REAL TIME AIR AND WATER POLLUTION MONITORING

Submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering by

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHOOL OF ELECTRICAL AND ELECTRONICS

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with Grade "A" by NAAC
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APRIL – 2023

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of **CH**. **PRASANTH** (**39130093**) and **CH**. **KASI VISWANADHAM** (**39130100**) who carried out the project entitled **"REAL TIME AIR AND WATER POLLUTION MONITORING**" under the supervision of **Dr.S**. **Barani. M.E., Ph.D.** from November 2022 to April 2023.

15/4

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DECLARATION

We CH. PRASANTH (39130093) and CH. KASI VISWANADHAM (39130100) hereby declare that the Project Report entitled **"Real Time Air and Water Pollution Monitoring"** done by us is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in **ELECTRONICS AND COMMUNICATION ENGINEERING.**

DATE: 27.04.23

PLACE: CHENNAI

1.

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SIGNATURE OF THE CANDIDATES

ACKNOWLEDGEMENT

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We would like to express my sincere and deep sense of gratitude to our Project guide **Dr.S.Barani,M.E.,Ph.D** for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of our project work.

I wish to express my thanks to all Teaching and Non-Teaching staff members of the **Department of Electronics and Communication Engineering** who were helpful in many ways for the completion of the project.

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ABSTRACT

Here we develop a device that measures air and water pollution along with displaying time. With this people will no longer special equipment to measure pollution levels, they can monitor pollution levels anywhere and anytime desired.

This battery powered system is operated by an STM32 Microcontroller along with a air quality sensor, gas sensor, pH sensor and mini OLED display. The device is a combination of sensors and electronics.

The air quality sensor is used to detect the amount of air pollution in the air as ppm levels. This data is processed by microcontroller to get the current air quality. The device also monitors for any flammable gases in the vicinity to detect any flammable gas leakages using flammable gas sensor. This sensor is constantly monitored by controller.

Now we have a pH sensor that is used to detect the pH level of any water body. The user can just dip the pH sensor on his/her smart watch to get pH level. The sensor data is processed by controller and displayed on the display module.

Similarly, the sensor is used to transmit the water turbidity value to controller which is displayed on display. Ph is used to display water quality of any water body (lake, pond, canal, sea).

It allows to set high and low acceptance values of each parameter using push buttons. If any of the values scanned shows up higher/lower than set limits it sounds a buzzer alert as well displays the alert message to the user on the OLED display.

CHAPTER 1
INTRODUCTION

Air and water pollution is the biggest problem of every nation, whether it is developed or developing. Health problems have been growing at faster rate especially in urban areas of developing countries where industrialization and growing number of vehicles leads to release of lot of gaseous pollutants. Harmful effects of pollution include mild allergic reactions such as irritation of the throat, eyes and nose as well as some serious problems like bronchitis, heart diseases, pneumonia, lung and aggravated asthma. According to a survey, due to air pollution 16.7 lakh deaths per year occur in the India alone. Whereas 6.5 million deaths each year globally. This widespread problem of water pollution is jeopardizing our health. Unsafe water kills more people each year than war and all other forms of violence combined. Meanwhile, our drinkable water sources are finite: Less than 1 percent of the earth's freshwater is actually accessible to us. Without action, the challenges will only increase by 2050, when global demand for freshwater is expected to be one-third greater than it is now. Air and water Pollution Monitoring System monitors the Air and water quality over the samples of air, water and will trigger an alarm when the air/water pollution levels is above the threshold value set. Means when there are sufficient amount of harmful gases present in the air like CO_2, smoke, alcohol, benzene, NH_3, LPG and NO_x. It will show the air quality in PPM on the OLED so that it can monitor it very easily. pH sensor is added in this to check the nature of the water by determining the pH level. The system can be installed where the pollution levels to be found and gives an alert message when the system crosses the threshold limit.

1.1 Problem Statement:

- Water pollution occurs when harmful substances often chemicals or microorganisms contaminate a stream, river, lake, ocean, aquifer, or other body of water, degrading water quality and rendering it toxic to humans or the environment.
- An air quality monitor is a device that measures the level of common air pollutants. Monitors are available for both indoor and outdoor settings. Indoor air quality monitors are typically sensor-based instruments. Some of them are able to measure ppb levels and come as either mixed gas or portable units. Sensor based instruments and air quality monitoring systems are used widely in outdoor ambient applications.

1.2 Objective:

- The objective of this Act is to provide for the prevention, control and abatement of air pollution, for the establishment, with a view to carrying out the aforesaid purposes, of Boards, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.
- Water quality objectives are set to protect the most sensitive designated water use at a specific location. Designated water uses include raw drinking water, public water.
- Here we develop a system that is combination of both air and water quality sensors like MQ135, MQ9 and pH Sensor. Along with displaying time on the screen.
- We are also using a low-cost OLED screen which is more effective than the LCD display in terms of providing different viewing angles, contrast, lighting precision.

CHAPTER 2
LITERATURE SURVEY

Syam Sidhardhan, Debabrata Das (2021) Rooms in cold countries usually have tight ventilation during the winter season. CO_2 is produced when people breathe, and it is the main source of pollution in indoor environment. An average adult exhale contains 35,000 to 50,000 parts per million (ppm) of CO_2 on each breath, which is 100 times higher than is typically found in the outside air (OSA) and it fluctuates based on the various activities. The increase in CO_2 level has toxic effects on human. Some of the side effects are Headache, increase blood pressure, increase heart rate, shortage of breath etc. Hence, it's essential to monitor indoor air quality (IAQ) to provide for occupant health, productivity, and comfort. Theoretically we can calculate how much the amount of CO_2 level inside an apartment or room based on various number of people inside the room, volume of the room, time, ventilations, activity level of people etc. Wearable devices such as smart watches can used to accurately calculate the current state of human. Ex: Jogging, Sleeping, Resting, Watching TV etc. Using a wearable smart watch device, we can calculate the amount of CO_2 level on inside an apartment and automatically control the air exhaust Internet of Things (IoT) system such air conditioner, exhaust fan etc using the build in wireless communication channel such as Bluetooth or Wi-Fi.

Gagan Parmar, Sagar Lakhani, Manju K.Chottapadhyay (Oct 2017) A prototype for an Environmental Air Pollution Monitoring System for monitoring the concentrations of major air pollutant gases has been developed. The system uses low-cost air-quality monitoring nodes comprises of low-cost semiconductor gas sensor with Wi-Fi modules. This system measures concentrations of gases such as CO, CO_2, SO_2 and NO_2 using semiconductor sensors. The sensors will gather the data of various environmental parameters and provide it to raspberry pi which act as a base station. Realization of data gathered by sensors is displayed on Raspberrypi 3 based Webserver. A MEAN stack is developed to display data over website. The fundamental aspect of proposed work is to provide low-cost infrastructure to enable the data collection and dissemination to all stakeholders.

Saritha Jiyal, Rakesh kumar Saini (Nov 2020) In all developing countries such as India the main problem of premature death is air pollution which also effect the economy of country. When urbanization started then various problem occurs such as environmental pollution, traffic system etc. there is so much loss of resources in crowded cities due to urbanization. The concept of smart sustainable city can be used to balance the resources. If we do loss of resources excessively than we will definitely create problems to our future generation and excessive use of resources causes air pollution. Then it is necessary to predict air pollution timely by which it can be monitored. Using Internet of Things monitoring of air pollution is necessary to save our environment from all harmful pollutants. Vehicles are the main cause of air pollution. Electric Vehicles and cycles can be used in place of other vehicles for controlling the air pollution. This research teaches that prediction of air pollution level is very important by which peoples can divert their route of travelling.

Mohammed Faeik Ruzaij Al-Okby, S.Neubert, T.Roddelkopf K.Thurow (Nov 2021) The occurrence of hazardous gases and toxic or harmful vapors in laboratories, factories, and chemical warehouses requires a fast detectionof leakage accidents to avoid health impairments. In this paper, the integration and validation of two novel metal oxide gas sensors (MOX) for the application in an IoT-based air quality monitoring and the alarming system is proposed. The sensors arecombined with WeMos D1 Mini IoT-based microcontroller for data processing and transmitting via Wi-Fi communication protocol. The system design takes into consideration the low-cost, light-weight, small-size, and low power consumption concepts to enable a portable compact system that can be operated stand-alone oreasily be adapted to any stationary or mobile robotic platform. The system was tested with several volatile organic materials (VOCs). The acquired air quality data are transferred to an IoT cloud, where the data are stored in a database for further analysis and research. Further, the data can be directly monitored on a PC, tablet, and smartphone. The system testing results confirm that the system can be used efficiently in laboratory environments.

M.Thu, Wunna Htun, Y. Aung, Pyone Ei Ei Shwe, N. Tun (Nov 2018)

Nowadays, cities all over the globe are transforming into smart cities. Smart cities initiatives need to address environmental concerns such as air pollution to provide clean air. A scalable and cost-effective air monitoring system is imperative to monitor and control air pollution for smart city development. Air pollution has notable effects on the well-being of the population a whole, global atmosphere, and worldwide economy. This paper presents a scalable smart air quality monitoring system with low-cost sensors and long-range communication protocol. The sensors collect four parameters, temperature, humidity, dust and carbon dioxide in the air. The proposed end-to-end system has been implemented and deployed in Yangon, the business capital of Myanmar, as a case study since Jun 2018. The system allows the users to log in to an online dashboard to monitor the real-time status. In addition, based the collected air quality parameters for the past two months, a machine learning model has been trained to make predictions of parameters such that proactive actions can be taken to alleviate the impacts from air pollution.

