TOXIC GAS DETECTION IN MANHOLES

CSE3009 – Internet of Things

PROJECT BASED COMPONENT REPORT

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(Deemed to be University under section 3 of UGC Act, 1956)

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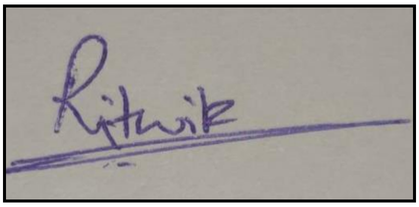
<u>**DECLARATION**</u>

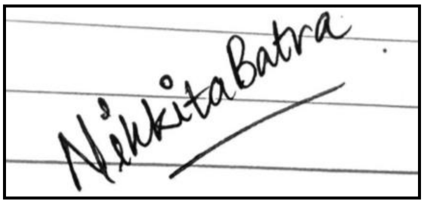
I hereby declare that the report entitled **TOXIC GAS DETECTION IN MANHOLES** submitted by me, for the CSE3009 Internet of Things (EPJ) to VIT is a record of bonafide work carried out by me under the supervision of Dr.N.Narayanan Prasanth.

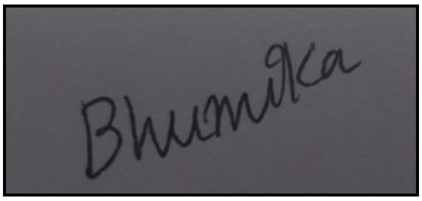
I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for any other courses in this institute or any other institute or university.

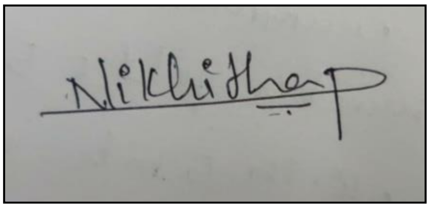
Place : Vellore

Date:26/05/2021









Signature of the Candidate

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Acknowledgement:

It is our privilege to express our sincerest regards to our teacher, Narayanan Prasanth, for his valuable inputs, able guidance, encouragement, whole-hearted cooperation and constructive criticism throughout the duration of the project. We deeply express our sincere thanks to our Head of Department and the Dean for encouraging and allowing us to present the project on the topic “Detection of Toxic gases in Manholes” for Internet of Things course. We pay our respects to our parents and all the other family members for supporting us throughout our career. Lastly, we express our appreciation to our friends for their cooperation and support.

Abstract:

Sewage systems are cleaned by physical labor. Over the years lots of death’s and environmental concern’s have been alarmingly increasing. Sewer gas is a composite amalgamation of venomous and hazardous gases. Predominantly It comprises oxides of carbon , Sulphur , nitrogen, ammonia and methane due to household or industrial wastes. Due to gases being trapped in manholes for prolonged periods of time, they become toxic and can be fatal if the right precautions aren't taken.

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INTRODUCTION

1.1. OBJECTIVE:

The objective of this project is to develop making an IOT device which gives real time statistics of the concentration of various gases in manholes. Not only will this device detect toxic gases, but it will also send the data of the infected manhole to the right authorities for further action. The data would be sent over the internet and also stored in a real time database.

Smart Drainage System helps to alert an workers of various gas levels, obstacle detection by using system application stores the sensor performance to reduce the future accidents in drainage channel along with efficient monitoring, high performance monitoring system and in a safe manner. The intelligence of sensors and system will identify the clogging inside the drainage system and will give the details of the location and other information for further actions.

1.2. MOTIVATION:

With increasing industrialization, we are learning about more life-threatening casualties. Sewage systems are cleaned by physical labor. Over the years lots of death's and environmental concerns have been alarmingly increasing. Sewer gas is a composite amalgamation of venomous and hazardous gases. Predominantly It comprises oxides of carbon, sulphur, nitrogen, ammonia and methane due to household or industrial wastes. Due to gases being trapped in manholes for prolonged periods of time, they become toxic and can be fatal if the right precautions aren't taken. The workers risk their lives to go in manholes in order to help everyone. Statistics show that there are numerous deaths due to gas poisoning from the toxic gases in these tunnels. Manholes leading to underground supply systems are essential for their maintenance, for example, it concerns telecommunication networks, water supply networks, gas supply networks and electricity networks, and so on. Although it is very crucial to a city's operations, the manhole can be one of the least protected and most vulnerable assets. To combat this, we are developing an affordable device which can help the social workers detect the gas levels and also send the details of infected manholes to the government.

LITERATURE SURVEY

1 .Portable Sensor Array System for Intelligent Recogniser of Manhole Gas

-Sugato Ghosh / Hiranmay Saha

- In this paper, a sensor array of 5 sensors was used with which various gases would be detected(methane, carbon dioxide, carbon monoxide, hydrogen sulfide,Ammonia).
- A GC machine was used to detect the gases and due to limitations, a chemical method was used in order to assess the gases. The issue with this is that due to this, the readings were not found immediately and could potentially be very hazardous as the readings can be looked over and immediate work cant start.
- The device is a simple gas collection system with a suction pump which is connected to sensors and a battery. This device is also not connected over the internet which delays the process of calculation and thereby imposes a higher chance of causalities and accidents.
- https://ieeexplore.ieee.org/iel5/6428838/6461638/06461748.pdf
- **Published in:** 2012 Sixth International Conference on Sensing Technology (ICST)
- Date of Conference: 18-21 Dec. 2012
- Date Added to IEEE *Xplore*: 14 February 2013
- DOI: 10.1109/ICSensT.2012.6461748

2. Smart Manhole Toxic Gas Identification and Alerting System

- L.K.Hema,Velmurugan S, Suriya. Pa, R. Indumathi

- .Sewer gas is a composite amalgamation of venomous and non-hazardous gases, which is collected in sewage systems. To conquer these impacts, in this proposed system, by using a set of integrated sensors MQ-4, MQ-7, MQ137 were incorporated with microcontroller unit process and LCD Display to quantify toxic gases which is produced in the system. It could be used to recognise the scale of toxicants and then intimated to the workers to acquire the safety precautions before entering into the manholes.
- The sensing range for the leak detection sensor should be from 300 ppm to 10,000 ppm. It is also mentioned that an additional sprinkler mechanism will be added which will help reduce predominant gases using suitable detoxification agent, when the gas exceeds its threshold limits.

- The sprinkler mechanism is a new and interesting concept we have learnt from this paper. However, this device does not provide the provision of sending alerts over the internet which is something we wish to implement for the increased safety of the workers / consumers of this product.
- https://www.ijrte.org/wp-content/uploads/papers/v8i3/A2150058119.pdf
- ISSN: 2277-3878, Volume-8 Issue-3, September 2019

3. Gas-Mixture using Classification Methods –

-Varun Kumar Ojha · Parmartha Dutta ·Atal Chaudhuri

- The main goal in this paper is to identify the hazardousness of sewer-pipeline to offer safe and non-hazardous access to sewer-pipeline workers.
- The dataset acquired through laboratory tests, experiments, and various literature-sources were organized to design a predictive model that was able to identify/classify hazardous and non-hazardous situation of sewer-pipeline.
- To design such prediction model, several classification algorithms were used and their performances were evaluated and compared, both empirically and statistically, over the collected dataset. In addition, the performances of several ensemble methods were analysed to understand the extent of improvement offered by these methods. They have categorized the classifiers in the four different groups of classifiers. Each category of classifiers contains three classifiers.
- This device isn't connected over the internet and doesn't give an alert if the reading are in hazardous levels. A person needs minimum 7-8 minutes training before he uses this device, which isn't very feasible in emergency situations. The statistical analysis of the algorithm is also complicated and consumes more time when compared to a device that is connected over internet
- https://arxiv.org/pdf/1707.00561.pdf
- arXiv:1707.00561v1 [cs.NE] 16 May 2017

4. Detection of Toxic Gases using Arduino and GSM Network

-T. Siddharthan,S. M. Kasiraj

- Department of Control &Instrumentation, Valliammai Engineering College, Chennai-603203, Tamil Nadu, India
- The main objective of this project is to detect the toxic gases while cleaning the drainage. During the cleaning process the toxic gases like nitrogen oxide, carbon monoxide and other gases are emitted. It can be detected by different sensors and indicated to alert the users and also a warning message is send to the base station to make the safety measures to the workers from the effect of toxic gases. Hence the system will help to solve the problem while cleaning the drainage.
- The above system helps the workers only in drainage cleaning from the effect of toxic gases. The device is portable . This device doesn't monitor the sewage toxic levels. It's just used during the cleaning. It can't be used to keep constant tabs on the levels of gases. In the existing system the worker will be in danger zone, it will send only an vibration alert to the higher officials or to the control room by the vibrator module
- https://www.ijert.org/research/detection-of-toxic-gases-using-arduino-and-gsm-network-IJERTCONV4IS24015.pdf
- International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Published by, www.ijert.org AMASE - 2016 Conference Proceedings

5. Electro-chemical gas sensor for multi-gas detection application –

-J. Kathirvelan 2011

- developed a system to detect minimum four gases by use of noble material and suitable intelligent techniques to prepare electrode and electrolyte.
- This process is a complex procedure to study and examine because of gases coming from reactions and it also can cause measure inaccuracy in value of gases. use of electrodes or electrolyte with multi metallic electrodes can increase the sensitivity towards particular gas which present in gas mixture.
- Indian Journal of Science and Technology Vol. 4 No. 11 (Nov 2011)

6. To Design & Analysis of Underground Drainage and Manhole Monitoring System for Smart Cities

- Nathila Anjum. G1 , Saniya Kouser. K2 , Pragathi M. S3 , Soundarya P. P4 , Prashanth Kumar H. K5 UG Student1, 2, 3, 4, Assistant Professor5 ,2020 UESC.
- Detect the location
- The system governing the flow of sewage from the pipes.
- Use of flow sensors to detect the variations in the flow.
- Get the prior alerts of blockages and locate them using IOT. Trace location using GPS and send SMS through GSM.
- Similar problem : No of monitoring and continuous tabs on the environment in the manhole.
- Point to be considered : GPS for blockages.

