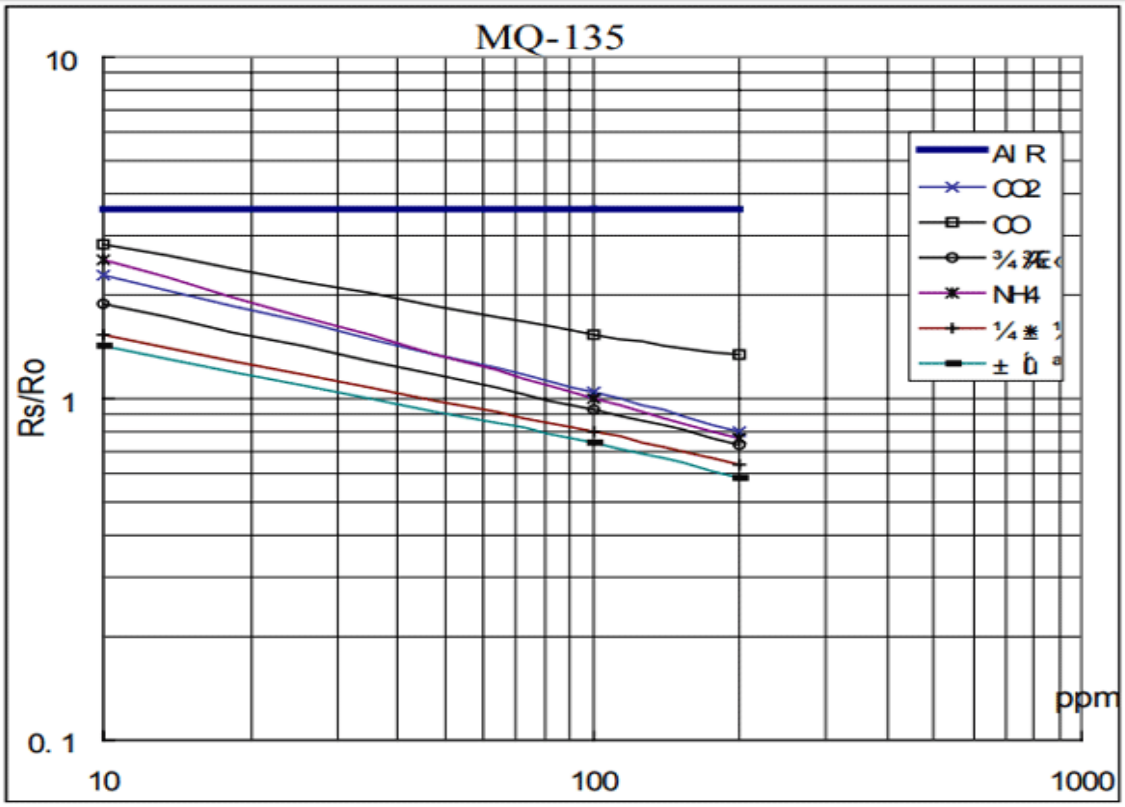
3	Electrode line	Pt
4	Heater coil	Ni-Cralloy
5	Tubular ceramic	Al_20_3
6	Anti-explosion Network	Stainless steel gauz (SUS316 100-mesh)
7	Clamp ring	Copper plating Ni
8	Resin base	Bakelite
9	Tube pin	Copper plating Ni



Structure and configuration of MQ-135 gas sensor is shown as Fig. 1 (Configuration**A or B),** sensor composed by micro AL_2O_3 ceramic tube, Tin Dioxide (SnO_2) 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 component

How to use MQ-135 sensor to measure PPM

MQ-135 gas sensor applies SnO2 which has a higher resistance in the clear air as a gas-sensing material. When there is an increase in polluting gases, the resistance of the gas sensor decreases along with that. To measure PPM using MQ-135 sensor we need to look into the (Rs/Ro) v/s PPM graph taken from the MQ135 datasheet.



The above figure shows the typical sensitivity characteristics of the MQ-135 for several gases in their: Temp: 20, Humidity: 65%, O2concentration21%, RL=20kΩ,

Ro: sensor resistance at 100ppm of NH3 in the clean air.

Rs: sensor resistance at various concentrations of gases.