Deeksha Singh Katiyar, Rahul Raj, Anil Kumar Dahiya (July 2022)

Increasing urbanization and industrialization, deforestation, and other human activities have caused high-level contamination of the air that we breathe. Breathing unhealthy air deteriorates human health and leads to serious and long-standing diseases such as asthma, congestive heart failure, respiratory infection, etc. As a result, monitoring and estimating the levels of various air defilements such as PM10, PM2.5, CO2, CO, SO2, NO2, and Ozone is required for raising citizen awareness about the quality of the air they breathe. This paper presents an IoT-enabled smart device named Air Health which provides geographical-based pollution insights by detecting and measuring the levels of different air pollutants, calculating the air quality index at the installed location along with temperature & humidity levels. The prototype design consists of a microcontroller assembled with electrochemical sensors, GPS, a GSM module, and a RTC clock. The data collected can be remotely monitored on the website & Thing Speak application on smartphones allowing people to know about the quality of the air they breathe and precautions they can take to refrain themselves from serious diseases.

S. I. Lopes, P. M.Moreira, A. Cruz, Pedro M. N. Martins, F. Pereira, A. Curado (Oct 2019) IoT-based monitoring (i.e. smart monitoring) technologies have been recently used for on-line monitoring in many application fields, such as home, environmental and industrial process monitoring. People spend at least half of their life inside buildings; therefore, Indoor Air Quality (IAQ) plays an important role both on human health and on buildings' sustainability. Radon gas is one of the most important parameters regarding IAQ assessment, being considered by the World Health Organization (WHO) as the second largest risk factor associated with lung cancer. This paper aims to present RnMonitor, a WebGIS-based platform developed for effective Radon Risk Management and expedite in situ deployment of IoT-based sensors. Given the fact that the spatial context is key for visual and data analytics, the proposed platform takes advantage of a hierarchy of spatially related entities (buildings/rooms/devices) that are natively georeferenced in the system, and thus providing spatial context to acquired data, and other relevant metrics, by means of a simple, responsive, and intuitive web-based application.

Anumandla Kiran Kumar, A.Sri Lakshmi ,P.Janaki Nivas Rao(Dec 2020) Researches show that almost seven million people worldwide are dying due to air pollution every year. Data given by World Health Organization observed that 9 out of 10 people breathe the air that contains significant proportions of poisons. Monitoring helps in evaluating the degree of contamination corresponding to the surrounding air quality benchmarks. In this work, a IoT based air quality monitoring system is developed using Raspberry Pi Internet of Things (IoT) platform. A MQ135 sensor is used to detect gases like CO, Ammonia, Smoke, Alcohol, etc., and the corresponding data is processed using moving average method to avoid the redundant data samples, stored in a database to do further analysis and future predictions of the air pollutants. This will help future generations to take precautions and stay safe.

Evariste Twahirwa, Kambombo Mtonga, Desire Ngabo, S. Kumaran
(May 2021) Keeping key air pollutants below the World Health Organization recommended limits is important for combating the ever increasing deaths resulting

from the associated health problems. This is especially true for indoor environments where poor ventilation can magnify the effects of air pollution. Having Knowledge about the level of pollutants in the air would serve as a stepping stone to take mitigation measures. In this work, a domesticated air pollution monitoring system over the LoRa enabled Internet of Things framework is proposed. Two sensors for CO2 and PM2.5that are important for air quality monitoring with compensated weather monitoring capabilities were deployed in the cafeteria kitchen and laboratory room of the University of Rwanda, College of Science and Technology. The sensed parameter readings are then sent to the cloud via LoRaWAN protocol supported gateway that interfaces the sensors and the cloud part of the network. The end users can query the system and access the data together with the analytic information via the developed Web-based user interface dashboard. An analysis of the data over a period of eleven (11) months is carried out and results show high parts per million of CO2of over 800 ppm and PM2.5 concentration of over 100 ppm in the kitchen environment. Whilst a concentration of 500 ppm for CO2and zero ppm for PM2.5 were observed in the laboratory room. Baseline algorithms that facilitate setting of triggers for each sensing node and pushing of notifications for when a measured parameter exceeds a certain threshold value are proposed and implemented.

N. Kularatna, B. Sudantha (Mar 2008) An Environmental Air Pollution Monitoring System (EAPMS) for monitoring the concentrations of major air pollutant gases has been developed, complying with the IEEE 1451.2 standard. This system measures concentrations of gases such as CO, NO2, SO2, and O3 using semiconductor sensors. The smart transducer interface module (STIM) was implemented using the analog devices' ADuC812 micro converter. Network Capable Application Processor (NCAP) was developed using a personal computer and connected to the STIM via the transducer independent interface. Three gas sensors were calibrated using the standard calibration methods. Gas concentration levels and information regarding the STIM can be seen on the graphical user interface of the NCAP. Further, the EAPMS is capable of warning when the pollutant levels exceed predetermined maxima and the system can be developed into a low-cost version for developing countries.

Md.Omar Faruq, Injamamul Hoque Emu, Md.Nazmul Haque, Maitry Dey, N. K. Das, Mrinmoy Dey (Dec 2017) Embodiment of low cost and immensely proficient water quality monitoring system is very crying need for those people living in the outlying territory where immune drinking water is not plethoric. This paper illustrates a microcontroller-based water quality monitoring system with high degree of accuracy and susceptible to determine several parameters of water such as temperature, turbidity and potential of hydrogen (pH). Detection of those parameters of water is very important and indispensable in order to lead healthy life as different source of water are being tainted due to excess population. Various analytical schemes are subsist for ascertainment of the quality of water where several are time-consuming and few are used for industrial applications that are not applicable for simple water quality monitoring system. Consequently, it is needless to model a simple device that track out various parameters of water unerringly. In this project based research work, a simple microcontroller is used as central processing unit (CPU) and multiple sensors that detect various parameters and send the data to microcontroller and finally the LCD gives the results.

A.S. Khalid Waleed, P. Kusuma, C. Setianingsih (July 2019) The development of the current era, and the rapid development of technology and the need for a significant increase in demand, as well as pollution, the water sector, especially the river has experienced a decline in water quality even to the occurrence of pollution, resulting in water can no longer be consumed either by human body also for other needs. Some of the systems that were developed began to be able to process existing data, be it conditions from water, chemical observations or physically. This is done because water is a necessity that cannot be tolerated, so this research is done to help fulfil or even provide a calm warning of water quality. With the development of Internet of Things (IoT) the monitoring system will develop, because with the existence of technology such as low-power wide-area network (LPWAN) as specific as possible, short data can be sent using lower power. In this research, it was proven that the author could make a monitoring system and classification of river water pollution. By using an artificial intelligence, using the fuzzy logic method. The results of system testing show that the average accuracy of the monitoring system results is 99.7% and the results of the appropriate classification values are based on the results of system testing.

Abha Porwal, S. Mishra, Arya Kela, Gargi Singh, Manish Panchal, Anjana Jain (April 2022) The ever-increasing water pollution level due to industries, pose a serious threat to the masses and once detected, it requires a significant amount of time for the remedial measures. The proposed IoT solution discusses a device, capable of determining the water pollution level caused by an industry, near water bodies. The system would also be able to predict when the pollution level tends to cross the threshold value set by C.P.C.B. India in future. This information would eventually help in taking proactive remedial measures. The proposed device consists of four major sensors: pH sensor, turbidity sensor, flow sensor, and temperature sensor. These sensors would measure the water-parameters in real-time and send that data to Google Firebase (database) either through the Wi-Fi module or, through the LoRa transmitter installed in the proposed device. Through LoRaWAN, all of these devices, which will be put at various industry-wastewater-outlets, will be wirelessly connected to a central hub. The goal is to use an optimized algorithm to make the system more energy efficient. The database would retain real-time data for two purposes: displaying it in the mobile app and using it in LSTM time-series forecasting (Machine Learning model) to predict when pollution levels could surpass the threshold.

Ahmed A. H. AL-Fahdawi, A. M. Rabee, Shaheen M. Al-Hirmizy(May 2015) The use of remote sensing and GIS in water monitoring and management has been long recognized. This paper, however discusses the application of remote sensing and GIS specifically in monitoring water quality parameters in Al-Habbaniyah Lake, and the results were compared with in situ measurements. Variations of different parameters under investigation were as follows: temperature (15-33°C), pH (7-9), dissolved oxygen (6-11mg/L), BOD5 (0.5-1.8), electrical conductivity (200-2280 µS/cm), TDS (147-1520 mg/L), TSS (68-3200), turbidity (5-51), nitrate

(0.7-20 mg/l), phosphate (77-220 µg/l), and chlorophyll-a (0.9-130 µg/l). Remote sensing results revealed that the band 5 was most likely significantly correlated with turbidity in the winter. Band 2 and 3 was most likely significantly correlated with TDS in autumn and summer, while band 2 was most likely significantly correlated with TSS in autumn, band 2 is most likely significantly correlated with chlorophyll-a in autumn. The current study results demonstrated convergence between in situ and remote sensing readings. The models were used to explore the values of each of chlorophyll-a, TSS, TDS, and turbidity did not deviate much from the values actually measured in the three seasons. Nevertheless, they were very useful in anticipating all seasons of the study due to the insignificant deviation between the remotely sensed values and actual measured values.