7. IoT Based Underground Drainage Monitoring System

- G Chandhini, B Chithra, P Kiruthikadevi, Bhagya Sasi, V. Kamal KumarInternational Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-9 Issue-3, September 2020
- Exposure of sewage workers to poisonous gases like hydrogen sulphide, sulphur dioxide, carbon monoxide, methane, ammonia, nitrogen oxide increases the death of the sewage workers. T
- The main aim of this paper is the designing of a network system which helps in monitoring poisonous gases present in sewage. Whenever the gas level crosses the threshold value, the information with different gas ppm values is displayed in the smart phone through the app. It also indicates whether it is safe for the manual scavengers to work in the environment or not.
- Here six gas sensors such as MQ136, MQ135, MQ4, MQ7,SO2, N02 are used for monitoring hazardous gases such as hydrogen sulphide, ammonia, methane, carbon monoxide, sulphur dioxide, nitrogen oxide. These six sensors are connected to Node MCU and the output is connected to digital dashboard through server and to buzzer and LED.
- This paper successfully shows the efficient detection of various hazardous gases and is also connected over the internet for safe prevention, however there is no provision for solving the problem at hand, which is something we would like to implement in our project.

8. Editors’ Choice - Critical Review - A Critical Review of Solid State Gas Sensors

- -Gary W. Hunter, Sheikh Akbar, Shekhar Bhansali, Michael Daniele, Patrick D. Erb, Kevin Johnson, Chung-Chiun Liu, Derek Miller, Omer Oralkan, Peter J. Hesketh, Pandiaraj Manickam, and Randy L. Vander Wal
- Journal of the Electrochemical Society, 2020
- Solid state gas sensors are a core enabling technology to a range of measurement applications including industrial, safety, and environmental monitoring. The technology associated with solid-state gas sensors has evolved in recent years with advances in materials, and improvements in processing and miniaturisation. This paper addresses chemical sensors that measure concentrations of gas species using “solid state” sensor platforms, whose sensing mechanism involves a reaction of the gas species with the sensing element in the sensing structure, and conversion of that reaction into an electrical signal. This paper has examined the state-of-the-art in multiple sensor technologies with the goal of understanding: 1) The core technology and approaches describing the sensor design and sensing mechanism, and how that mechanism is used to provide a measurement of the ambient gas species; 2) Sensor response based on that core technology, and how it can be modified to provide specific functionality for a given application and gas species measurement with an example structure; 3) Future prospects discussing critical issues, challenges, and future directions in the field for each sensor class.
- This paper has provided a series of examples of a subset of the available types of gas sensors, and even those examples could only address a small fraction of these individual subfields.

9. A risk-based methodology for the optimal placement of hazardous gas detectors

- Kang Cen, Ting Yao, Qingsheng Wang, Shengyong Xiong
- May 2018
- Hazardous gas detection systems play an important role in preventing catastrophic gas-related accidents in process industries. In this paper, a risk-based methodology is being proposed to optimize the placement of hazardous gas detectors. The methodology includes three main steps, namely, the establishment of representative leak scenarios, computational fluid dynamics (CFD)-based gas dispersion modeling, and the establishment of an optimized solution.

- Based on the combination of gas leak probability and joint distribution probability of wind velocity and wind direction, a quantitative filtering approach is presented to select representative leak scenarios from all potential scenarios. Finally, a practical application of the methodology is performed to validate its effectiveness for the optimal design of a gas detector system in a high-sulfur natural gas purification plant.
- From this paper, we learn that this methodology provides an effective approach to guide the optimal placement of point-type gas detection systems involved with either single or mixed gas releases.
- https://www.sciencedirect.com/science/article/abs/pii/S1004954117311084

10. IoT Device For Sewage Gas Monitoring And Alert System

- Nitin Asthana, Ridhima Bahl
- April 2019
- DOI:10.1109/ICIICT1.2019.8741423
- Conference: 2019 1st International Conference on Innovations in Information and Communication Technology (ICIICT)
- This project aims at providing smart solutions to monitor poisonous sewage gases and works on a system of live sewage level detection and monitoring. Whenever, a certain threshold is crossed, an alert is sent to the observer who is examining the conditions from a remote location. The information is then forwarded along with different gas ppm values indicating whether it is safe for the worker to clean or work in that environment or not.
- The remotely placed IoT monitoring equipment and IoT platform are integrated to create proposed system. This requires calibration of gas sensors for industrial purposes and determining the correct threshold levels for septic plants and facilities.
- The hardware is designed such that it shall send a prior alert to the sewage worker to ensure their safety, if damaging gaseous constituents increase in concentration over time. Various types of sensors are utilized to monitor parameters present in sewage like gas, temperature etc.

- When the threshold value is lesser than the sensed values, this system alerts the sewage worker/cleaner by sending SMS and call alerts by analyzing concentrations of different toxic gases and graphing out their results for real-time monitoring thereby aiding in protection from hazardous diseases and hence serves a social cause as well.
- From this paper we learn that in the proposed system, sample values for sensors have been recorded and plotted on ThingSpeak analysis tool. Carbon monoxide and methane sensors charted values up-to 2.3 and 60 ppm respectively, and this breached threshold and GSM module was utilized for sending alert to mobile number fed in the code.
- https://ieeexplore.ieee.org/document/8741423

11. IoT based Sewage Monitoring and Alert System using Raspberry PI

- Jyothi Chillapalli
- August 2020
- DOI:10.32628/CSEIT12064114
- In this paper, the intention has been to provide a system that can quantify and analyze the amount of harmful gasses in real time and send a warning message when the levels are beyond the threshold.
- This project attempts to device an IoT technology using Raspberry Pi, ThingSpeak platform, and Pushover application.
- The gas levels along with humidity and temperature shall be observed. The experimental results show that whenever the gas levels exceed the threshold, the authorized individuals receive an alert on the connected mobile devices. In addition, the device offers live streaming of video to check blockages, if any. The directions for future research have been included at the end of the conclusion.
- The system comprises gas sensors namely methane and carbon monoxide, apart from which an additional sensor that will measure the humidity and temperature is connected.
- The IoT analytics platform produces graphs and sends warnings whenever the gas values go beyond the standard limits.

- The attached camera can provide live video on the HTTP server, which can be used to identify blockages that guide workers to take the appropriate precautions.
- https://www.researchgate.net/publication/345766681_IoT_based_Sewage_Monitoring_and_Alert_System_using_Raspberry_PI

12. Smart Sewage Alert System For Workers In Real-Time Applications Using IoT

- M. Lizzy Nesa Bagyam, B. Raja Nithya, D. Rubikumar, S.Sangeetha , J.Santhosh
- INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 9, ISSUE 02, FEBRUARY 2020
- In this paper, it is discussed about the method to measure the water level in sewage continuously using the ultrasonic sensor. The toxicity of CO and methane gases are also sensed to avoid danger for human life.
- The objective of this system is to obtain an effective low-cost and flexible solution for checking water level and sensing the toxicity of gas and updating it in real time through IoT. In this system, it is shown that the level of drainage is continuously monitored.
- It also senses the toxicity of gas, as well as sending automatic SMS, if the toxicity of the gas measured is above an expected normal range.
- Since the output of level and gas sensors are interfaced with microcontroller, it checks the threshold level and sends an alert message through GSM and monitored using IoT. The main advantage of this proposed system is to avoid deaths due to exposure of harmful sewage gas.
- From this paper we learn that, a level sensor is also used to detect the water level in the drainage. It also displays the level. It does not detect the level continuously. If the water level in drainage exceeds above the normal range, it causes leakage and affects the environment.
- Sensor is used to detect the clog. When the drain is clogged, water will have a difficult time passing through the time, causing drainage to be slower than usual. To overcome the above drawbacks, the proposed system uses level and gas sensor with WEMOS D1.

- In this method, a sensor node containing two gas sensors and a level sensor that transfers the appropriate sensed information about the harmful gases and water levels of drainage system. The WEMOS D1 checks for the specific conditions and it sends automatic SMS through GSM and update it in real time through IoT.
- http://www.ijstr.org/final-print/feb2020/Smart-Sewage-Alert-System-For-Workers-In-Real-time-Applications-Using-Iot.pdf

13. Drainage Monitoring System Using IoT

- Aditya Patel, Parth Dave, Aatish Patel
- International Journal for Research in Engineering Application & Management (IJREAM)
- ISSN : 2454-9150 Vol-06, Issue-08, NOV 2020
- The purpose of this research paper is explained as a successful attempt to develop a system based on the concept of Drainage Water Automation.
- The system will consist of hardware in order to capture various harmful gases by sensors in Sewage lines that can cause human breathing systems, and software to analyse the capture data by different sensors on the display screen.
- Their major goal is given as receiving and capturing data from sewage lines and to perform analysis on the received data to extract and interpret useful harmful gases by various sensors and use them in real-time applications.
- By using various sensors such as gas detection, water level as well as blockage detection one can monitor the real-time scenario of the drainage system by detecting the problems in the drainage system.
- By doing this one would be able to take particular action to the problems due to the early alerts of blockage as well as increase.
- One very helpful component that we observed in this paper is the efficient use of Java Firebase Realtime Database, Android Studio and Java in addition to the hardware.
- http://ijream.org/papers/IJREAMV06I0868012.pdf

14. Iot Based Smart Safety Monitoring System For Sewage Workers With Two Way Communication

- A. Vellingiri, K. Dharni, M. Arunadevi, R.L. Aravind Lal
- International Research Journal of Engineering and Technology (IRJET)
- Volume: 07 Issue: 06 | June 2020
- In this paper, the system is proposed with gas sensors like Carbon Monoxide, Hydrogen sulphide sensors and Methane, one Heart Beat sensor used to Calculate the pulse rate of Human.
- Carbon Monoxide, Hydrogen sulphide, Methane gases are highly toxic to human hence the proposed system will gives alert through the LCD Display after reaching the threshold level of each gas sensors then people gets alerts Heart Beat sensor will calculate the range of the Pulse rate then output at the abnormal range will give alert through notification through an IOT.
- The Heart beat sensor is a new concept observed by us in this specific research paper.
- In the given system if the worker is in a danger zone, it will send only a vibration alert to the higher officials or to the control room by the vibrator module, which is also an interesting and fresh addition to these kind of systems.
- https://www.irjet.net/archives/V7/i6/IRJET-V7I6599.pdf

15. Smart Underground Drainage Blockage Monitoring and Detection System Using IoT

- Ankita Karale, Snehal Dhurjad, Seema Lahamage, Mansi Chaudhari, Arati Gend
- International Research Journal of Engineering and Technology (IRJET)
- Volume: 07 Issue: 02 | Feb 2020
- In this paper it is mentioned that, due to poor maintenance of the underground drainage system, the water in the drainage system gets mixed up with the pure water and consumption of this polluted water leads to water borne diseases.
- The sudden changes in the atmosphere and variations in the climate during different seasons the drainage gets blocked or water logged, making environment unhealthy and disturbs the healthy routine of common people.