The value of Ro is the value of resistance in fresh air (or the air with we are comparing) and the value of Rs is the value of resistance in Gas concentration. First you should calibrate the sensor by finding the values of Ro in fresh air and then use that value to find Rs using the below formula:

Resistance of sensor(Rs): Rs=(Vc/VRL-1)×RL

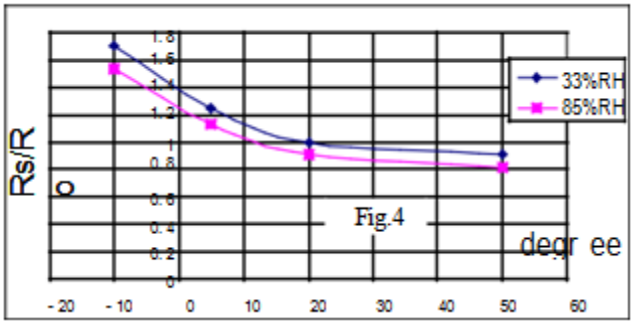


Fig shows the typical dependence of the Mq-135 on temperature and humidity.

Ro: sensor resistance at 100ppm of NH in air at 33% RH and 20 degree.

RS: Sensor of resistance at 100ppm of NH3 at different temperatures and humidity's.

SENSITVITY ADJUSTMENT

Resistance value of MQ-135 is difference to various kinds and various concentration gases. So, when using these components, sensitivity adjustment is very necessary. we recommend that you calibrate the detector for 100ppm NH_3 or 50ppm Alcohol concentration in air and use value of Load resistance that(R_L) about 20 KΩ(10KΩ to 47 KΩ).

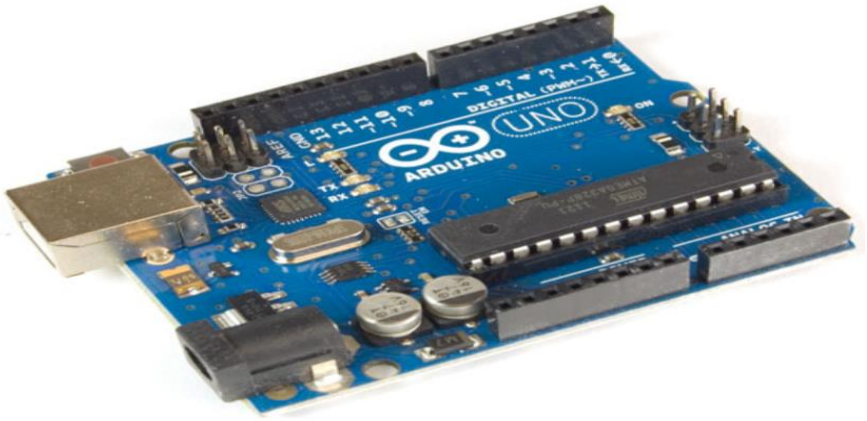
When accurately measuring, the proper alarm point for the gas detector should be determined after considering the temperature and humidity influence.

Once we calculate Rs and Ro we can find the ratio and then using the graph shown above we can calculate the equivalent value of PPM for that particular gas.

Applications:

- Used to detect leakage/excess of gases like Ammonia, nitrogen oxide, alcohols, aromatic compounds, sulphide and smoke.
- Air quality monitors.