Ajith Jerom B, M. R (Feb 2020) The Internet of Things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators and connectivity which enables these things to connect and exchange data. The number of IoT devices has increased 31% year-over-year to 8.4 billion in 2017 and it is estimated that there will be 30 billion devices by 2020. Water pollution is a major environmental problem in India. The largest source of water pollution in India is untreated sewage. Other sources of pollution include agricultural runoff and unregulated small-scale industry that results in polluting, most of the rivers, lakes and surface water in India. In this paper, An IoT Based Smart Water Quality Monitoring System using Cloud and Deep Learning is proposed to monitor the quality of the water in waterbodies. In conventional systems, the monitoring process involves the manual collection of sample water from various regions, followed by laboratory testing and analysis. This process is ineffective, as this process is arduous and time-consuming and it does not provide real-time results. The quality of water should be monitored continuously, to ensure the safe supply of water from any water bodies and water resources. Hence, the design and development of a low-cost system for real-time monitoring of water quality using the Internet of Things (IoT) is essential. Monitoring water quality in water bodies using Internet of Things (IoT) helps in combating environmental issues and improving the health and living standards of all living things. The proposed system monitors the quality of water relentlessly with the help of IoT devices, such as, NodeMCU. The in-built Wi-Fi module is attached in NodeMCU which enables internet connectivity transfers the measured data from sensors to the Cloud. The prototype is designed in such a way that it can monitor the number of pollutants in the water. Multiple sensors are used to measure various parameters to assess the quality of water from water bodies. The results are stored in the Cloud, deep learning techniques are used to predict whether the water suitable or not.

G.Wiranto, Grace A.Mambu, Hiskia, I. D. P.Hermida, S.Widodo(Sep 2015) In this research, it has been designed a continuous water quality monitoring system consisting of sensors for measuring Dissolved Oxygen (DO) and pH, data acquisition based on a PCDuino microcontroller, a sample collection unit, and PC based graphical display. The main part of the system is the PCDuino microcontroller, that has a function of controlling the data transmission and the operation of the automatic sampling unit based on comparison of the measured parameter values against certain threshold. The automatic sampling unit was constructed from PVC holder, a 12V motor stepper, a 12V DC pump, and 8 glass tube sample storages. Experimental results showed that when the measured DO value dropped below 5 mg/l, or the pH values below 4 or above 9, the sample collection unit worked by filling up 20 ml sample in just under 650 ms. All the measured data can be displayedon a PC for further analysis. This prototype system is expected to find wide applications in the field of environmental and aquaculture monitoring.

Somphop Chanthakit, Choopan Rattanapok(2018) This paper present an implementation of MQTT based air quality monitoring system. The air quality measurement device is a hardware using ESP8266 NodeMCU that connects to sensors for measuring temperature, humidity, concentration of carbon monoxide (CO), ozone gas (O3), and PM2.5. The firmware of device makes the device act as a publisher that reads the sensor data and sends them to MQTT Broker. Node-RED is used to be a subscriber that subscribes to receive data from MQTT Broker. With Node-RED, we can easily make a flow to manage and handle received data. Then, Node-RED will send data to the air quality monitoring dashboard which is a responsive web application to display data in gauge, text and chart user interface. In addition, when the value of some data exceeds the configured range, Node-REDwill send an alarm message via LINE Notify to notify users.

CHAPTER 3
SCOPE OF THE PRESENT INVESTIGATION

3.1 Existing System:

There has been a lot of work going on in the field of air quality monitoring systems. There has been a lot of proposals that cater to different types of use cases. There are bulky and therefore stationary air quality monitoring systems that are based on the concept of Internet of Things. They connect to smartphones and in some cases use the smartphone as a gateway device to talk to the cloud. There are portable devices with displays that monitor air pollutant levels and send them to cloud.

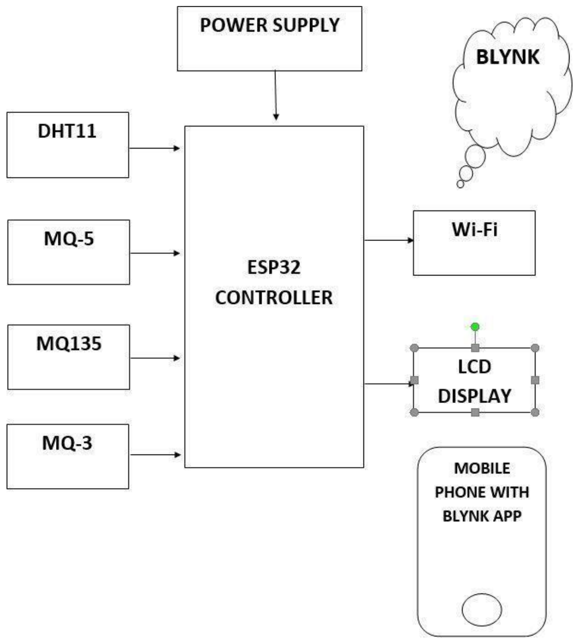


Fig. 3.1 Existing Block Diagram

3.2 Proposed System:

Here we develop a system that measures air and water pollution along with displaying time. With this people will no longer need special equipment to measure pollution levels, they can monitor pollution levels anywhere and anytime desired.

- This battery powered system is operated by an STM32 Microcontroller along with an air quality sensor, gas sensor, pH sensor and mini display. The system is a combination of sensors and electronics to enable every citizen to monitor and protect our environment.

- This allows us to set high and low acceptance values of each parameter using push buttons. If any of the values scanned shows up higher/lower than set limits it sounds a buzzer alert as well.

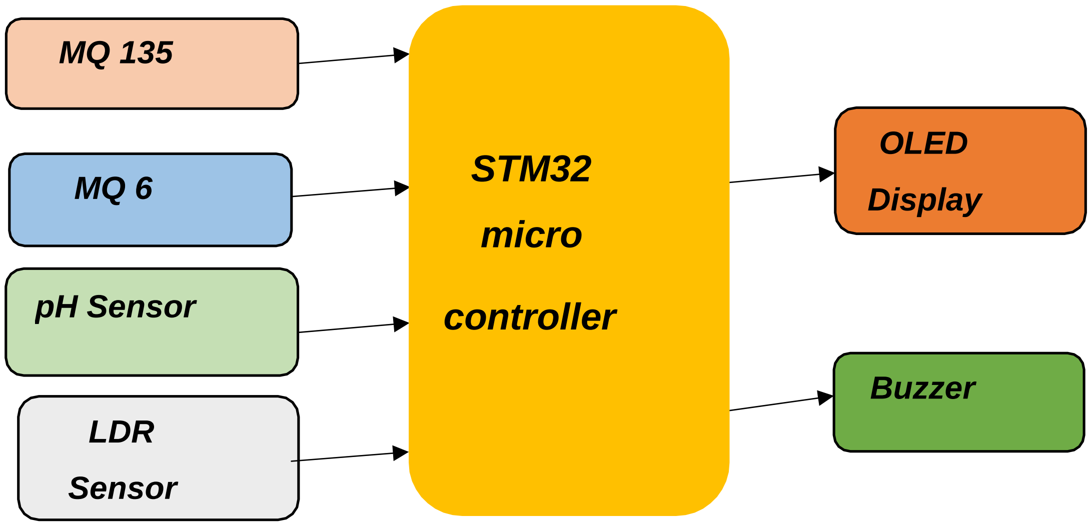


Fig 3.2 Block Diagram

Hardware Required:

- STM32 Microcontroller
- pH Sensor
- Air Quality Sensor MQ135
- Flammable Gas Sensor MQ6
- OLED Display
- LDR Sensor
- Buzzer
- Connecting Wires
- Power Supply

3.3 Future Scope:

In future the project can be upgraded in more ways than one.

- Interface more no of sensors to know gases present in air.
- Design webpage and upload data on webpage.
- Interface SDCARD to store data.
- Interface GPS module to monitor the pollution.

CHAPTER-4
HARDWARE COMPONENTS

4.1 STM32 Microcontroller:

- The STM32 series is based on the ARM Cortex-M3 core specially designed for embedded applications that require high performance, low cost, and low power consumption. This article introduces the definition, types, difference between the STM32 microcontroller and 51 microcontrollers as well as the basic system of STM32.
- The STM32 series is based on the **ARM Cortex-M3 core** specially designed for embedded applications that require high performance, low cost, and low power consumption. It is divided into different products according to the core architecture: Among them, the STM32F series include: STM32F103 "enhanced" series, STM32F101 "basic" series, STM32F105, STM32F107 "interconnected" series, and enhanced series with a clock frequency of 72MHz, which is the highest performance product among similar products. The basic clock frequency is 36MHz, and the performance of 16-bit products is greatly improved at the price of 16-bit products. It is the best choice for usersof 32-bit products.
- Both series have built-in flash memory of 32K to 128K, the difference is the combination of the maximum capacity of SRAM and the peripheral interface. When the clock frequency is 72MHz, the code is executed from the flash memory, and the STM32 consumes 36mA, which is equivalent to 0.5mA/MHz.
- The microcontroller is a kind of integrated circuit chip, which uses VLSI technology to integrate the central processing unit CPU, random access memory RAM, read-only memory ROM, various I/O ports, interrupt systems, timers with data processing capabilities, counter and other functions (may also include display drive circuit, pulse width modulation circuit, an analog multiplexer, A/D converter, and other circuits) into a silicon chip to form a small and complete microcomputer system. Because 8-bit single-chip microcomputers have a simple internal

structure, small size, and low cost, they are widely used in some simpler controllers.

- The Common 8-bit microcontrollers mainly include Intel's 51 series, Atmel's AVR system, Microchip's PIC series, TI's MSP430 series, and so on. And STM32 is a kind of more powerful 32-bit microcontroller. The biggest difference between it and the 8-bit microcontroller is that it cannot only use registers for programming but also use officially provided library files for programming, which is not only convenient for programming but also easier to transplant.