- To overcome all these issues in the underground drainage system we have designed the smart drainage system that will have:
- Sensors to detect blockage, flood and gases.
- The intelligence of sensors and system can clogging the impeding within the system and will offer the details of the location and different data for further actions.
- System will also sense hazardous gases like methane (CH_4), Sulphur Di-oxide(SO_2) carbon monoxide (CO) etc.
- As the level of such gases pass value worth thee system will generate the alert using alarm system by which the Health department can take correct action on it.
- These entire data packet will be jointly sent by the gateway node and stored at the cloud all the system, we are able to simply monitor, modify and rectify the issues in real time.
- The interesting factor observed in this paper was th use of ultrasonic blockage detection sensor.
- https://www.irjet.net/archives/V7/i2/IRJET-V7I2452.pdf

16. IoT based Sewage Monitoring System

- Anushka Pendharkar, Jyothi Chillapalli, Kanishka Dhakate, Subhalaxmi Gogoi
- October 2020
- DOI:10.2139/ssrn.3697395
- Conference: International Conference on Recent Advances in Computational Technology(E - ICRACT 2020)At: Amity University Mumbai
- The aim of this paper is to measure and analyze the real-time levels of toxic gases. In order to ensure the safety of the workers working under such severe conditions.
- This project attempts to device an IOT technology that shall detect the humidity, temperature levels, and mixture of gases, sensing each type of gas to measure its level while keeping track of the real-time dynamic changes in the above factors.
- If levels exceed beyond the threshold, it shall send an alert on the connected mobile devices of the authorized people who are remotely located in the job.
- If any blockage is encountered, it can be monitored with the help of live video streaming, which is a an innovative addition to the project.
- https://www.researchgate.net/publication/345766646_IoT_based_Sewage_Monitoring_System

17. IoT based Low-Cost Gas Leakage, Fire, and Temperature Detection System with Call Facilities.

- Sourav Debnath, Samin Ahmed, Suprio Das, Abdullah Nahid
- December 2020
- DOI:10.1109/ICAICT51780.2020.9333530
- Conference: International Conference on Advanced Information and Communication TechnologyAt: Dhaka, Bangladesh
- The proposed work is a simple system using low-cost devices, has been designed to send a phone call to the user via the GSM module in case of any gas or smoke leakage. It also sends data to the alarm, alerting the users and sending a graphical alert to the server via NodeMCU.
- Besides, a temperature sensor also detects the temperature of that hazardous situation at the same time and sends data to the web server.
- Different algorithms are being employed to know the sensor's early predictions' overall accuracy in real-life-critical situations through the machine learning approach.
- This proposed work will contribute if gas leaks or fires occur at home or in the industry, then people can take the necessary precaution in advance.
- https://www.researchgate.net/publication/346654851_IoT_based_Low-Cost_Gas_Leakage_Fire_and_Temperature_Detection_System_with_Call_Facilities

18.Automated Internet of Things for Underground Drainage and Manhole Monitoring System for Metropolitan Cities

- Muragesh SK, Santosha Rao
- International Journal of Information & Computation Technology
- ISSN 0974-2239 Volume 4, Number 12 (2014), pp. 1211-1220
- Automated Internet of Things for Underground Drainage and
- The vital considerations of this proposed system are low cost, low maintenance, fast deployment, and high number of sensors, long life-time and high quality of service. The proposed model provides a system of monitoring the water level and atmospheric temperature and pressure inside a manhole and to check whether a manhole lid is open. It also monitors underground installed electric power lines. In real time, UDMS can remotely monitor current states of the manholes.

- Underground installed electric power lines are also monitored through temperature sensors. Pressure sensors are used to avoid manhole explosions, explosions can be a result of the release of chemical and electrical energy. So the main focus is monitoring manholes using sensors. If drainage gets blocked and water overflows, and if manhole lid is opens, it is sensed by the sensors, then that sensor sends information via transmitter which is located in that area to the corresponding managing station.
- An important observation is the unique system architecture of the proposed system, which is quite different to the ones observed in other research papers.
- ...https://www.ripublication.com › irph › ijict_spl

TECHNICAL SPECIFICATIONS

ARDUINO UNO :

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

ESP8266 (WIFI MODULE) :

Processor: L106 32-bit RISC microprocessor core based on the Tensilica Xtensa Diamond Standard 106Micro running at 80 MHz[5]

Memory:

- 32 KiB instruction RAM
- 32 KiB instruction cache RAM
- 80 KiB user-data RAM
- 16 KiB ETS system-data RAM

External QSPI flash: up to 16 MiB is supported (512 KiB to 4 MiB typically included)

IEEE 802.11 b/g/n Wi-Fi

- Integrated TR switch, balun, LNA, power amplifier and matching network
- WEP or WPA/WPA2 authentication, or open networks

17 GPIO pins[6]

SPI

I²C (software implementation)[7]

I²S interfaces with DMA (sharing pins with GPIO)

UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2

10-bit ADC (successive approximation ADC)

OLED DISPLAY :

Monochrome 7-pin SSD1306 0.96" OLED display.
128×64 pixel resolution with 160° viewing angle.
Supply voltage 3V – 5V (supports both 5V and 3.31v logic devices).
Uses SSD1306 for interfacing hence can communicate through SPI or IIC.
Multiple SPI or IIC devices are supported
Can be easily interfaced with Arduino (Library available).
Supports decent graphics of bitmap images.
Available in different colors and sizes as discussed below

MQ-135 SENSOR :

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)
Can be used as a Digital or analog sensor

MQ-4 SENSOR :

Power requirements: VCC - 5V±0.1

DO output: TTL digital 0 and 1 (0.1 and 5V)

AO output: 0.1-0 .3 V (relative to pollution), the maximum concentration of a voltage of about 4V

Detection Gas: Natural gas/Methane

Detection Concentration: 200-10000ppm (Natural gas / Methane)

Interface: 1 TTL compatible input (HSW), 1 TTL compatible output (ALR)

Heater consumption: less than 750mw

Operating temperature: 14 to 122 °F (-10 to 50°C)

RH Related humidity less than 95%Rh

Load resistance: 20KΩ

Sensing Resistance Rs: 10KΩ- 60KΩ (1000ppm CH_4)

GSM800I SENSOR

- Supply voltage: 3.8V - 4.2V
- Recommended supply voltage: 4V
- Power consumption:
    - sleep mode < 2.0mA
    - idle mode < 7.0mA
    - GSM transmission (avg): 350 mA
    - GSM transmission (peek): 2000mA
- Module size: 25 x 23 mm
- Interface: UART (max. 2.8V) and AT commands
- SIM card socket: microSIM (bottom side)
- Supported frequencies: Quad Band (850 / 950 / 1800 /1900 MHz)
- Antenna connector: IPX
- Status signaling: LED
- Working temperature range: -40 do + 85 ° C

DHT11 SPECIFICATIONS

Operating Voltage: 3.5V to 5.5V

Operating current: 0.3mA (measuring) 60uA (standby)

Output: Serial data

Temperature Range: 0°C to 50°C

Humidity Range: 20% to 90%

Resolution: Temperature and Humidity both are 16-bit

Accuracy: ±1°C and ±1%

DESIGN

HARDWARE USED:

MQ136
MQ137
MQ4
MQ7
LCD (LIQUID CRYSTAL DISPLAY) LCD
Temperature Sensor
GPS The Global Positioning System
GSM SIM900 GSM
WIFI Module The ESP8266
Arduino Uno

MQ136

MQ136 gas sensor has high sensitivity to H2S gas, also can monitor organic vapor including sulphur well. It a kind of low-cost sensor for kinds of applications. Detection range : 1～200ppm

MQ135 :

Ammonia , benzene , smoke and co2 MQ137 Gas Sensor can be used to monitor the concentration Ammonia gas (NH3).The gas-sensitive material used in the MQ137
Gas sensor is tin dioxide (SnO2), which has low conductivity in clean air. When ammonia is present in the environment, the conductivity of the sensor increases as the ammonia concentration in the air increases. A simple circuit can be used to convert the change in conductivity into an output signal corresponding to the concentration of the gas. Detection range : 1～500ppm

MQ4 :

The methane gas sensor detects the concentration of methane gas in the air and output is an analog voltage . The concentration of sensing range is about 300 ppm to 10,000 ppm The sensitivity of the detector is set by a resistive load between the output pins and ground. The sensor's conductivity increases when the gas concentration gets increases. MQ-4 gas sensor has high sensitivity to methane. Methane gas sensor The specifications of methane gas sensor are.

MQ7 :

carbon monoxide : A carbon mono-oxide or MQ-7 sensor is used to measure carbon mono-oxide gas [4].The most common principles for CO sensors are infrared gas sensors and chemical gas sensors. The CO Gas Sensor measures gaseous carbon mono-oxide in two ranges 0 to 10,000 ppm and 0 to 100,000 ppm.

LCD (LIQUID CRYSTAL DISPLAY) :

LCD is finding wide spread use replacing LEDs (seven segment LEDs or other multi segment LEDs) because of the following reasons: 1. The declining prices of LCDs. 2. The ability to display numbers, characters and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.

GSM SIM900 GSM :

Module is the module that supports communication in 900MHz band. We are from India and most of the mobile network providers in this country operate in the 900 MHz band. If you are from another country, you have to check the mobile network band in your area. A majority of United States mobile networks operate in 850 MHz bands (the band is either 850 MHz or 1900 MHz). Canada operates primarily in 1900 MHz band.

(DHT11 Temperature Sensor)The DHT11 :

is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed).

ESP8266 Wifi Module:

The ESP8266 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 function from another application processor.

Arduino Uno / Arduino Uno Wifi :

The Arduino Uno is an open-source microcontroller board based on the microchip ATmega328P microcontroller .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.

SOFTWARE IMPLEMENTATION

Arduino IDE ArduinoIDE IDE stands for "Integrated Development Environment":it is an official software introduced by Arduino.cc, that is mainly used for editing, compiling and uploading the code in the Arduino Device. Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module.

WORKING:

Various types of sensors are interfaced with microcontroller Arduino uno in order to make the system smart. When the respective sensors reach the threshold level, the indication of that respective value and sensor is being sent to the microcontroller. Furthermore, Arduino uno then sends the signal and location of the manhole to the municipal corporation through GSM and GPS and the officials could easily locate which manhole is having the problem and could take appropriate steps. Also, Arduino Uno updates the live values of all the sensors in the manholes falling under the respective area using IoT. A message will also be displayed on the LCD. The Air fan automatically switches on and off according to the rise in temperature.