ARDUINO UNO BOARD



The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It

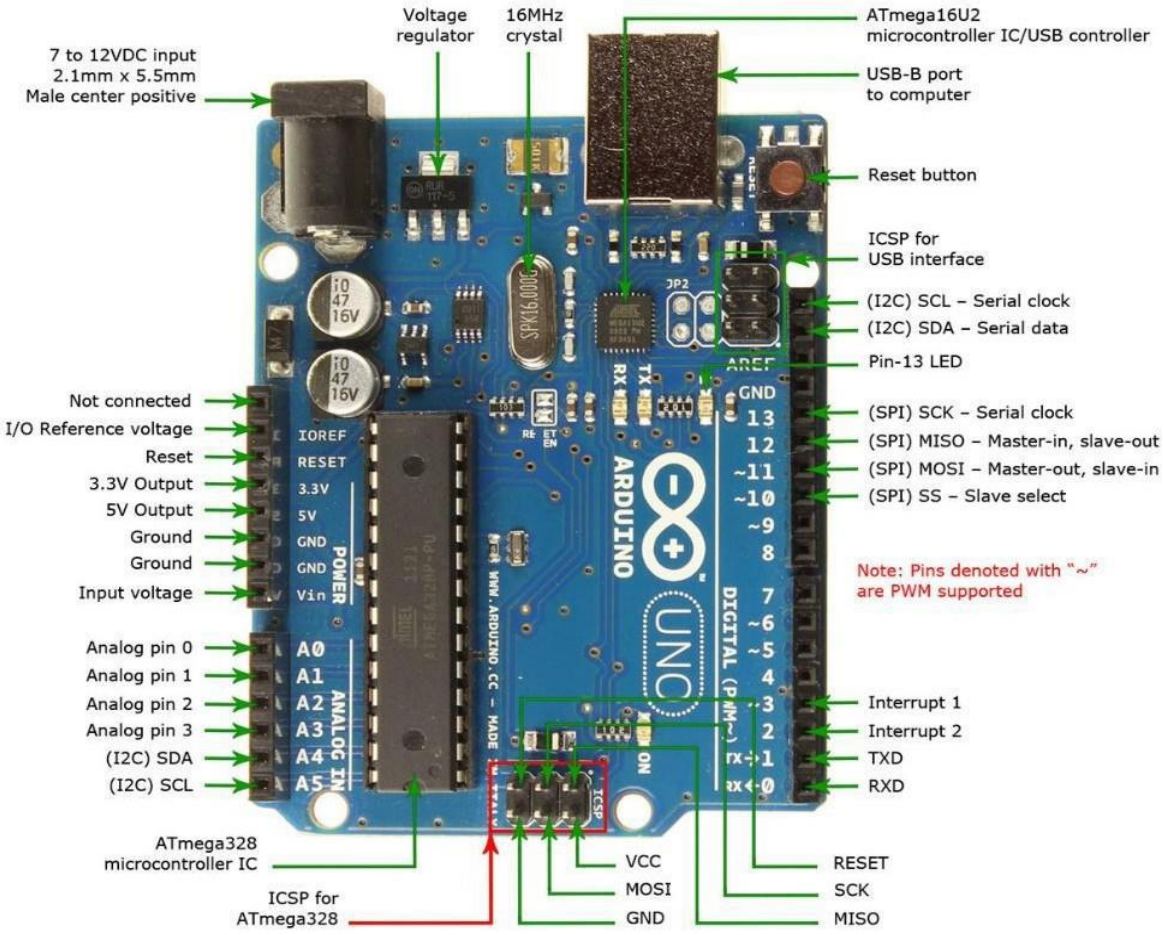
contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means "One" in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Technical Specifications

- Microcontroller ATmega328
- Operating Voltage 5V
- Supply Voltage (recommended) 7-12V
- Maximum supply voltage (not recommended) 20V
- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 6 DC Current per I/O Pin 40 mA
- DC Current for 3.3V Pin 50 mA
- Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader
- SRAM 2 KB (ATmega328)
- EEPROM 1 KB (ATmega328)
- Clock Speed 16 MHz

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Some of its different features are:-



Power USb

Arduino board can be powered by using the USB cable from your computer. All you need to do is connect the USB cable to the USB connection.

Voltage Regulator

The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages used by the processor and other elements.

Crystal Oscillator

The crystal oscillator helps Arduino in dealing with time issues. How does Arduino calculate time? The answer is, by using the crystal oscillator. The number printed on top of the Arduino crystal is 16.000H9H. It tells us that the frequency is 16,000,000 Hertz or 16 MHZ.

Reset

You can reset your Arduino board, i.e., starts your program from the beginning. You can reset the UNO board in two ways. First, by using the reset button (17) on the board. Second, you can connect an external reset button to the Arduino pin labelled RESET.

Pins

- 3.3V (6) − Supply 3.3 output volt
- 5V (7) − Supply 5 output volt

- Most of the components used with Arduino board works fine with 3.3 volt and 5 volt.
- GND (8) (Ground) − There are several GND pins on the Arduino, any of which can be used to ground your circuit.
- VIN (9) − this pin also can be used to power the Arduino board from an external power source, like AC mains power supply.

Analog Pins

The Arduino UNO board has six analog input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.