STM32 microcontroller features:

(1) Core: ARM 32-bit Cortex-M3 CPU, maximum operating frequency 72MHz, 1.25DMIPS/MHz, single-cycle multiplication and hardware division.

(2) Memory: 32-512KB Flash memory and 6-64KB SRAM memory are integrated on-chip.

(3) Clock, reset, and power management: 2.0-3.6V power supply and I/O interface drive voltage, POR, PDR and programmable voltage detector (PVD), 4-16MHz crystal oscillator, embedded before leaving the factory-adjusted 8MHz RC oscillator circuit, internal 40 kHz RC oscillator circuit, PLL for CPU clock, 32kHz crystal oscillator with calibration for RTC.

(4) Debug mode: serial debug (SWD) and JTAG interface, up to 112 fast I/O ports, up to 11 timers, up to 13 communication interfaces.

STM32 commonly used devices:

The most used devices: STM32F103 series, STM32 L1 series, STM32W series. These microcontrollers are used in a variety of applications, from simple printers to complex circuit boards in vehicles.

As a result, the technical know-how of developing firmware and embedded systems using STM32 microcontrollers is an essential skill-set for an engineer in electronics and communications.

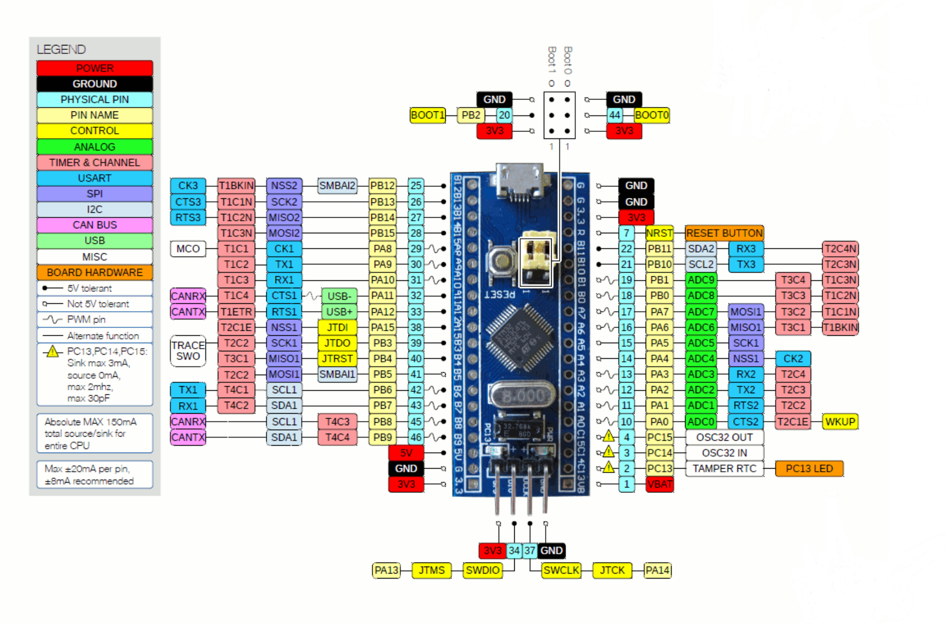


Fig 4.1 STM32 Microcontroller

The basic system of STM32 mainly involves the following parts:

1. Power supply

1) Regardless of whether the analog part and the AD part are used, VCC and GND, VDDA, VSSA, Vref (if the package has this pin) must be connected to the outside of the MCU, and cannot be left floating.

2) For each group of corresponding VDD and GND, at least one 104 ceramic capacitors should be placed for filtering, and the capacitor should be placed as close to the MCU as possible.

3) Use a multimeter to test whether the power supply voltage is correct. It is best to use a digital power supply when debugging to prevent overvoltage or overcurrent. It is best to test the voltage step by step from the incoming wire end to the chip power supply end.

2.reset and start

1) Boot pin has nothing to do with JTAG. It is only used to determine the starting address of the execution code after the MCU is started;

2) In the circuit design, the Boot pin may not be used, but an external resistor must be connected to the ground or power supply, and it must

not be left floating; the storage media corresponding to the three boot modes of STM32 are all built-in in the chip. They are:

(1) User flash memory = Flash built into the chip.

(2) SRAM = RAM area built into the chip, which is the memory.

(3) System memory = a specific area inside the chip. A section of Bootloader is present in this area when the chip leaves the factory, which is usually called ISP program. No one can modify or erase the content of this area after the chip leaves the factory, that is, it is a ROM area.

There are two pins BOOT0 and BOOT1 on each STM32 chip. The level state of these two pins when the chip is reset determines the area from which the program is executed after the chip is reset.

BOOT1=x BOOT0=0 Boot from user flash memory, this is the normal operating mode.

BOOT1=0 BOOT0=1 Boot from the system memory. The program function of this mode is set by the manufacturer.

BOOT1=1 BOOT0=1 Boot from the built-in SRAM, this mode can be used for debugging.

Use JTAG port or SWD mode to program and select to boot from user flash memory.

Choose to start from the system storage when programming the program in the serial port ISP mode.

3.Programming interface

If you want to reduce the number of sockets, use SWD mode simulation. In this mode, if you use JLINK, you only need four wires. The four wires are: 3.3V, GND, SWDIO, SWCLK

Among them

The JTMS/SWDIO of STM32 is connected to the TMS of the JTAG port;

The JTCK/SWCLK of STM32 is connected to the TCK of the JTAG port.

If you want to use ULINK2, add one more "NRST", that is, five.

You can define this interface by yourself. You can connect the emulator and the target board with a DuPont wire jumper or a block conversion interface board when you use it.

4. The reasons for the failure of debugging and programming

1) The target chip is not connected properly and cannot work normally:

Solution: Ensure that the minimum system of the target board is properly connected and the chip can work normally: VDD, VDDA, VSS, and VDDS are all connected correctly, the reset circuit can be reset reliably, and the reset sources do not affect each other.

2) The originally burned code in the chip affects the new debugging operation:

The code originally burned in the chip is wrong, the chip is powered on and enters an undefined state, and the debug mode cannot be entered. The originally programmed code in the chip activates some peripherals or configures the SWJ pin as a normal I/O port.

Solution: Select the BOOT0/BOOT1 pin of the chip to boot from RAM, or erase the code in the chip first.

3) The chip has been read/write protected:

The debugging tool cannot read or write the Flash built into the chip. Solution: first use a debugging tool to release the read/write protection of the chip.

4.2 pH sensor:

pH Sensors and Principles of Operation

Understanding pH measurement

- In the process world, pH is an important parameter to be measured and controlled. The pH of a solution indicates how acidic or basic (alkaline) it is. The pH term translates the values of the hydrogen ion concentration- which ordinarily ranges between about 1 and 10 x -14gram-equivalents per litre - into numbers between 0 and 14.On the pH scale a very acidic solution has a low pH value such as 0, 1, or 2 (which corresponds to a large concentration of hydrogen ions; 10 x 0, 10 x -1, or 10 x -2 gram-equivalents per litre) while a very basic solution has a high pH value, such as12, 13, or 14 which corresponds to a small number of hydrogenous (10 x -12, 10 x -13, or 10 x -14 gram-equivalents per litre).A neutral solution such as water has a pH of approximately 7.

- A pH measurement loop is made up of three components, the pH sensor, which includes a measuring electrode, a reference electrode, and a temperature sensor; a preamplifier; and an analyser or transmitter. A pH measurement loop is essentially a battery where the positive terminal is the measuring electrode, and the negative terminal is the reference electrode. The measuring electrode, which is sensitive to the hydrogen ion, develops a potential (voltage) directly related to the hydrogen ion concentration of the solution. The reference electrode provides a stable potential against which the measuring electrode can be compared.

Fig 4.2 pH Sensor

- When immersed in the solution, the reference electrode potential does not change it the changing hydrogen ion concentration. A solution in the reference electrode also makes contact with the sample solution and the measuring electrode through a junction, completing the circuit. Output of the measuring electrode changes with temperature (even though the process remains at a constant pH), so a temperature sensor is necessary to correct for this change in output. This is done in the analyser or transmitter software.
- The pH sensor components are usually combined into one device called a combination pH electrode. The measuring electrode is usually

glass and quite fragile. Recent developments have replaced the glass with more durable solid-state sensors. The preamplifier is a signal-conditioning device. It takes the high-impedance pH electrode signal and changes it into a low impedance signal which the analyser or transmitter can accept. The preamplifier also strengthens and stabilizes the signal, making it less susceptible to electrical noise.

- The sensor's electrical signal is then displayed. This is commonly done in a 120/240 V ac-powered analyser or in a 24 V dc loop-powered transmitter.
- Additionally, the analyser or transmitter has a man machine interface for calibrating the sensor and configuring outputs and alarms, if pH control is being done.
- Keep in mind, application requirements should be carefully considered when choosing a pH electrode. Accurate pH measurement and the resulting precise control that it can allow, can go a long way toward process optimisation and result in increased product quality and consistency. Accurate, stable pH measurement also controls and often lowers chemical usage, minimising system maintenance and expense. Keeping the system up and running A system's pH electrodes require periodic maintenance to clean and calibrate them. The length of time between cleaning and calibration depends on process conditions and the user's accuracy and stability expectations.
- Overtime, electrical properties of the measuring and reference electrode change. Calibration in known-value pH solutions called buffers will correct for some of these changes. Cleaning of the measuring sensor and reference junction will also help. However, just as batteries have a limited life, a pH electrode's lifetime is also finite. Even in the "friendliest" environments, pH electrodes have to be replaced eventually.