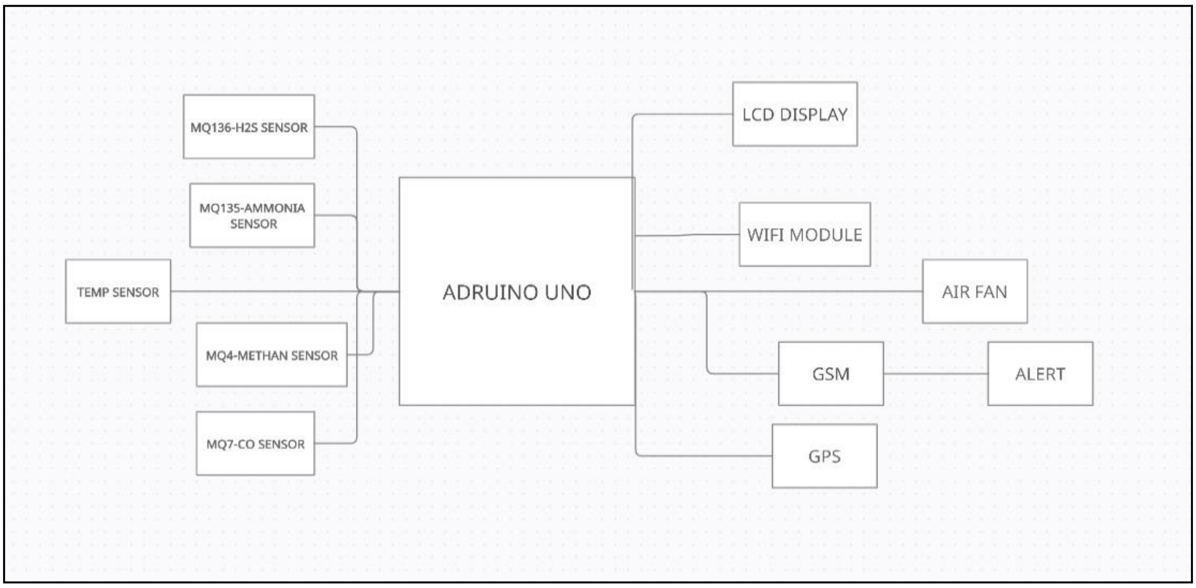


Figure: Working of the project

ARCHITECTURE/ ALGORITHM :

• Power Up hardware.

• Initialize hardware Module.

• Arduino sense Sensor value.

• Other sensors check for toxic levels in environment.

• If any sensor exceeds than its set value. Then GSM through message will be sent.

• Air fan would automatically turn and off according to the temperature levels.

• IOT used for sensor related data will be updated on the web server.

• All information will be display on LCD.

• STOP

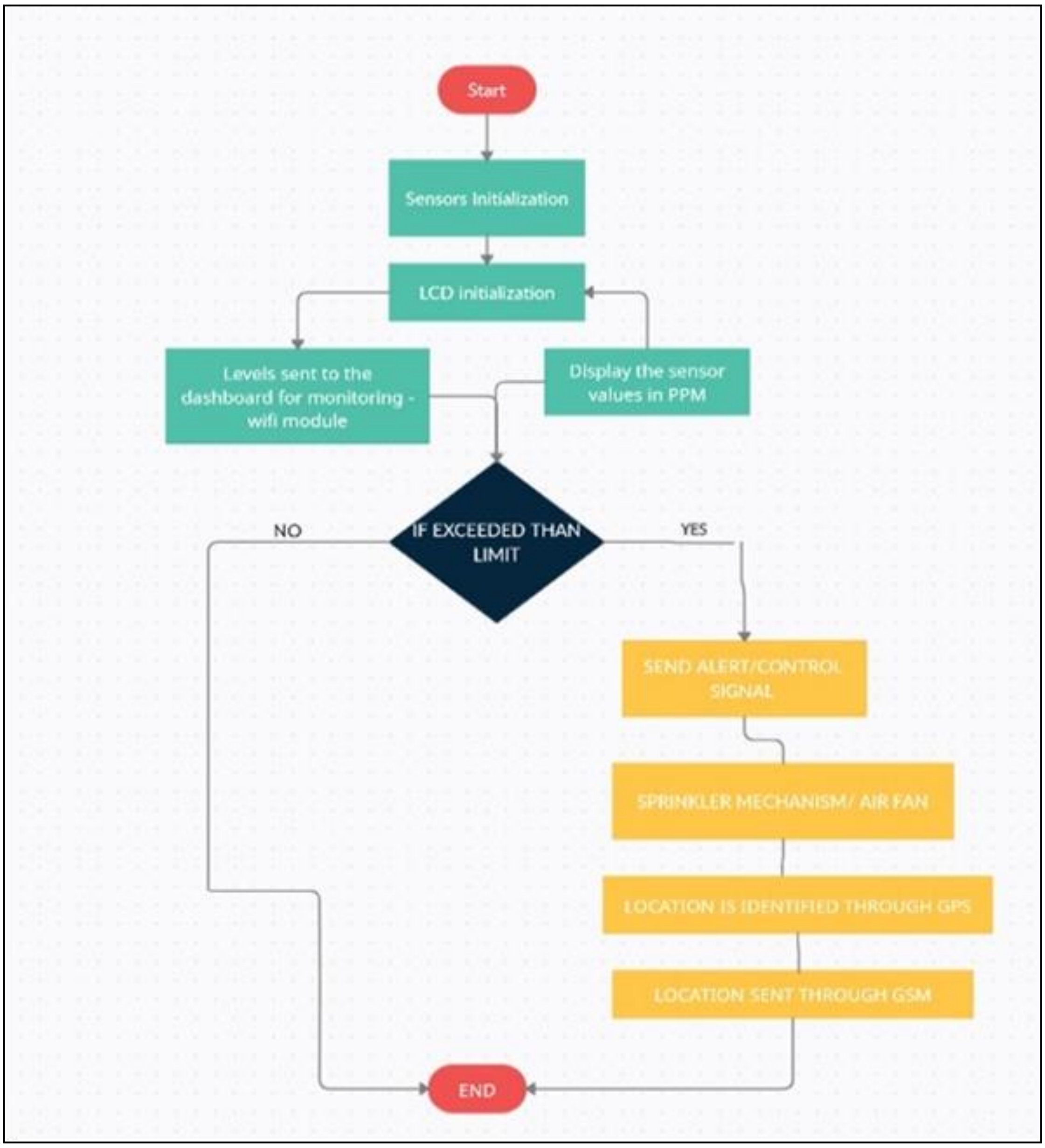


Figure: Algorithm Flow-chart

APPLICATION FOR THE PROJECT:

Figure: One screen APP

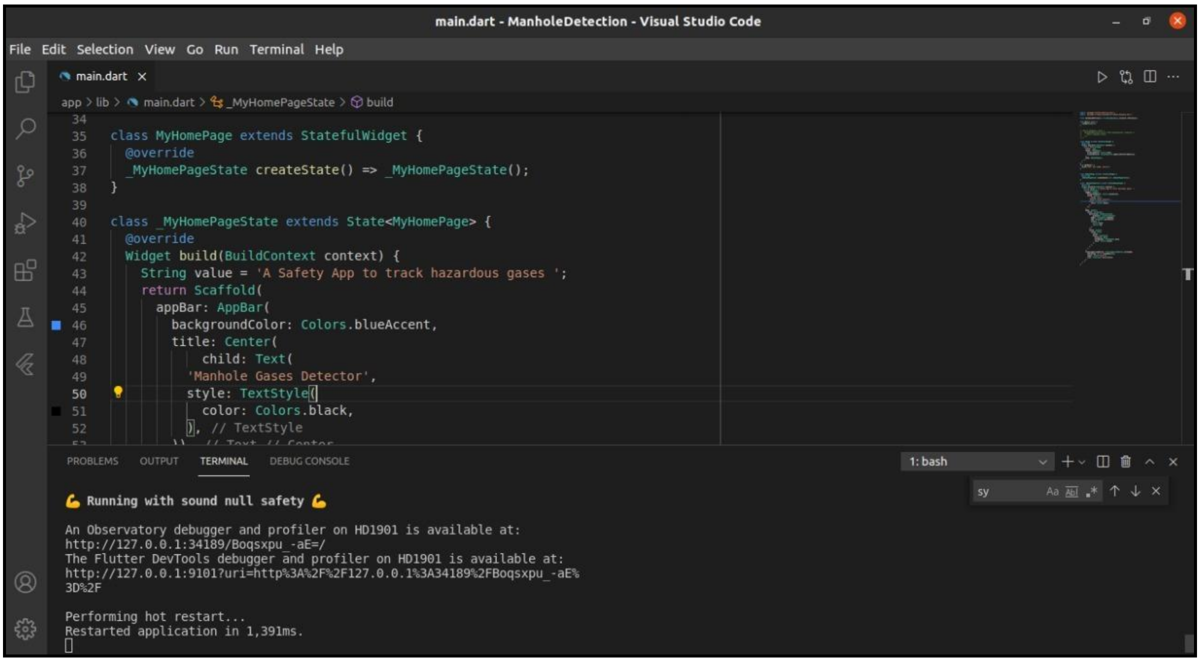


Figure: Code Running

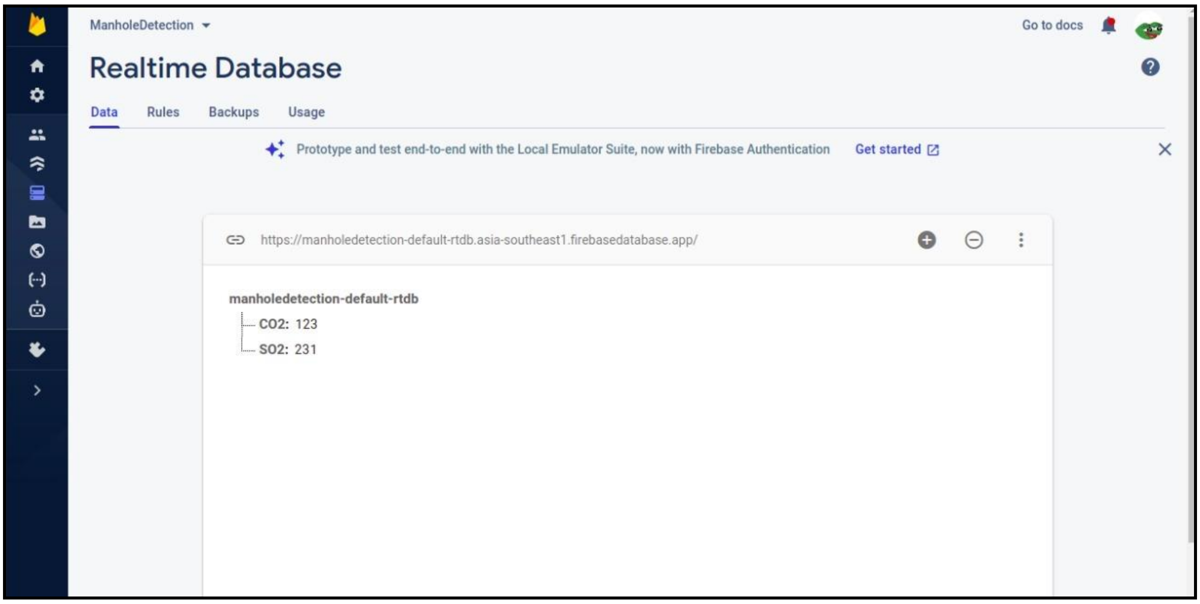


Figure: The real-time database on firebase

PROPOSED SYSTEM

The system proposed here is stated as:

The sensors and the LCD screen is initialized.