Main Microcontroller

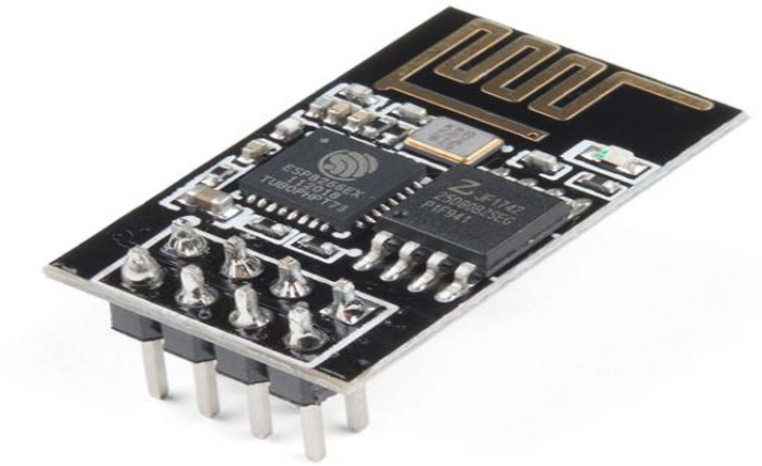
Each Arduino board has its own microcontroller. We can assume it as the brain of your board. The main IC (integrated circuit) on the Arduino is slightly different from board to board. The microcontrollers are usually of the ATMEL Company. You must know what IC your board has before loading up a new program from the Arduino IDE. This information is available on the top of the IC. For more details about the IC construction and functions, you can refer to the data sheet.

ICSP Pin

Mostly, ICSP (12) is an AVR, a tiny programming header for the Arduino consisting of MOSI, MISO, SCK, RESET, VCC, and GND. It is often referred to as an SPI (Serial Peripheral Interface), which could be considered as an "expansion" of the output. Actually, you are slaving the output device to the master of the SPI bus.

WIFI MODULE ESP 8266

The ESP8266 is a very user friendly and low cost device to provide internet connectivity to your projects. The module can work both as an Access point (can create hotspot) and as a station (can connect to Wi-Fi), hence it can easily fetch data and upload it to the internet making internet of things as easy as possible. It can also fetch data from internet using API's hence your project could access any information that is available in the internet, thus making it smarter. Another exciting feature of this module is that it can be programmed using the Arduino IDE which makes it a lot more user friendly.



Power Supply

ESP8266EX has two digital pins for power supply, pin11 and pin17. For digital power supply, there is no need to add additional filter capacitors. The operating voltage range of digital power supply pins is 1.8 V ~ 3.3 V.

ESP8266EX has five analog pins for power supply. including pin1, pin3, pin4 which provides internal power supply for internal PA and LNA respectively, and pin28, pin29 which supply power for internal PLL. The operating voltage for analog power supply pins is 1.8 V ~ 3.3 V.

Flash

The demo flash used by ESP8266EX is SPI Flash with 2 MB ROM in SOIC_8 (SOP_8) package. Pin21 SD_CLK is connected to the Flash CLK pin together with a 0402 resistor in serial connection to reduce the drive current and eliminate external interruption. The initial resistance of the resistor is 200 ohm.

Crystal Oscillator

40MHz, 26MHz and 24MHz crystal oscillators are supported. The accuracy of crystal oscillators should be ± 10PPM, and the operating temperature range should be between -20°C and 85°C.

RF

The output impedance of RF pin (Pin 2) is 50 ohm. Normally, when the antenna impedance approaches 50 ohm, antenna matching is not necessary. However, some low-price antennas commercially available in the market do not feature 50 ohm impedance. Besides, the impedance in 2.4 G to 2.5 G frequency band is rather scattered. Therefore, N-type matching network is essential in circuit design to facilitate antenna matching.

External Resistor 12K

An external ground resistor should be connected o ERS12K pin (Pin31). The ground resistor requires high accuracy when controlling the bias current.

IOT

The internet of things, or Iot, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

. History of IoT

Kevin Ashton, co-founder of the Auto-ID Center at the Massachusetts Institute of Technology (MIT), first mentioned the internet of things in a presentation he made to Procter & Gamble (P&G) in 1999. Wanting to bring radio frequency ID (RFID) to the attention of P&G's senior management, Ashton called his presentation "Internet of Things" to incorporate the cool new trend of 1999: the internet. MIT professor Neil Gershenfeld's book, When Things Start to think, also appeared in 1999. It didn't use the exact term but provided a clear vision of where IoT was headed. IoT has evolved from the convergence of wireless technologies, microelectromechanical systems (MEMSes), micro services and the internet. The convergence has helped tear down the silos between operational technologies (OT) and information technology (IT), enabling unstructured machine-generated data to be analyzed for insights to drive improvements.

Although Ashton's was the first mention of the internet of things, the idea of connected devices has been around since the 1970s, under the monikers embedded internet and computing. The first internet appliance, for example, was a Coke machine at Carnegie Mellon University in the early 1980s. Using the web, programmers could check the status of the machine and determine whether there would be a cold drink awaiting them, should they decide to make the trip to the machine. IoT evolved from M2M communication, i.e., machines connecting to each other via a network without human interaction. M2M refers to connecting a device to the cloud, managing it and collecting data. Taking M2M to the next level, IoT is a sensor network of billions of

smart devices that connect people, systems and other applications to collect and share data. As its foundation, M2M offers the connectivity that enables IoT.