4.3 MQ135 Air Quality Sensor:

An MQ135 air quality sensor is one type of MQ gas sensor used to detect, measure, and monitor a wide range of gases present in air like ammonia, alcohol, benzene, smoke, carbon dioxide, etc. It operates at a 5V supply with 150mA consumption. Preheating of 20 seconds is required before the operation, to obtain the accurate output.

It is a semiconductor air quality check sensor suitable for monitoring applications of air quality. It is highly sensitive to NH3, NOx, CO2, benzene, smoke, and other dangerous gases in the atmosphere. It is available at a low cost for harmful gas detection and monitoring applications.

- To measure or detect the gases, use analog pins or digital pins. Just apply 5V to the module and you can observe that the module's power LED turns ON (glows) and the output LED turns OFF when no gas is detected by the module. This means that the output of the digital pin is 0V. Note that the sensor must be kept for preheating time for 20seconds (as mentioned in the specifications) before the actual operation.
- Now, once when the MQ135 sensor is operated to detect, then the LED output goes high along with the digital output pin. Otherwise, use the potentiometer until the output increases. Whenever the sensor detects a certain gas concentration, the digital pin goes high (5V), otherwise it stays low (0V).
- We can also use analog pins to get the same result. The output analog values (0-5V) are read from the microcontroller. This value is directly proportional to the gas concentration detected by the sensor. By the experimental values, we can observe the working and reaction of the MQ135 sensor with different gas concentrations and the programming developed accordingly.

Fig 4.3 MQ135 Sensor

- If the concentration of gases exceeds the threshold limit in the air, then the digital output pin goes high. The threshold value can be varied by using the potentiometer of the sensor. The analog output voltage is obtained from the analogy pin of the sensor, which gives the approximate value of the gas level present in the air.

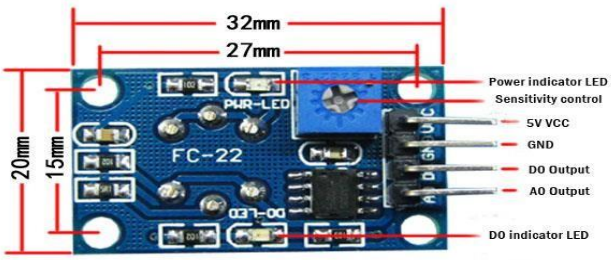


Fig 4.4 MQ135 Air Quality Sensor Pin Configuration

Pin 1: VCC: This pin refers to a positive power supply of 5V that power up the MQ135 sensor module.

Pin 2: GND (Ground): This is a reference potential pin, which connects the MQ135 sensor module to the ground.

Pin 3: Digital Out (Do): This pin refers to the digital output pin that gives the digital output by adjusting the threshold value with the help of a potentiometer. This pin is used to detect and measure any one gas and makes the MQ135 sensor work without a microcontroller. **Pin 4: Analog Out (Ao):** This pin generates the analog output signal of 0V to 5V and it depends on the gas intensity. This analog output signal is proportional to the gas vapor concentration, which is measured by the MQ135 sensor module. This pin is used to measure the gases in PPM. It is driven by TTL logic, operates with 5V, and is mostly interfaced with microcontroller.

The applications of the MQ135 quality sensor are:

- Used in the detection of excess or leakage of gases like nitrogen oxide, ammonia, alcohol, aromatic compounds, smoke, and sulphide.
- Used as air quality monitors.
- Used in air quality equipment for offices and buildings.
- Used as a domestic air pollution detector.
- Used as an industrial air pollution detector.
- Works as a portable air pollution detector.

4.4 Carbon Monoxide & Flammable Gas Sensor MQ-6:

The **MQ-6 Gas sensor** can detect or measure gases like LPG and butane. The MQ-6 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 gas. When it comes to measuring the gas in ppm the analog pin has to be used, the analog pin also TTL driven and works on 5V and hence can be used with most common microcontrollers. So, if you are looking for a sensor to detect or measure gasses like LPG, or methane with orwithout a microcontroller, then this sensor might be the right choice for you.

- It detects the concentrations of CO in the air and output's its reading as an analog voltage. The sensor can measure concentrations of 10 to 10,000 ppm for CO and 100 to 10000ppm for flammable gas.
- The sensor can operate at temperatures from -10 to 50°C and consumes less than 150 mA at 5V. Connecting five volts across the heating (H) pins keeps the sensor hot enough to function correctly. Connecting five volts at either the A or B pins causes the sensor to emit an analog voltage on the other pins.
- Using a MQ sensor it detects a gas is very easy. You can either use the digital pin or the analog pin to accomplish 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).

- You 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. You can experiment with these values and check how the sensor reacts to different concentration of gas and develop your program accordingly.
- A resistive load between the output pins and ground sets the sensitivity of the detector. The resistive load should be calibrated for your application using the equations in the datasheet, but a good starting value for the resistor is 20 kΩ.
- This is a simple-to-use liquefied petroleum gas (LPG) sensor, suitable for sensing LPG (composed of mostly propane and butane) concentrations in the air. The MQ-6 can detect gas concentrations anywhere from 200 to 10000ppm.
- This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple; all you need to do is power the heater coil with 5V, add a load resistance, and connect the output to an ADC.

Features of MQ6 Gas sensor:

- Operating Voltage is +5V
- Can be used to detect LPG or Butane gas
- Analog output voltage: 0V to 5V
- Digital Output Voltage: 0V or 5V (TTL Logic)
- Preheat duration 20 seconds

- Can be used as a Digital or analog sensor The Sensitivity of Digital pin can be varied using the potentiometer.

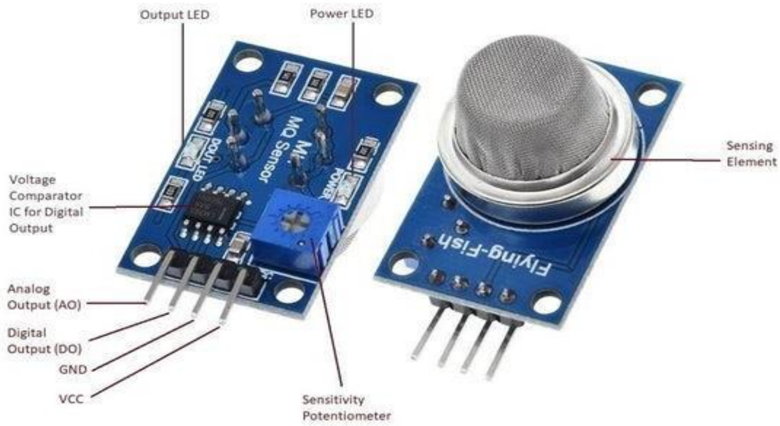


Fig 4.5 MQ6 Sensor

4.5 OLED Display:

OLED (Organic Light Emitting Diodes) is a flat light emitting technology, made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. OLEDs are emissive displays that do not require a backlight and so are thinner and more efficient than LCD displays (which do require a white backlight).

You should expect high colour contrasts and wider viewing angles. The true blacks of the OLED display make the other colours stand out more. OLEDs also lose less colour contrast at wider viewing angles compared to LCDs. LCDs are best viewed from the centre and lose colour contrast quickly as the angle increases. OLED technology is also improving rapidly. OLEDs now have a larger colour gamut (selection of colours) than before as well as higher HDR and faster response times.

OLED is fundamentally different from LED which is based on a p-n diode structure. In LEDs doping is used to create p- and n- regions by changing the conductivity of the host semiconductor. OLEDs do not employ a p-n structure. Doping of OLEDs is used to increase radiative efficiency by directmodification of the quantum-mechanical optical recombination rate. Doping is additionally used to determine the wavelength of photon emission.

An OLED display works without a backlight because it emits its own visible light. Thus, it can display deep black levels and can be thinner and lighter than a liquid crystal display (LCD). In low ambient light conditions (such as a dark room), an OLED screen can achieve a higher contrast ratio than an LCD, regardless of whether the LCD uses cold cathode fluorescent lamps or an LED backlight.

OLED displays are made in the same way as LCDs, but after TFT (for active matrix displays), addressable grid (for passive matrix displays) or indium-tin oxide (ITO) segment (for segment displays) formation, the display is coated with hole injection, transport and blocking layers, as well with electroluminescent material after the first 2 layers, after which ITO or metal may be applied again as a cathode and later the entire stack of materials is encapsulated.

The TFT layer, addressable grid or ITO segments serve as or are connected to the anode, which may be made of ITO or metal. OLEDs can be made flexibleand transparent, with transparent displays being used in smartphones

with optical fingerprint scanners and flexible displays being used in foldable smartphones. An OLED is made by placing a series of organic thin films between two conductors. When electrical current is applied, a bright light is emitted. Click here for a more detailed view of the OLED technology.

Components of an OLED:

OLEDs can be made up of either two or three layers of organic material. A two-layer OLED consists of the following parts:

Substrate– OLED is supported by either a thin translucent glass or foil material known as substrate. It acts as the base for OLED.

Anode– When an electric current is passed, the anode loses an electron or adds holes. It is transparent. It is also known as an emitter.

Organic Layer– They are made up of organic molecules or polymers such as hydrogen or carbon which are placed on top of the anode.

Conductive Layer– It consists of organic plastic molecules such as polyaniline that are used to transport holes from the anode.

Emissive Layer – This is the layer where light is made. It is made up of organic plastics molecules, but different ones from the conducting layer that transmits electrons from the cathode. One such polymer is polyfluorene.