The Arduino

circuit is connected to the WiFi module which connects it to a Firebase database.

After the initialization of the hardware, there is an infinite loop in the Arduino code which repetitively keeps a track on the values calculated by the sensors.

Using conditional statements in the code, we can find out if the levels of toxic gases are hazardous and deadly.

In the Arduino code, we read the values from the sensors and record them in the real time database.

If the value from the sensors are hazardous, using the GSM Module, an SMS is sent to the owner of the module pointing the excess value.

All the data and location is stored for big data analytics of trends.

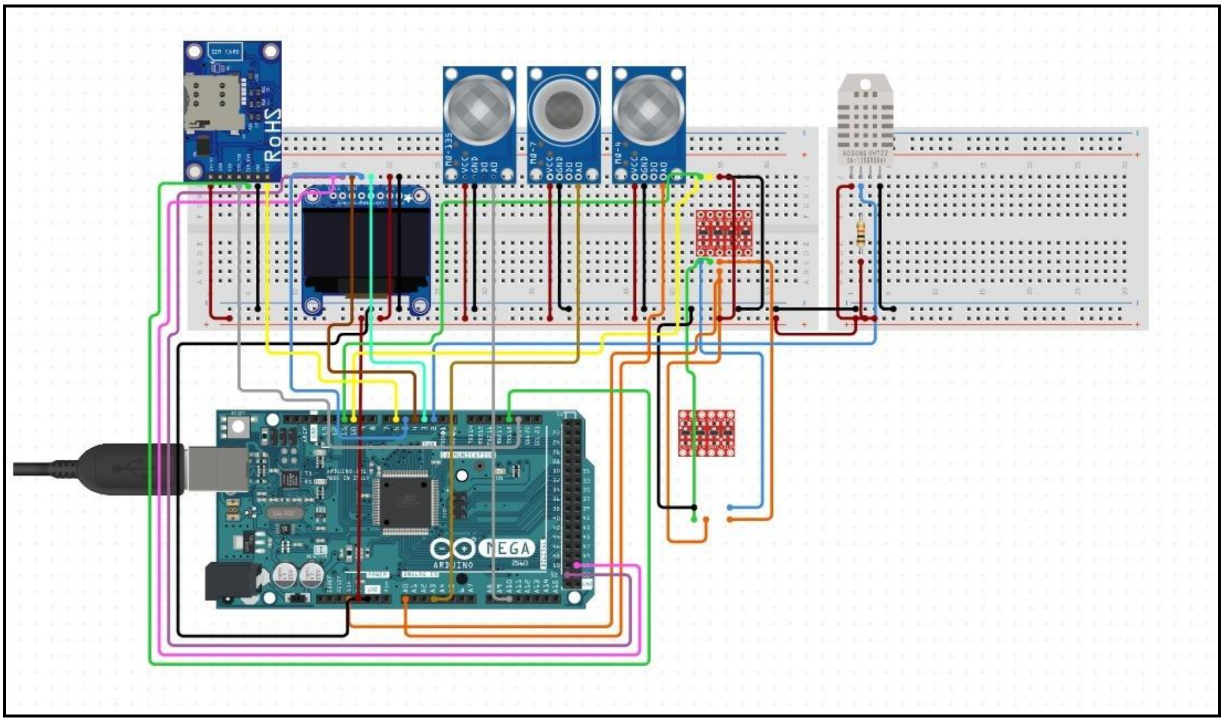


Figure: Project Circuit Diagram

RESULTS AND DISCUSSION

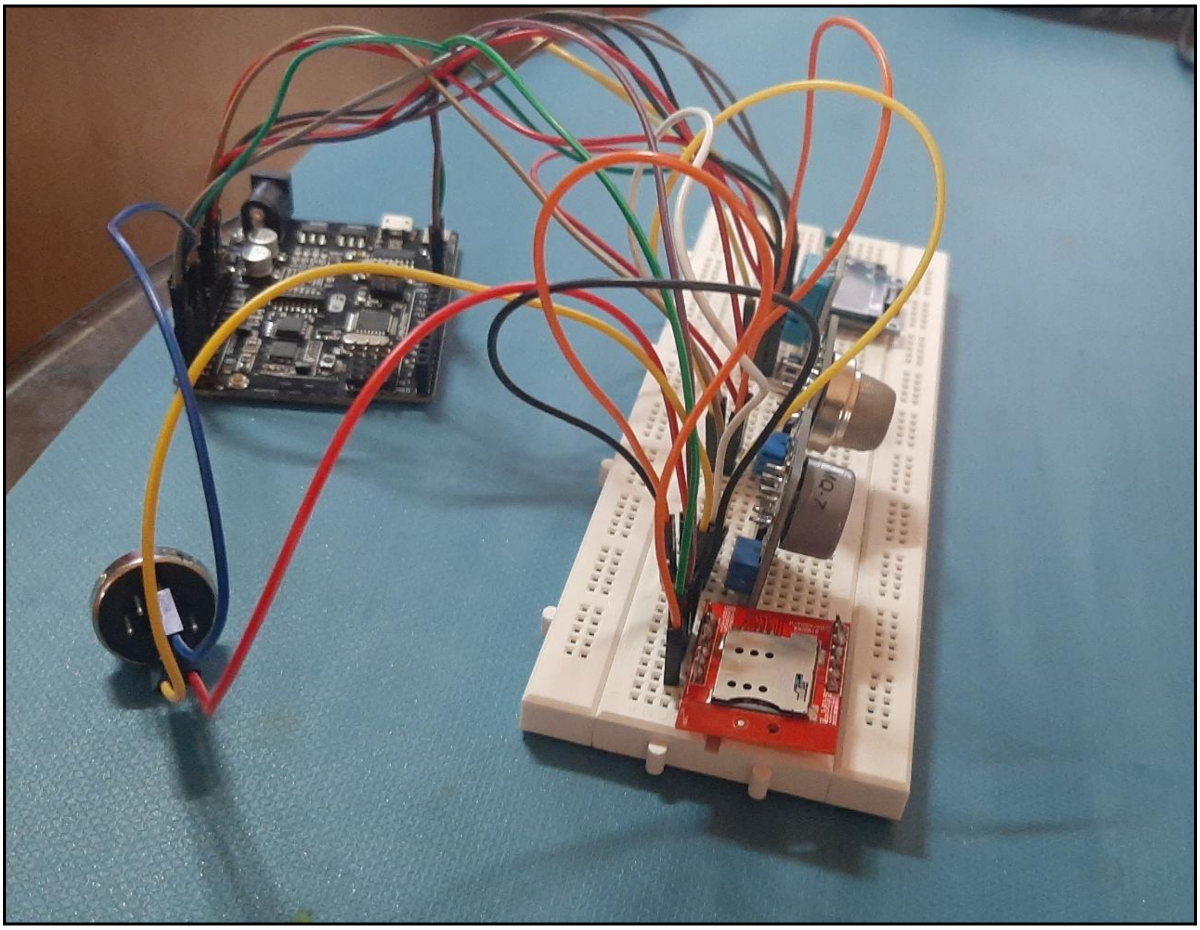


Figure: Hardware circuit connections(1)

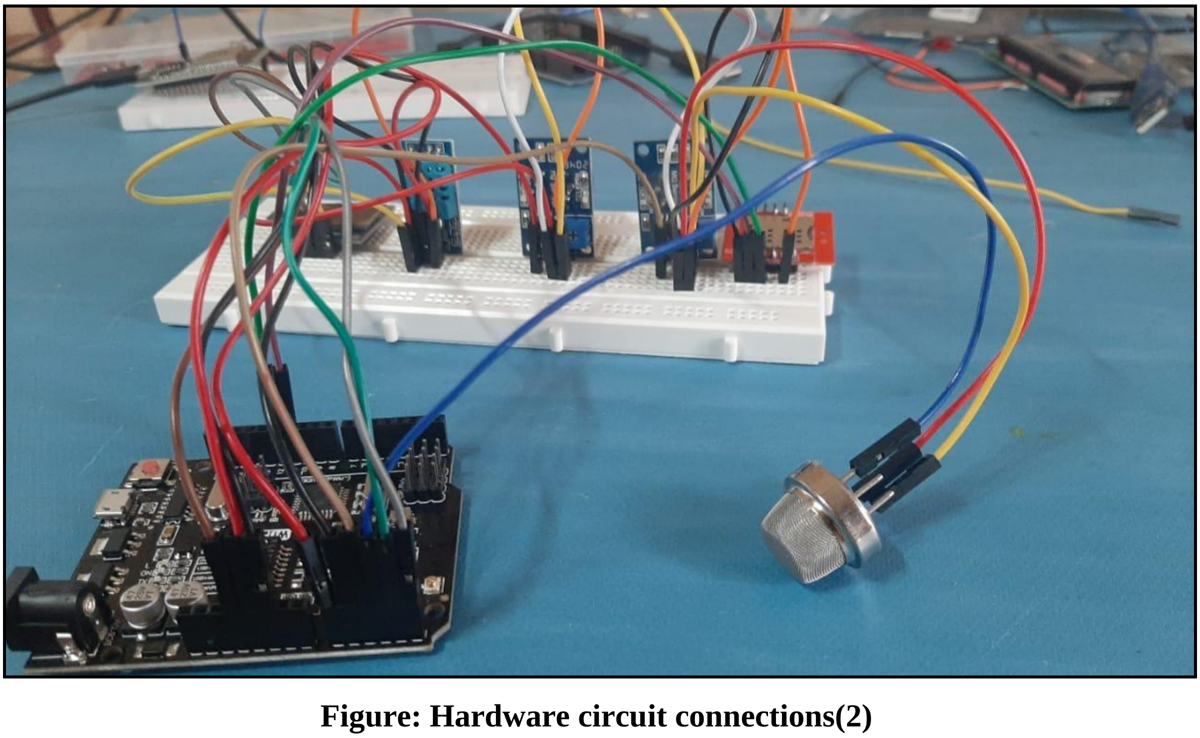


Figure: Hardware circuit connections(2)