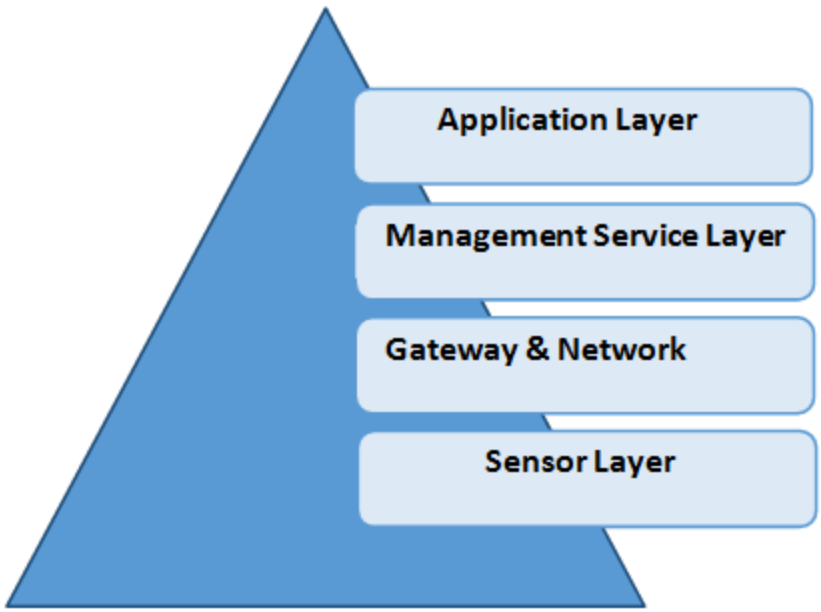
The internet of things is also a natural extension of supervisory control and data acquisition (SCADA), a category of software application programs for process control, the gathering of data in real time from remote locations to control equipment and conditions. SCADA systems include hardware and software components. The hardware gathers and feeds data into a computer that has SCADA software installed, where it is then processed and presented in a timely manner. The evolution of SCADA is such that late-generation SCADA systems developed into first-generation IoT systems. The concept of the IoT ecosystem, however, didn't really come into its own until the middle of 2010 when, in part, the government of China said it would make IoT a strategic priority in its five-year plan.

Importance of Iot

The internet of things helps people lives and work smarter, as well as gain complete control over their lives. In addition to offering smart devices to automate homes, Iot is essential to business. Iot provides businesses with a real-time look into how their systems really work, delivering insights into everything from the performance of machines to supply chain and logistics operations. Iot enables companies to automate processes and reduce labor costs. It also cuts down on waste and improves service delivery, making it less expensive to manufacture and deliver goods, as well as offering transparency into customer transactions. As such, Iot is one of the most important technologies of everyday life, and it will continue to pick up steam as more businesses realize the potential of connected devices to keep them competitive.

Iot Architecture

IoT architecture consists of different suite of technologies supporting it. It serves to illustrate how various technologies relate to each other and to communicate the scalability, modularity and configuration of IoT deployments in different scenarios.



Sensor Layer is the lowest layer is made up of smart objects integrated with sensors. The main function of this layer is to obtain the various types of static/ dynamic information of the real world through various types of sensors and to share with Internet access. The miniaturization of hardware has enabled powerful sensors to be produced in much smaller forms which are integrated into objects in the physical world. There are various types of sensors for different purposes. The sensors have the capacity to take measurements such as temperature, air quality, distance, movement and electricity. In some cases, they may also have a degree of memory, enabling them to record a certain number of measurements. A sensor can measure the physical property and convert it into signal that can be understood by an instrument.

Gateways and Networks were a large volume of data will be produced by these sensors and this requires a robust and high performance wired or wireless network infrastructure as a transport medium. The network helps to distinguish each object that is interconnected in the physical world. Current networks, often tied with very different protocols, have been used to support machine-to-machine (M2M) networks and their applications. With demand needed to serve a wider range of IOT services and applications such as high speed transactional services, context-aware applications, etc. multiple networks with various technologies and access protocols are needed to work with each other in a heterogeneous configuration. These networks can be in the form of a private, public or hybrid models and are built to support the communication requirements for latency, bandwidth or security.