Cathode– When an electric current is applied the cathode injects electrons. It is made up of metals such as aluminium and calcium. It may be transparent or not. The cathode is also known as a conductor.

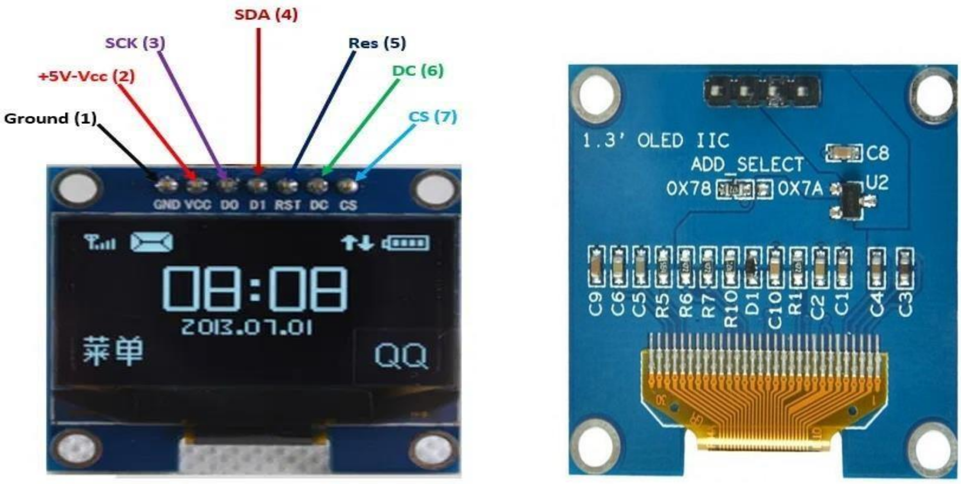


Fig4.6 OLED Display

The future - flexible and transparent OLED displays

As we said, OLEDs can be used to create flexible and transparent displays. This is exciting as it opens up a whole world of possibilities:

- Curved OLED displays, placed on non-flat surfaces
- Wearable OLEDs
- Foldable OLEDs and rollable OLEDs which can be used to create new mobile devices.
- Transparent OLEDs embedded in windows or car windshields and many more we cannot even imagine today.

4.6 LDR Sensor:

LDR (Light Dependent Resistor) as the name states is a special type of resistor that works on the photoconductivity principle means that resistance changes according to the intensity of light. Its resistance decreases with an increase in the intensity of light. It is often used as a light sensor, light meter, Automatic street light, and in areas where we need to have light sensitivity. It is also called a Light Sensor. LDR are usually available in 5mm, 8mm, 12mm, and 25mm dimensions.

The Light-dependent resistors made with photosensitive semiconductor materials like Cadmium Sulphides (CdS), lead sulphide, lead selenide, indium antimonide, or cadmium selenide and they are placed in a Zig-Zag shape as you can see in the pic below.

Two metal contacts are placed on both ends of the Zig-Zag shape these metal contacts help in creating a connection with the LDRs. Now, a transparent coating is applied on the top so that the zig-zag-shaped photosensitive material gets protected and as the coating is transparent the LDR will be able to capture light from the outer environment for its working.

- It works on the principle of photoconductivity whenever the light falls on its photoconductive material, it absorbs its energy and the electrons of that photoconductive material in the valence band get excited and go to the conduction band and thus increasing the conductivity as per the increase in light intensity.
- Also, the energy in incident light should be greater than the bandgap gap energy so that the electrons from the valence band got excited and go to the conduction band.
- The LDR has the highest resistance in dark around 1012 Ohm and this resistance decreases with the increase in Light.

Light Intensity V/S Resistance:

As per the property of LDRs, the amount of light entering the LDR the inversely proportional to the resistance of the sensor, and the graph is hyperbolic in nature.

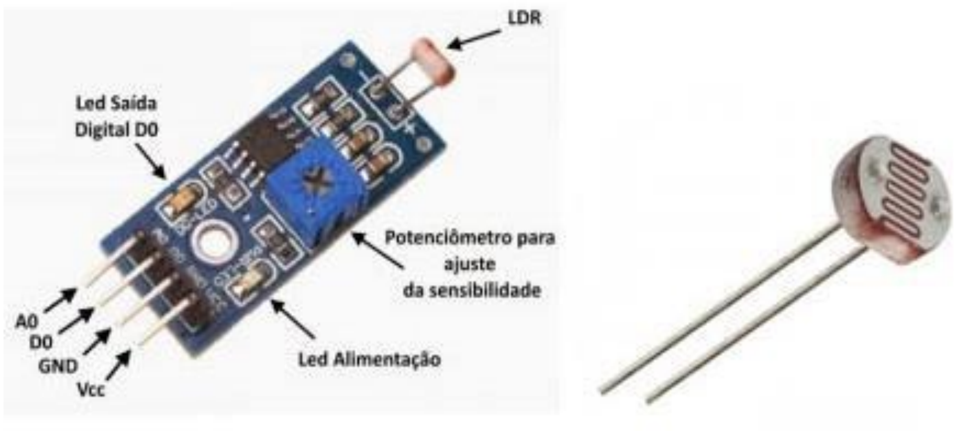


Fig 4.7 LDR Sensor

4.7 Buzzer:

An audio signalling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

The pin configuration of the buzzer is shown below. It includes two pins namely positive and negative. The positive terminal of this is represented with the '+' symbol or a longer terminal. This terminal is powered through 6Volts whereas the negative terminal is represented with the '-'symbol or short terminal and it is connected to the GND terminal.

This buzzer uses a DC power supply that ranges from 4V – 9V. To operate this, a 9V battery is used but it is suggested to utilize a regulated +5V/+6V DC supply. Generally, it is connected through a switching circuit to switch ON/OFF the buzzer at the necessary time interval.

Fig 4.8 Buzzer

The specifications of the buzzer:

- The frequency range is 3,300Hz
- Colour is black
- Operating Temperature ranges from – 20° C to +60°C
- Operating voltage ranges from 3V to 24V DC
- The sound pressure level is 85dBA or 10cm
- The supply current is below 15mA

The applications of the buzzer:

- Communication Devices
- Electronics used in Automobiles
- Alarm Circuits
- Portable Devices
- Security Systems
- Timers
- Household Appliances
- Electronic Metronomes
- Sporting Events
- Annunciator Panels
- Game Shows

4.8 WORKING:

- Proposed Air Pollution Monitoring System is based on the block diagram as shown in Fig.3.2. The data of air is recognized by MQ135 gas sensor and MQ6 LPG gas sensor. The MQ135 sensor can sense NH3, NOx, alcohol, Benzene, smoke, CO2. So, it is dynamic gas sensor for our Air pollution Monitoring system. When it will be connected to STM32 then it will sense all gases, and it will give the Pollution level in PPM (parts per million). Sensor is giving us value of 90 when there is no gas near it and the air quality safe level is 350 PPM and it should not exceed 1000 PPM.

- When it will exceed the limit of 1000 PPM, it will cause Headaches, sleepiness and stagnant, stuffy air. If it exceeds beyond 2000 PPM then it will cause increased heart rate and many different diseases When the value will increase from 400 PPM, then the buzzer will start beeping and the OLED will display the value. Along with these gas sensors the pH sensor is integrated to STM32 board the values of air are displayed with the pH sensor dipped in the water sample gives the pH value of the water.

- The device also monitors for any flammable gases in the vicinity to detect any flammable gas leakages using flammable gas sensor. This sensor is constantly monitored by controller. Now we have a pH sensor that is used to detect the pH level of any water body.
- The user can just dip the pH sensor on his/her smart watch to get pH level. The sensor data is processed by controller and displayed on the display module. Ph Sensor is used to display water quality of any water body (lake, pond, canal, sea).
- It allows to set high and low acceptance values of each parameter using push buttons. If any of the values scanned shows up higher/lower than set limits it sounds a buzzer alert as well displays the alert message to the user on the OLED display.
- The Circuit Diagram of our Project "Realtime Air and Water Pollution Monitoring" is shown in below.