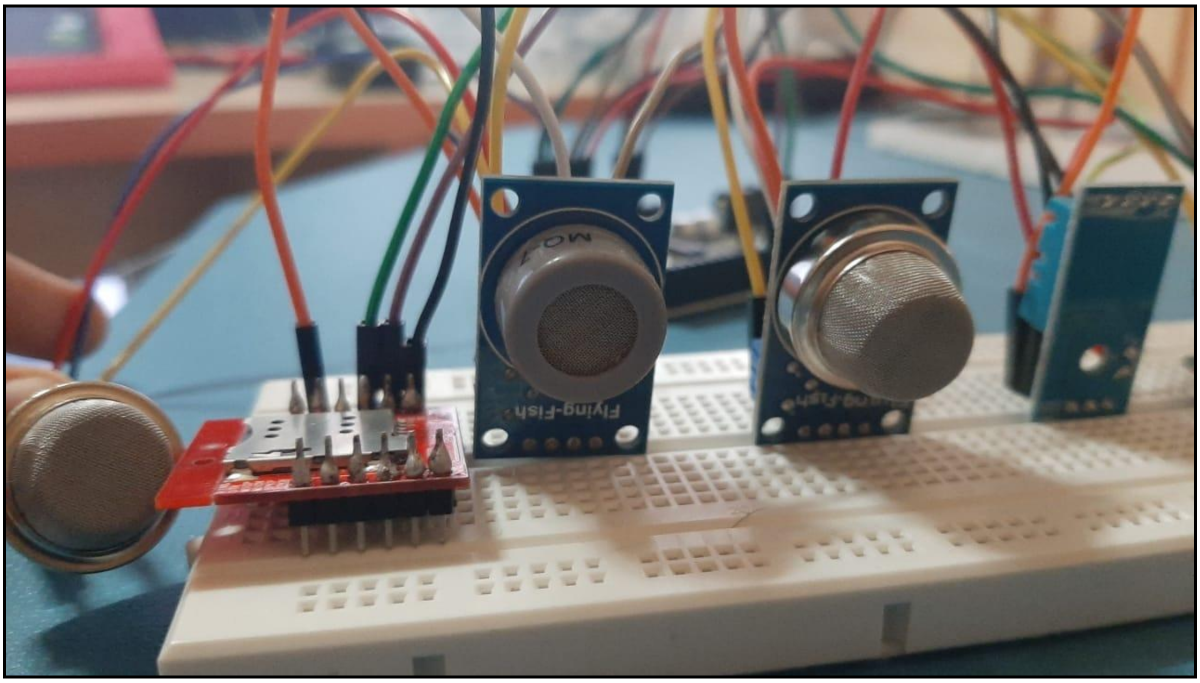


Figure: Hardware circuit connections(3)