Management Service Layer renders the processing of information possible through analytics, security controls, process modelling and management of devices. One of the important features of the management service layer is the business and process rule engines. IOT brings connection and interaction of objects and systems together providing information in the form of events or contextual data such as temperature of goods, amount of fuel, current location and traffic data. Some of these events require filtering or routing to post-processing systems such as capturing of periodic sensory data, while others require response to the immediate situations such as reacting to emergencies on patient‘s health conditions. Data management is the ability to manage data information flow. With data management in the management service layer, information can be accessed, integrated and controlled.

Application Layer is at the top of the stack is responsible for delivery of various applications to different users in IoT. It consists of protocols that focus on process-to-process communication across an IP network and provides a firm communication interface and end-user services

Working of Iot

An Iot ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors and communication hardware, to collect, send and act on data they acquire from their environments. Iot devices share the sensor data they collect by connecting to an Iot gateway or other edge device where data is either sent to the cloud to be analyzed or analyzed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions or access the data.

The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific Iot applications deployed. Iot can also make use of artificial intelligence (AI) and machine learning to aid in making data collecting processes easier and more dynamic.

Iot benefits to organizations

The internet of things offers several benefits to organizations. Some benefits are industry-specific, and some are applicable across multiple industries. Some of the common benefits of Iot enable businesses to:

- monitor their overall business processes;
- improve the customer experience (CX);
- save time and money;
- enhance employee productivity;
- integrate and adapt business models;
- make better business decisions; and
- Generate more revenue.

Iot encourages companies to rethink the ways they approach their businesses and gives them the tools to improve their business strategies. Generally, Iot is most abundant in manufacturing, transportation and utility organizations, making use of sensors and other Iot

devices; however, it has also found use cases for organizations within the agriculture, infrastructure and home automation industries, leading some organizations toward digital transformation.

Iot can benefit farmers in agriculture by making their job easier. Sensors can collect data on rainfall, humidity, temperature and soil content, as well as other factors, that would help automate farming techniques. The ability to monitor operations surrounding infrastructure is also a factor that Iot can help with. Sensors, for example, could be used to monitor events or changes within structural buildings, bridges and other infrastructure. This brings benefits with it, such as cost saving, saved time, quality-of-life workflow changes and paperless workflow.

A home automation business can utilize Iot to monitor and manipulate mechanical and electrical systems in a building. On a broader scale, smart cities can help citizens reduce waste and energy consumption. Iot touches every industry, including businesses within healthcare, finance, retail and manufacturing.

Advantages of Iot

Some of the advantages of Iot include the following:

- ability to access information from anywhere at any time on any device;
- improved communication between connected electronic devices;
- transferring data packets over a connected network saving time and money;
- Automating tasks helping to improve the quality of a business's services and reducing the need for human intervention.

Iot standards and frameworks

There are several emerging Iot standards, including the following:

- IPv6 over Low-Power Wireless Personal Area Networks *(*6LoWPAN*)* is an open standard defined by the Internet Engineering Task Force (IETF). The 6LoWPAN standard enables any low-power radio to communicate to the internet, including 804.15.4, Bluetooth Low Energy (BLE) and Z-Wave (for home automation).
- ZigBee is a low-power, low-data rate wireless network used mainly in industrial settings. ZigBee is based on the Institute of Electrical and Electronics Engineers (IEEE) 802.15.4 standard. The ZigBee Alliance created Dotdot, the universal language for Iot that enables smart objects to work securely on any network and understand each other.
- LiteOS is a Unix-like operating system (OS) for wireless sensor networks. LiteOS supports Smartphone's, wearable's, intelligent manufacturing applications, smart homes and the internet of vehicles (IoV). The OS also serves as a smart device development platform.
- OneM2M is a machine-to-machine service layer that can be embedded in software and hardware to connect devices. The global standardization body, OneM2M, was created to develop reusable standards to enable Iot applications across different verticals to communicate.
- Data Distribution Service (DDS) was developed by the Object Management Group (OMG) and is an Iot standard for real-time, scalable and high-performance M2M communication.

- Advanced Message Queuing Protocol (AMQP) is an open source published standard for asynchronous messaging by wire. AMQP enables encrypted and interoperable messaging between organizations and applications. The protocol is used in client-server messaging and in Iot device management.
- Constrained Application Protocol (CoAP) is a protocol designed by the IETF that specifies how low-power, compute-constrained devices can operate in the internet of things.
- Long Range Wide Area Network (Lora WAN) is a protocol for WANs designed to support huge networks, such as smart cities, with millions of low-power devices.