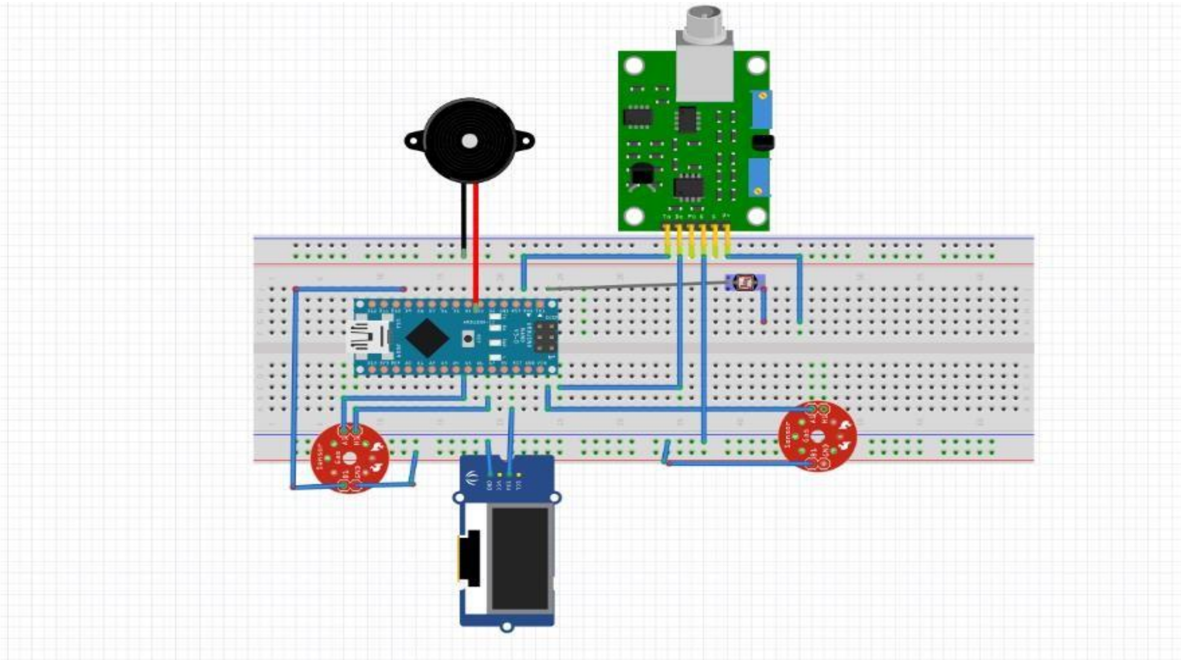
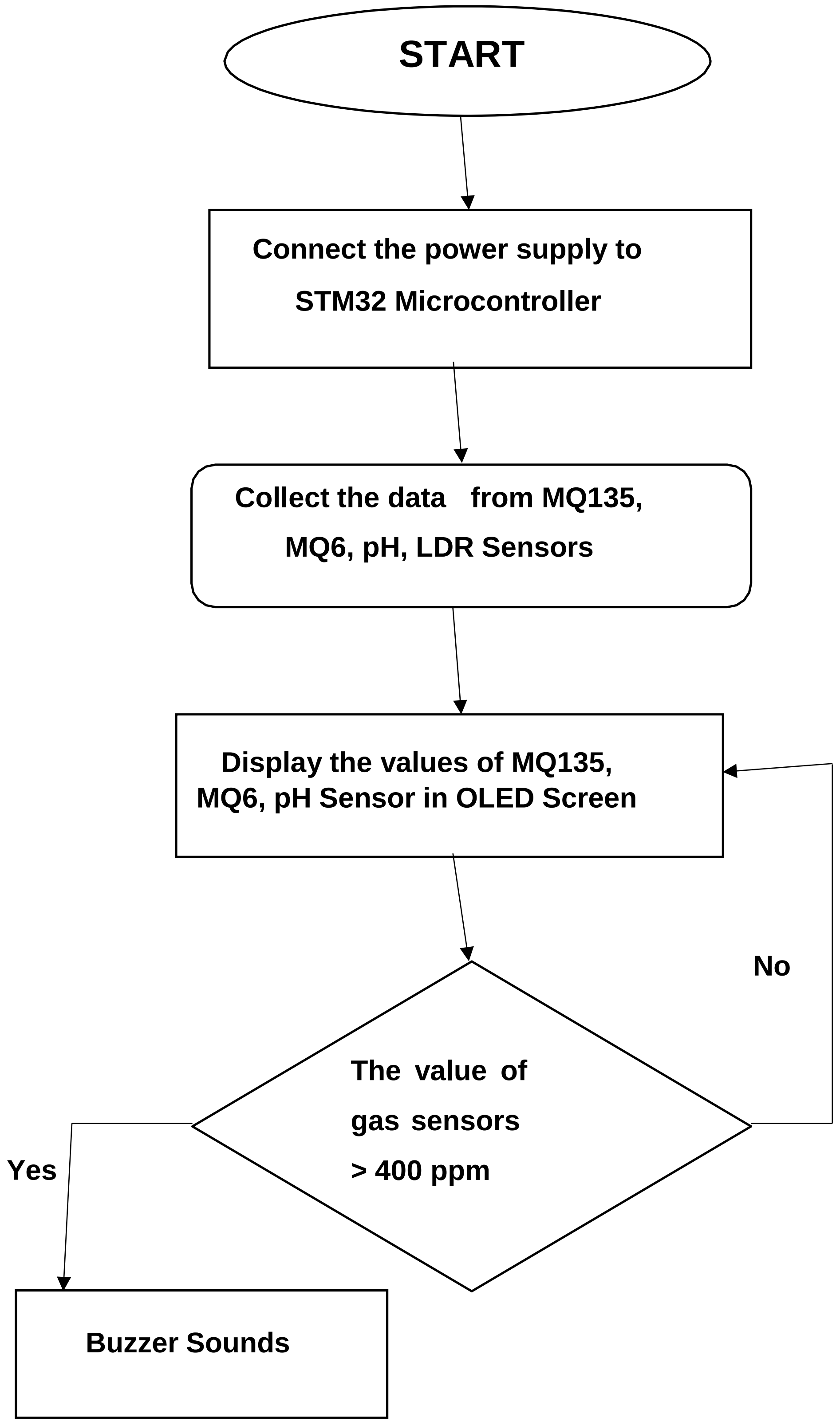


Fig.4.9 Circuit Diagram

- The Flow Chart of our Project “Realtime Air and Water Pollution Monitoring” is shown in below.



CHAPTER 5

OBSERVATIONS & RESULTS:

- In here, By the using of MQ135 and MQ6 sensor we can observe some values based on gas samples in test in PPM Value. The vales can show in OLED Display.
- Working of seven days by taking the different gases samples (Smoke, Sanitizer, Normal Air, Dust) on each day we get different output.
- The graphs below are drawn based on the different air samples sprayed on the gas sensors by taking the PPM values on y-axis and on x-axis by taking the number of days it is tested for.

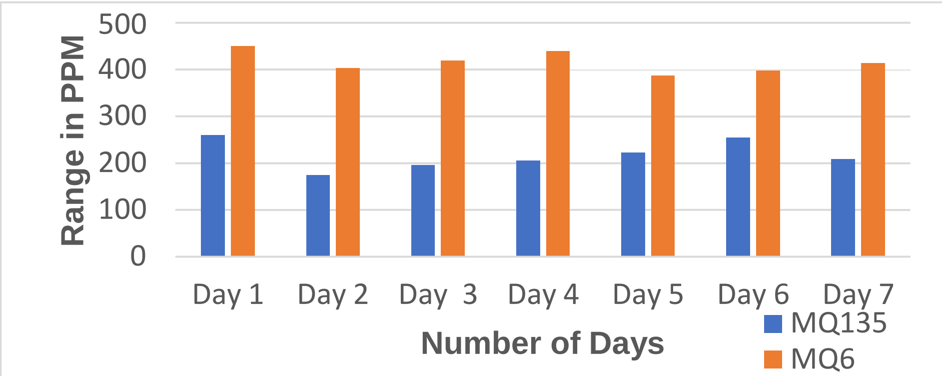


Fig.5.1 Air Quality on selected Days with Smoke as pollution

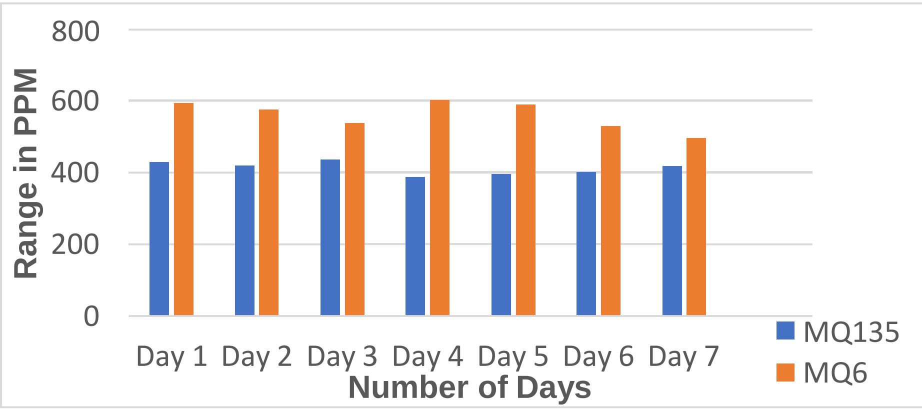


Fig.5.2 Air Quality on selected Days with Sanitizer as pollution

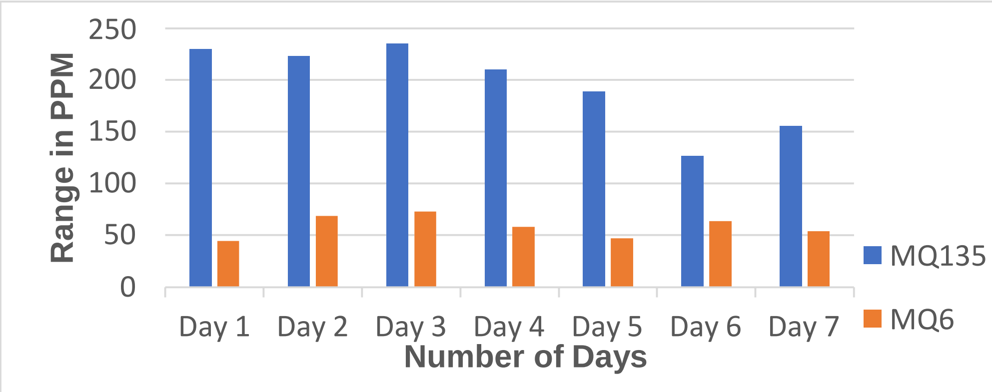


Fig.5.3 Air Quality on selected Days with Normal Air as pollution

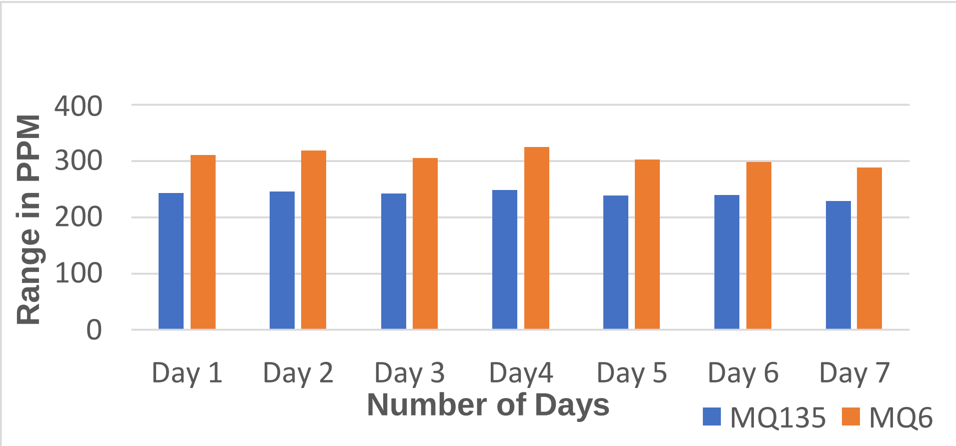


Fig.5.4 Air Quality on selected Days with Dust as pollution

After the observation of different samples of gases, we can conclude the following range of observation of gases in PPM.