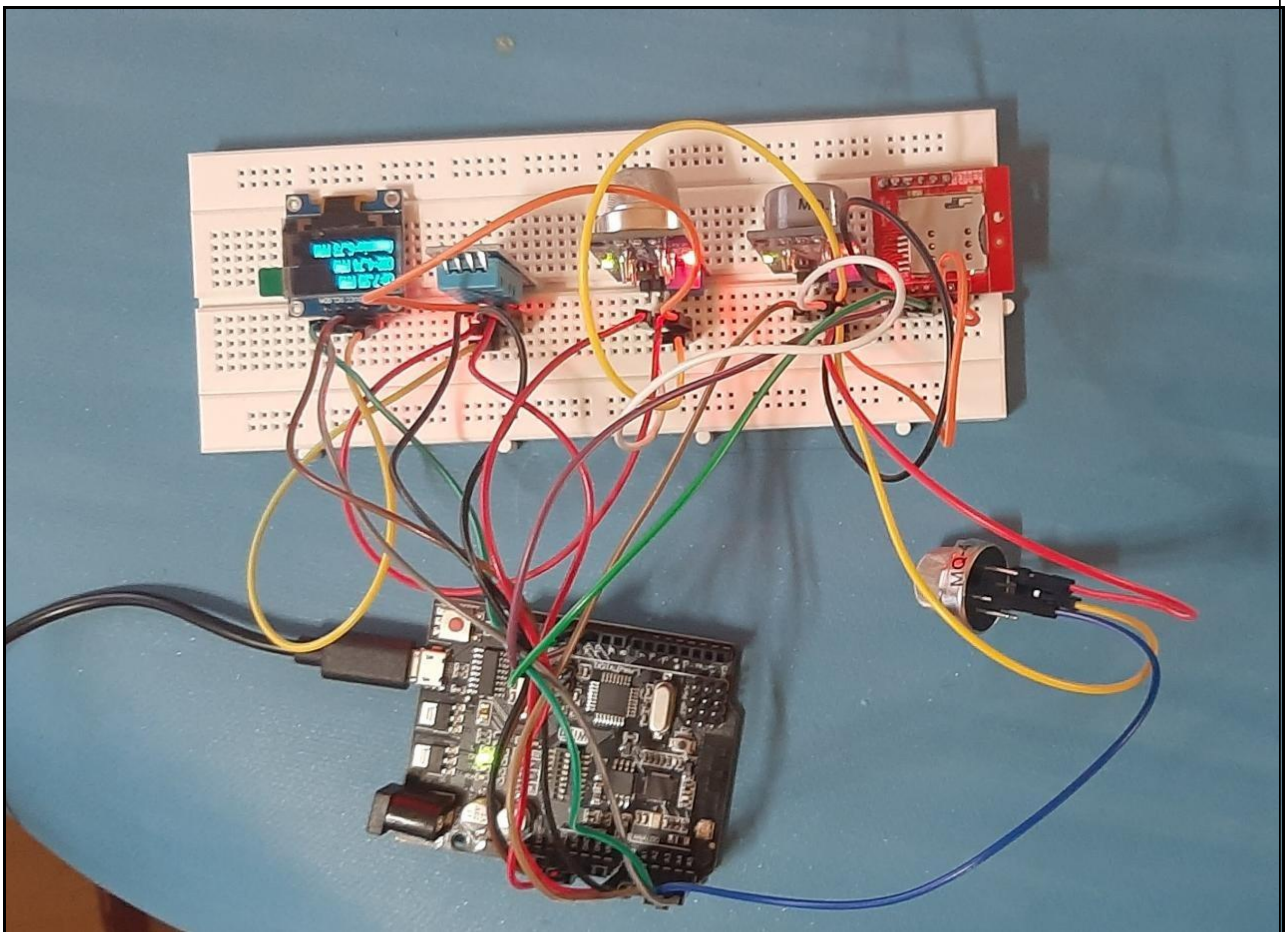


Figure: Output LED Display

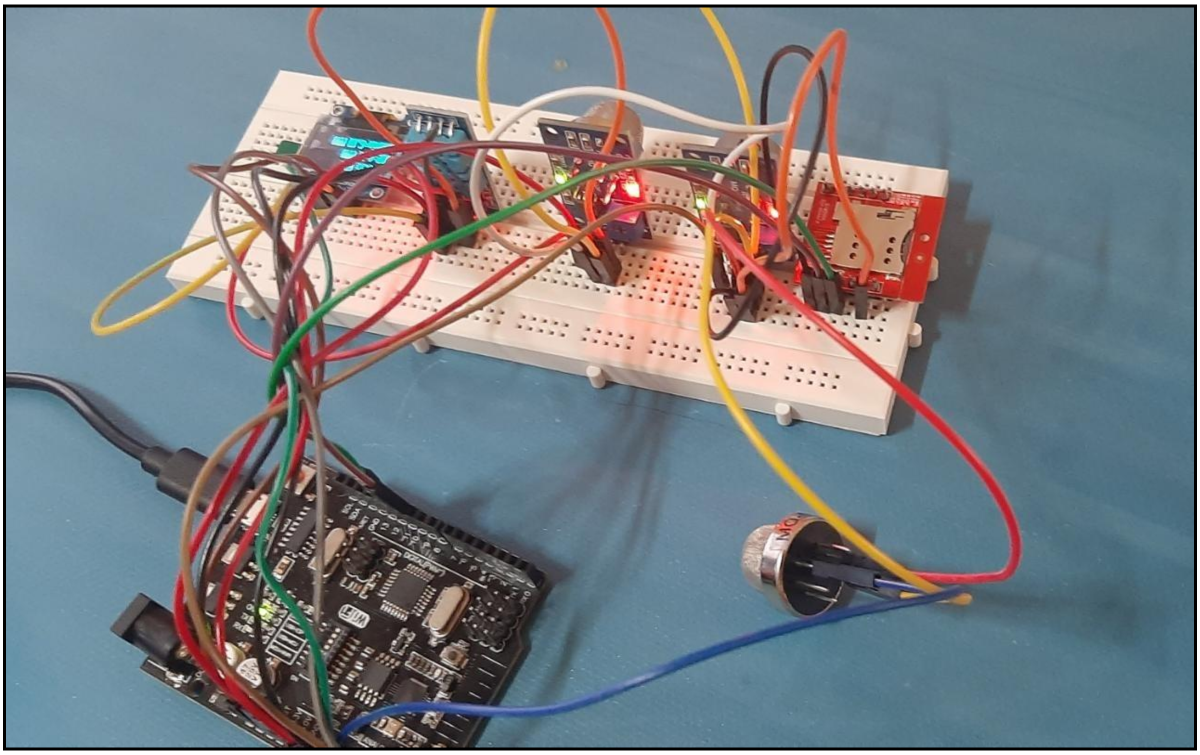


Figure: Output LED with working circuit

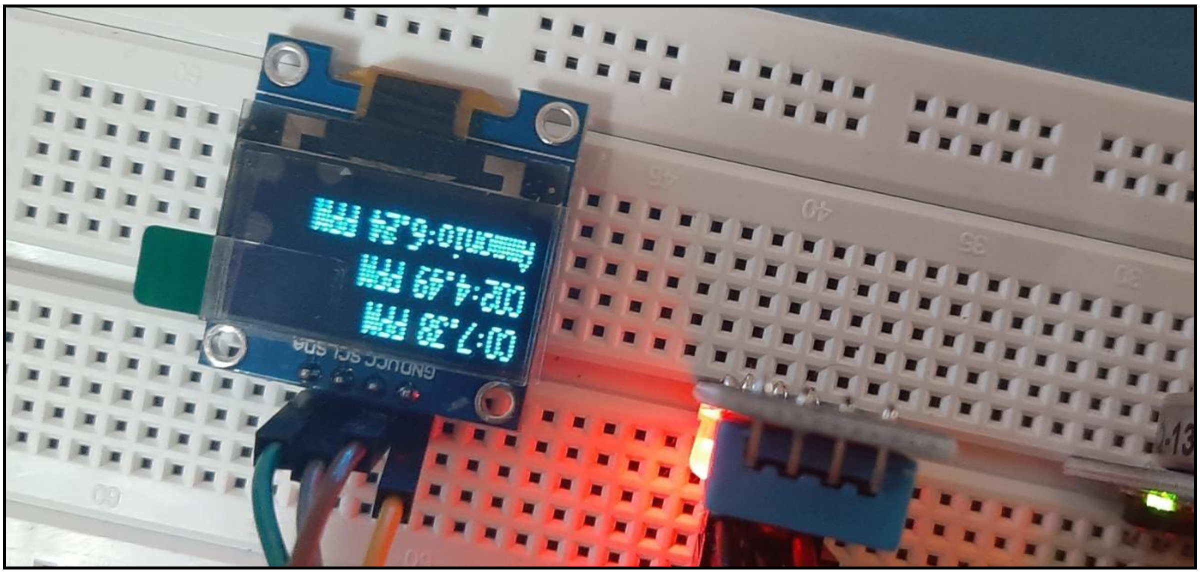
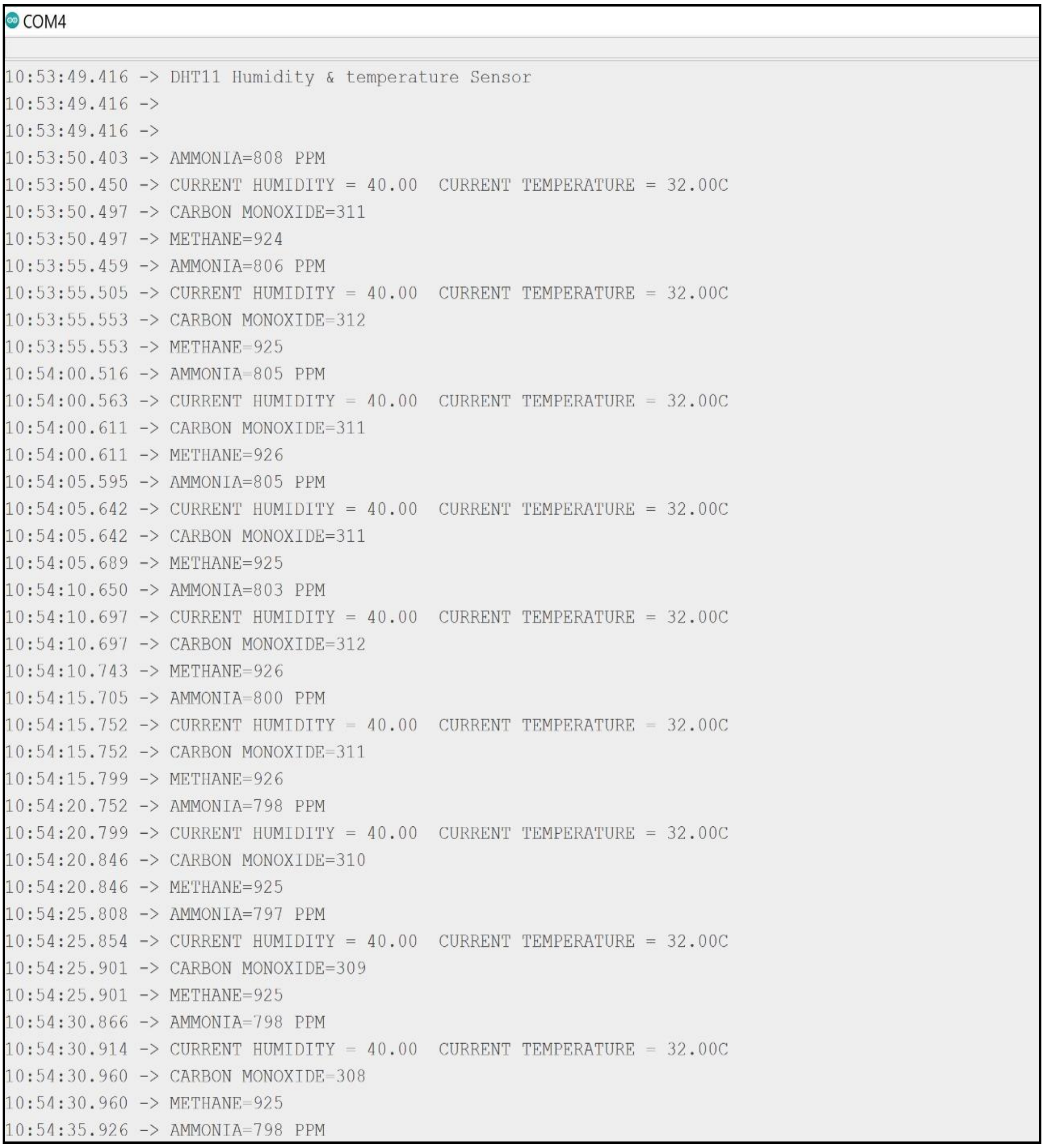


Figure: OLED Display of readings



```
COM4

10:53:49.416 -> DHT11 Humidity & temperature Sensor
10:53:49.416 ->
10:53:49.416 ->
10:53:50.403 -> AMMONIA=808 PPM
10:53:50.450 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:53:50.497 -> CARBON MONOXIDE=311
10:53:50.497 -> METHANE=924
10:53:55.459 -> AMMONIA=806 PPM
10:53:55.505 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:53:55.553 -> CARBON MONOXIDE=312
10:53:55.553 -> METHANE=925
10:54:00.516 -> AMMONIA=805 PPM
10:54:00.563 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:00.611 -> CARBON MONOXIDE=311
10:54:00.611 -> METHANE=926
10:54:05.595 -> AMMONIA=805 PPM
10:54:05.642 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:05.642 -> CARBON MONOXIDE=311
10:54:05.689 -> METHANE=925
10:54:10.650 -> AMMONIA=803 PPM
10:54:10.697 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:10.697 -> CARBON MONOXIDE=312
10:54:10.743 -> METHANE=926
10:54:15.705 -> AMMONIA=800 PPM
10:54:15.752 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:15.752 -> CARBON MONOXIDE=311
10:54:15.799 -> METHANE=926
10:54:20.752 -> AMMONIA=798 PPM
10:54:20.799 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:20.846 -> CARBON MONOXIDE=310
10:54:20.846 -> METHANE=925
10:54:25.808 -> AMMONIA=797 PPM
10:54:25.854 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:25.901 -> CARBON MONOXIDE=309
10:54:25.901 -> METHANE=925
10:54:30.866 -> AMMONIA=798 PPM
10:54:30.914 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:30.960 -> CARBON MONOXIDE=308
10:54:30.960 -> METHANE=925
10:54:35.926 -> AMMONIA=798 PPM
```

Figure: Simulation output of the project screenshot(1)

```
10:54:30.914 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:30.960 -> CARBON MONOXIDE=308
10:54:30.960 -> METHANE=925
10:54:35.926 -> AMMONIA=798 PPM
10:54:35.981 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:35.981 -> CARBON MONOXIDE=309
10:54:36.031 -> METHANE=925
10:54:40.971 -> AMMONIA=796 PPM
10:54:41.017 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:41.065 -> CARBON MONOXIDE=314
10:54:41.065 -> METHANE=923
10:54:46.024 -> AMMONIA=795 PPM
10:54:46.070 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:46.118 -> CARBON MONOXIDE=315
10:54:46.164 -> METHANE=924
10:54:51.110 -> AMMONIA=797 PPM
10:54:51.156 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:51.156 -> CARBON MONOXIDE=323
10:54:51.208 -> METHANE=926
10:54:56.168 -> AMMONIA=799 PPM
10:54:56.215 -> CURRENT HUMIDITY = 40.00  CURRENT TEMPERATURE = 32.00C
10:54:56.215 -> CARBON MONOXIDE=327
10:54:56.267 -> METHANE=912
10:55:01.187 -> AMMONIA=816 PPM
10:55:01.234 -> CURRENT HUMIDITY = 41.00  CURRENT TEMPERATURE = 32.00C
10:55:01.281 -> CARBON MONOXIDE=328
10:55:01.328 -> METHANE=928
10:55:06.282 -> AMMONIA=815 PPM
10:55:06.330 -> CURRENT HUMIDITY = 41.00  CURRENT TEMPERATURE = 32.00C
10:55:06.330 -> CARBON MONOXIDE=332
10:55:06.382 -> METHANE=920
10:55:11.338 -> AMMONIA=809 PPM
10:55:11.385 -> CURRENT HUMIDITY = 41.00  CURRENT TEMPERATURE = 32.00C
10:55:11.385 -> CARBON MONOXIDE=330
10:55:11.441 -> METHANE=921
10:55:16.402 -> AMMONIA=805 PPM
10:55:16.402 -> CURRENT HUMIDITY = 41.00  CURRENT TEMPERATURE = 32.00C
10:55:16.450 -> CARBON MONOXIDE=329
10:55:16.497 -> METHANE=922
```

Figure: Simulation output of the project screenshot (2)