Iot frameworks include the following:

- Amazon Web Services (AWS) Iot is a cloud computing platform for Iot released by Amazon. This framework is designed to enable smart devices to easily connect and securely interact with the AWS cloud and other connected devices.
- Arm Mbed IoT is a platform to develop apps for Iot based on Arm microcontrollers. The goal of the Arm Mbed Iot platform is to provide a scalable, connected and secure environment for Iot devices by integrating Mbed tools and services.
- Microsoft's Azure Iot Suite is platforms that consists of a set of services that enables users to interact with and receive data from their Iot devices, as well as perform various operations over data, such as multidimensional analysis, transformation and aggregation, and visualizes those operations in a way that's suitable for business.
- Google's Brillo/Weave is a platform for the rapid implementation of Iot applications. The platform consists of two main backbones: Brillo, an Android-based OS for the development of embedded low-power devices, and Weave, an Iot-oriented communication protocol that serves as the communication language between the device and the cloud.
- Calvin is an open source Iot platform released by Ericsson designed for building and managing distributed applications that enable devices to talk to each other. Calvin includes a development framework for application developers, as well as a runtime environment for handling the running application.

ANDROID APPLICATION

Android is an open source and Linux-based Operating System for mobile devices such as Smartphone's and tablet computers. Android was developed by the Open Handset Alliance, led by Google, and other companies.

Sr.No.	Feature & Description
1	**Beautiful UI** Android OS basic screen provides a beautiful and intuitive user interface.
2	**Connectivity** GSM/EDGE, IDEN, CDMA, EV-DO, UMTS, Bluetooth, Wi-Fi, LTE, NFC and WiMAX.
3	**Storage** SQLite, a lightweight relational database, is used for data storage purposes.
4	**Media support** H.263, H.264, MPEG-4 SP, AMR, AMR-WB, AAC, HE-AAC, AAC 5.1, MP3, MIDI, OggVorbis, WAV, JPEG, PNG, GIF, and BMP.
5	**Messaging** SMS and MMS
6	**Web browser** Based on the open-source WebKit layout engine, coupled with Chrome's V8 JavaScript engine supporting HTML5 and CSS3.
7	**Multi-touch** Android has native support for multi-touch which was initially made available in handsets such as the HTC Hero.
8	**Multi-tasking** User can jump from one task to another and same time various application can run simultaneously.
9	**Resizable widgets** Widgets are resizable, so users can expand them to show more content or shrink them to save space.
10	**Multi-Language** Supports single direction and bi-directional text.

11	**GCM** Google Cloud Messaging (GCM) is a service that lets developers send short message data to their users on Android devices, without needing a proprietary sync solution.
12	**Wi-Fi Direct** A technology that lets apps discover and pair directly, over a high-bandwidth peer-to-peer connection.
13	**Android Beam** A popular NFC-based technology that lets users instantly share, just by touching two NFC-enabled phones together.

Android offers a unified approach to application development for mobile devices which means developers need only develop for Android, and their applications should be able to run on different devices powered by Android. The first beta version of the Android Software Development Kit (SDK) was released by Google in 2007 where as the first commercial version, Android 1.0, was released in September 2008.

On June 27, 2012, at the Google I/O conference, Google announced the next Android version, 4.1 Jelly Bean. Jelly Bean is an incremental update, with the primary aim of improving the user interface, both in terms of functionality and performance. The source code for Android is available under free and open source software licenses. Google publishes most of the code under the Apache License version 2.0 and the rest, Linux kernel changes, under the GNU General Public License version 2.

Importance of Android

- Open source
- Larger developer and community reach
- Increased marketing
- Inter app integration
- Reduced cost of development
- Higher success ratio
- Rich development environment

Features of Android

Android is a powerful operating system competing with Apple 4GS and supports great features. Few of them are listed below