Range in PPM	Air Quality Index	Associated Health Efforts
0-50	Good	Minimal Impact
51-100	Satisfactory	May cause minor breathing discomfort to sensitive people.
101-200	Moderately polluted	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.

201-300	Poor	May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease
301-400	Very Poor	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
401-500	Severe	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.
500-1000	Dangerous	may occurs to death

Fig.5.5 Air Quality Index Report

From the other side of the monitoring In here, we use the pH sensor for the water quality test the different samples of water like ground water, distilled water, Tap water, Bottled drinking water, Acid rain sample.

- Groundwater flows through rocks and soil that can affect the water's pH level. For example, contact with sandstone results in a nearly neutral pH between 6.5 and 7.5. Limestone, on the other hand, can result in an alkaline pH of 8.5.
  Soils contain minerals and other substances that affect groundwater pH. Decaying organic matter in soils causes pH levels in groundwater to drop as low as 4.0. That pH level is well below the recommended 6.5 to 7.5 pH for drinking water.
  Human-induced pollution affects groundwater pH as well. For example, runoff from shale and coal mining contains iron sulphide, which can result in pH readings as low as 2.

- The pH level in a lake or stream is crucial for the survival of fish and aquatic plants. Freshwater lakes and streams typically have pH levels between 6.0 and 8.0. Deeper lakes usually have a higher pH near the surface.
  Aquatic organisms are sensitive to pH changes. For example, the optimal pH level for fish ranges from 6.5 to 9.0. At levels outside this range, fish become susceptible to poisoning from toxic chemicals. Changes in pH can also cause an overload of available plant nutrients, resulting in excessive plant growth and depleted oxygen levels for fish.
- In acidic water, iron causes a metallic taste as well as reddish stains on clothing and plumbing, while other metals such as lead are toxic.Alkaline or “hard” water contains excess calcium and other minerals thatcause the familiar scaly deposits on cookware and a bitter taste in coffee.

The main purpose of water testing with pH sensor is the water testing takes place on-site using a relatively small, portable meter or in a lab using a larger benchtop meter. The benchtop meter has a cup that holds the water sample and a glass probe with two specialized electrodes. The pH electrode measures the acidity of the water sample, while the reference electrode is immersed in a liquid with a fixed acidity. After the reading from the pH electrode is compared with the reading from the reference electrode, the meter converts the voltage to a pH level.

A pH meter provides a much more accurate reading than a test strip kit and prevents the mess associated with having to use droppers. Calibration before testing water samples ensures that the pH meter will provide accurate readings and test results.

The importance of pH in Water is the Water quality is crucial for all living things, as well as for agriculture and recreation. Optimal pH levels are an essential factor in maintaining water quality and healthy ecosystems. Accurate pH testing helps keep drinking water and groundwater safe and helps protect aquatic plants and animals.

- pH values are measured on a scale of 0 to 14.
- It measures the alkalinity and acidity of water and other solutions with this type of sensor pH sensors help assure the safety and quality of water from manufacturing facilities.
- We know that if the pH of a sample is <7 it is acidic, =7 is neutral, >7 is basic.

Below table is the different samples of water that are collected and determined their pH values.

Type of Water	pH level
Tap Water	7.5
Distilled Reverse Osmosis water	5 to 7
Packaged Drinking water	6.5 to 7.5
Bottled water with 5mg of salt	8 to 9

Fig. 5.5 common water pH levels

APPLICATIONS:

- The air quality sensor is used to detect the amount of air pollution in the air as ppm levels.
- It is a combination of sensors and electronics to enable every citizen monitor and protect our environment.
- This data is processed by microcontroller to get the current air quality.
- alert message on display to the user.
- Roadside pollution monitoring.

- Industrial perimeter monitoring.
- Site selection for reference monitoring stations.
- Wide detecting scope.
- Pollution levels in the drinking water can be measured
- Industrial effluents released into lakes can be determined.

LIMITATIONS:

- Only 3 sensors are used.
- Humidity should be less than 95%.
- Accurate measure of contaminating gases cannot be detected in ppm.

CONCERNS:

Air quality monitors require up to 7 days to calibrate. The sensors used in the air quality monitors are very expensive. Moreover, their maintenance cost is also very high. It can detect compounds that cannot be detected by sight, taste, or smell. Water quality is determined by just Here we are using OLED in place of LCD display and it is cost effective. We are also in the view to use STM32 bit microcontroller in place of Arduino Uno for better results. Simple, compact, and easy to handle. No need to carry multiple devices because this project mainly focuses on air and water monitoring as well as displaying time. Continuous update of change in percentage of quality.

CHAPTER 6
IoT STANDARDS

STM32W series of Wireless MCUS

The STM32W extends the STM32 family to the IEEE 802.15.4 wireless network domain bringing outstanding radio and low-power microcontroller performances.

- Embedded 2.4 GHZ IEEE 802.15.4 radio
- Best-in-class code density, thanks to its ARM Cortex-M3 core
- power architecture.
- Open platform with extra resources for application integration:
- Configurable I/OS, ADC, timers, SPI, UART
- Main software libraries: RF4CE, IEEE 802.15.4 MAC, ZigBee-PRO, 6LOWPAN and more.

With a configurable total link budget up to 109 dB and the efficiency of the ARM Cortex-M3 core, the STM32W is a perfect fit for the wirele sensor network market.

The STM32W series includes devices with 64 to 256 K Flash, up to 16 KRam and is available in VFQFN40, UFQFN48 and VFQFN48 packages.

STM32W - IEEE 802.15.4 System on Chip

- Microcontroller
  ARM Cortex-M3 core architecture
- Embedded memory
  eFlash: 64 Kbytes or 128 Kbytes
  SRAM: 8 Kbytes
- IEEE 802.15.4, 2.4 GHz radio
  Transmitter: 2-point direct synthesizer modulation
  Receiver: low IF super heterodyne architecture.
  Digital baseband DSP and MAC support
  -100 dBm sensitivity and up to 7 dBm output power.

- Networking

  ZigBee compliant PRO, IP and RF4CE stacks.

  6lowPan Contiki open source

  IEEE 802.15.4 optimized MAC library

- Peripherals

  AES-128 encryption HW accelerator

  Debug channel via JTAG

  USART, SPI, PC, 24 GPIOs

- Other

  QFN48 and QFN40 packages available

HIGHEST PERFORMANCE BASED ON CORTEX-M4: STM32 F4 SERIES WITH DSP AND FPU

- 608 CoreMark at 180 MHz from Flash
- Up to 2-Mbyte dual-bank Flash, 256-Kbyte SRAM
- SDRAM, TFT LCD controller with graphics acceleration and serial audio interface

ULTRA-LOW-POWER BASED ON CORTEX-M3: STM32 L1 SERIES

- Now operates at 20% lower power
- 0.9 µA in Standby mode +RTC
- New STM32L100 Value line now available

MIXED-SIGNAL BASED ON CORTEX-M4: STM32 F3 SERIES WITH DSP AND FPU

- Fast 12-bit ADC, 5 MSPS and precise 16-bit sigma-delta ADCs
- Fast comparators (50 ns), programmable gain amplifiers (4 gains, 1% accuracy), 12-bit DACs

ENTRY LEVEL BASED ON CORTEX-M0: STM32 F0 SERIES

- From 16- to 128-Kbyte* embedded Flash
- Comes with even smaller package (TSSOP20)
- New STM32F030 Value line now available.

CHAPTER 7

CONCLUSION:

- The system to monitor the air of environment using STM32 microcontroller,
- Different levels of pH as be measured and the water suitable drinking as been identified.
- Air pollutant have been measured and identified by these sensors MQ135, MQ6.
- Here, using the MQ135 or gas sensor gives the sense of different type of dangerous gases.
- The system can sound the alarm to alert the user when the air quality is detected in a hazardous condition pH sensor for water whether it is safe for drinking and for the daily purposes.
- We had tested the working of various sensors like MQ135, MQ6, pH Now we had to integrate the gas sensors and water quality sensors into a single working model with the inclusion of SMT32 Microcontroller.
- We had successfully calibrated the STM32 microcontroller and used it in the place of Arduino Uno as the development board and satisfied with its efficiency in giving the desired results that we expected.

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