CODE :

```
// Include Libraries
#include "Arduino.h"
#include "DHT.h"
#include "ESP8266.h"
#include "Wire.h"
#include "SPI.h"
#include "Adafruit_SSD1306.h"
#include "Adafruit_GFX.h"

// Pin Definitions
#define DHT_PIN_DATA  2
#define WIFI_PIN_TX 11
#define WIFI_PIN_RX 10
#define MQ135_5V_PIN_AOUT A10
#define MQ4_5V_PIN_AOUT A0
#define MQ7_5V_PIN_AOUT A3
#define OLED128X64_PIN_RST  5
#define OLED128X64_PIN_DC 4
#define OLED128X64_PIN_CS 3

// Global variables and defines
//
==================================================================
===
// vvvvvvvvvvvvvvvvvvvvvv ENTER YOUR WI-FI SETTINGS  vvvvvvvvvvvvvvvvvvvvv
//
const char *SSID     = "BHUMI"; // Enter your Wi-Fi name
const char *PASSWORD = "BHUMIKA123" ; // Enter your Wi-Fi password
//
// ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
//
==================================================================
===
```

```
char* const host = "www.google.com";
int hostPort = 80;
// object initialization
DHT dht(DHT_PIN_DATA);
ESP8266 wifi(WIFI_PIN_RX,WIFI_PIN_TX);
#define SSD1306_LCDHEIGHT 64
Adafruit_SSD1306 oLed128x64(OLED128X64_PIN_DC, OLED128X64_PIN_RST,
OLED128X64_PIN_CS);

// define vars for testing menu
const int timeout = 10000;       //define timeout of 10 sec
char menuOption = 0;
long time0;

// Setup the essentials for your circuit to work. It runs first every time your circuit is
powered with electricity.
void setup()
{
    // Setup Serial which is useful for debugging
    // Use the Serial Monitor to view printed messages
    Serial.begin(9600);
    while (!Serial) ; // wait for serial port to connect. Needed for native USB
    Serial.println("start");

    dht.begin();
    wifi.init(SSID, PASSWORD);
    oLed128x64.begin(SSD1306_SWITCHCAPVCC);  //
    oLed128x64.clearDisplay(); // Clear the buffer.
    oLed128x64.display();
    menuOption = menu();

}
```

```
// Main logic of your circuit. It defines the interaction between the components selected.
After setup, it runs over and over again, in an eternal loop.
void loop()
{
    if(menuOption == '1') {
    // DHT22/11 Humidity and Temperature Sensor - Test Code
    // Reading humidity in %
    float dhtHumidity = dht.readHumidity();
    // Read temperature in Celsius, for Fahrenheit use .readTempF()
    float dhtTempC = dht.readTempC();
    Serial.print(F("Humidity: ")); Serial.print(dhtHumidity); Serial.print(F(" [%]\t"));
    Serial.print(F("Temp: ")); Serial.print(dhtTempC); Serial.println(F(" [C]"));

    }
    else if(menuOption == '2') {
    // ESP8266-01 - Wifi Module - Test Code
    wifi.httpGet(host, hostPort);
    // get response buffer. Note that it is set to 250 bytes due to the Arduino low memory
    char* wifiBuf = wifi.getBuffer();
    //Comment out to print the buffer to Serial Monitor
    //for(int i=0; i< MAX_BUFFER_SIZE ; i++)
    //  Serial.print(wifiBuf[i]);
    //search buffer for the date and time and print it to the serial monitor. This is GMT time!
    char *wifiDateIdx = strstr (wifiBuf, "Date");
    for (int i = 0; wifiDateIdx[i] != '\n' ; i++)
    Serial.print(wifiDateIdx[i]);

    }
    else if(menuOption == '3')
    {
    // Disclaimer: The Hazardous Gas  Sensor - MQ-135
    }
    else if(menuOption == '4')
    {
    // Disclaimer: The Natural Gas (CNG) Sensor - MQ-4
    }
```

```
    else if(menuOption == '5')
    {
    // Disclaimer: The Carbon Monoxide Sensor - MQ-7
    else if(menuOption == '6') {
    // Monochrome 1.3 inch 128x64 OLED graphic display - Test Code
    oLed128x64.setTextSize(1);
    oLed128x64.setTextColor(WHITE);
    oLed128x64.setCursor(0, 10);
    oLed128x64.clearDisplay();
    oLed128x64.println("Circuito.io Rocks!");
    oLed128x64.display();
    delay(1);
    oLed128x64.startscrollright(0x00, 0x0F);
    delay(2000);
    oLed128x64.stopscroll();
    delay(1000);
    oLed128x64.startscrollleft(0x00, 0x0F);
    delay(2000);
    oLed128x64.stopscroll();
    }
    else if(menuOption == '7')
    {
    // Disclaimer: The QuadBand GPRS-GSM SIM800L
    }

    if (millis() - time0 > timeout)
    {
        menuOption = menu();
    }

}
// Menu function for selecting the components to be tested
char menu()
```

```
{

    Serial.println(F("\nWhich component would you like to test?"));
    Serial.println(F("(1) DHT22/11 Humidity and Temperature Sensor"));
    Serial.println(F("(2) ESP8266-01 - Wifi Module"));
    Serial.println(F("(3) Hazardous Gas  Sensor - MQ-135"));
    Serial.println(F("(4) Natural Gas (CNG) Sensor - MQ-4"));
    Serial.println(F("(5) Carbon Monoxide Sensor - MQ-7"));
    Serial.println(F("(6) Monochrome 1.3 inch 128x64 OLED graphic display"));
    Serial.println(F("(7) QuadBand GPRS-GSM SIM800L"));
    Serial.println(F("(menu) send anything else or press on board reset button\n"));
    while (!Serial.available());

    // Read data from serial monitor if received
    while (Serial.available())
    {
        char c = Serial.read();
        if (isAlphaNumeric(c))
        {

            if(c == '1')
          Serial.println(F("Now Testing DHT22/11 Humidity and Temperature Sensor"));
        else if(c == '2')
          Serial.println(F("Now Testing ESP8266-01 - Wifi Module"));
        else if(c == '3')
          Serial.println(F("Now Testing Hazardous Gas  Sensor - MQ-135 "));
        else if(c == '4')
          Serial.println(F("Now Testing Natural Gas (CNG) Sensor - MQ-4 "));
        else if(c == '5')
          Serial.println(F("Now Testing Carbon Monoxide Sensor - MQ-7"));
        else if(c == '6')
          Serial.println(F("Now Testing Monochrome 1.3 inch 128x64 OLED graphic
display"));
```

```
        else if(c == '7')
          Serial.println(F("Now Testing QuadBand GPRS-GSM SIM800L "));
          else
          {
              Serial.println(F("illegal input!"));
              return 0;
          }
          time0 = millis();
          return c;
        }
    }
}
```

DISPLAY ON OLED :

```
//Include the library
#include <MQUnifiedsensor.h>
#include <Adafruit_SSD1306.h>
#include <Adafruit_GFX.h>
//Definitions
#define placa "Arduino Nano"
#define Voltage_Resolution 5
#define pin A0 //Analog input 0 of your arduino
#define type "MQ-135" //MQ135
#define ADC_Bit_Resolution 10 // For arduino UNO/MEGA/NANO
#define RatioMQ135CleanAir 3.6//RS / R0 = 3.6 ppm
#define OLED_RESET     -1 // Reset pin # (or -1 if sharing Arduino reset pin)
//declare oled display
Adafruit_SSD1306 display(OLED_RESET);
```

```
//Declare Sensor
MQUnifiedsensor MQ135(placa, Voltage_Resolution, ADC_Bit_Resolution, pin, type);

//*************************************SETUP*****************************
******************//
void setup() {
  Serial.begin(115200); //Init serial port
  //Init the oled display
  display.begin(SSD1306_SWITCHCAPVCC, 0x3C);// initialize I2C addr to 0x3C ( for 
128x64 Display )
  display.display();
  delay(1000);
  display.clearDisplay();

  //Set math model to calculate the PPM concentration and the value of constants
  MQ135.setRegressionMethod(1); //_PPM =  a*ratio^b
  /*****************************  MQ Init 
********************************************/
  //Remarks: Configure the pin of arduino as input.

/*************************************************************************
***********/
  MQ135.init();
  /*
    //If the RL value is different from 10K please assign your RL value with the following 
method:
    MQ135.setRL(10);
  */
  /*****************************  MQ CAlibration 
********************************************/
```

```
  // Explanation:
  // In this routine the sensor will measure the resistance of the sensor supposing before was pre-heated
  // and now is on clean air (Calibration conditions), and it will setup R0 value.
  // We recomend execute this routine only on setup or on the laboratory and save on the eeprom of your arduino
  // This routine not need to execute to every restart, you can load your R0 if you know the value
  // Acknowledgements: https://jayconsystems.com/blog/understanding-a-gas-sensor
  Serial.print("Calibrating please wait.");
  float calcR0 = 0;
  for (int i = 1; i <= 10; i ++)
  {
    MQ135.update(); // Update data, the arduino will be read the voltage on the analog pin
    calcR0 += MQ135.calibrate(RatioMQ135CleanAir);
    Serial.print(".");
  }
  MQ135.setR0(calcR0 / 10);
  Serial.println("  done!.");

}
//************************************************LOOP*******************************************//
void loop() {
  MQ135.update(); // Update data, the arduino will be read the voltage on the analog pin
  MQ135.setA(605.18); MQ135.setB(-3.937); // Configurate the ecuation values to get CO concentration
  float CO = MQ135.readSensor(); // Sensor will read PPM concentration using the model and a and b values setted before or in the setup

  MQ135.setA(110.47); MQ135.setB(-2.862); // Configurate the ecuation values to get CO2 concentration
  float CO2 = MQ135.readSensor(); // Sensor will read PPM concentration using the model and a and b values setted before or in the setup
```

```
  MQ135.setA(102.2 ); MQ135.setB(-2.473); // Configurate the ecuation values to get NH4 concentration

  float NH4 = MQ135.readSensor(); // Sensor will read PPM concentration using the model and a and b values setted before or in the setup

  MQ135.setA(34.668); MQ135.setB(-3.369); // Configurate the ecuation values to get Acetona concentration

  float Acetona = MQ135.readSensor(); // Sensor will read PPM concentration using the model and a and b values setted before or in the setup
  //scrivo sul seriale i dati del sensore MQ135

  Serial.print("******Lettura valori sensore MQ135******");
  Serial.println(" ");
  Serial.print("Monossido di carbonio CO: ");
  Serial.print(CO);
  Serial.println(" PPM");
  Serial.print("Anidride carbonica CO2: ");
  Serial.print(CO2);
  Serial.println(" PPM");
  Serial.print("Ammonio NH4+: ");
  Serial.print(NH4);
  Serial.println(" PPM");
  Serial.print("Acetone: ");
  Serial.print(Acetona);
  Serial.println(" PPM");
  //scrivo sul display i dati del sensore MQ135
  display.setTextColor(WHITE);
  display.clearDisplay();
  display.setTextSize(1);
```

```
  display.setCursor(0, 0);
  display.print("CO:");          //CO monossido di carbonio
  display.print(CO);
  display.println(" PPM");

  display.setCursor(0, 10);    //CO2 anidride carbonica
  display.print("CO2:");
  display.print(CO2);
  display.println(" PPM");

  display.setCursor(0, 20);     //ammonio
  display.print("Ammonio:");
  display.print(NH4);
  display.println(" PPM");

  delay(1000);
  display.display();
}
```

CONCLUSION

The manhole can be one of the least protected and most vulnerable assets. To combat this, we developed an affordable device which can help the social workers detect the gas levels and also send the details of infected manholes to the government. Smart Drainage System helps to alert an workers of various gas levels, Obstacle detection by using system application stores the sensor performs for reduce the future accidents in drainage channel. This device comprises of Efficient Monitoring, Detecting High performance Management system and safe manner. The intelligence of sensors and system will identify the clogging inside the drainage system and will give the details of the location and other information for further actions. Our product will definitely help reduce the tragedies due to gas poisoning from manholes and to be alert for any hazardous gas outburst.

References

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