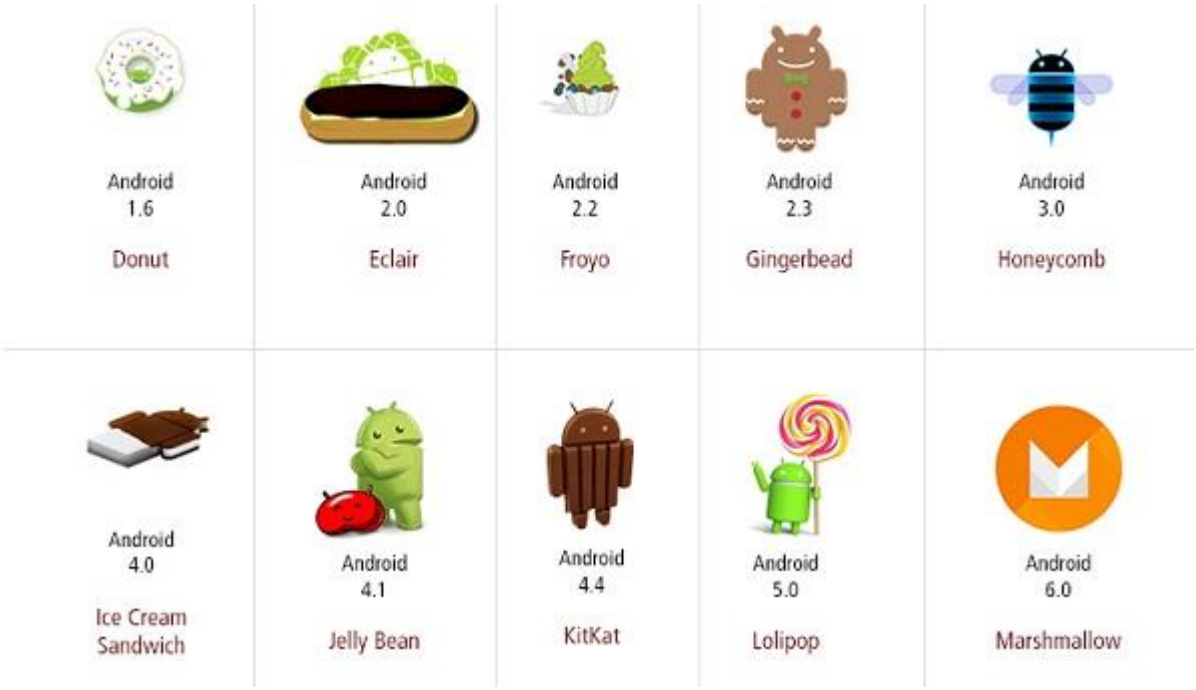
Android Applications

Android applications are usually developed in the Java language using the Android Software Development Kit. Once developed, Android applications can be packaged easily and sold out either through a store such as Google Play, SlideME, Opera Mobile Store, Mobango, F-droid and the Amazon Appstore.

Android powers hundreds of millions of mobile devices in more than 190 countries around the world. It's the largest installed base of any mobile platform and growing fast. Every day more than 1 million new Android devices are activated worldwide. This tutorial has been written with an aim to teach you how to develop and package Android application. We will start from environment setup for Android application programming and then drill down to look into various aspects of Android applications.

History of Android

The code names of android ranges from A to N currently, such as Aestro, Blender, Cupcake, Donut, Eclair, Froyo, Gingerbread, Honeycomb, Ice Cream Sandwitch, Jelly Bean, KitKat, Lollipop and Marshmallow. Let's understand the android history in a sequence.



API level

API Level is an integer value that uniquely identifies the framework API revision offered by a version of the Android platform.

Platform Version	API Level	VERSION_CODE
Android 6.0	23	MARSHMALLOW
Android 5.1	22	LOLLIPOP_MR1
Android 5.0	21	LOLLIPOP
Android 4.4W	20	KITKAT_WATCH
Android 4.4	19	KITKAT
Android 4.3	18	JELLY_BEAN_MR2
Android 4.2, 4.2.2	17	JELLY_BEAN_MR1

Android 4.1, 4.1.1	16	JELLY_BEAN
Android 4.0.3, 4.0.4	15	ICE_CREAM_SANDWICH
Android 4.0, 4.0.1, 4.0.2	14	ICE_CREAM_SANDWICH
Android 3.2	13	HONEYCOMB_MR2
Android 3.1.x	12	HONEYCOMB_MR1
Android 3.0.x	11	HONEYCOMB
Android 2.3.4 Android 2.3.3	10	GINGERBREAD_MR1
Android 2.3.2 Android 2.3.1 Android 2.3	9	GINGERBREAD
Android 2.2.x	8	FROYO
Android 2.1.x	7	ECLAIR_MR1
Android 2.0.1	6	ECLAIR_0_1
Android 2.0	5	ECLAIR
Android 1.6	4	DONUT
Android 1.5	3	CUPCAKE
Android 1.1	2	BASE_1_1

Android 1.0	1	BASE

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