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Sewer Guard - Protector for Manhole Scavengers

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Abstract **–Sewage disposal cleanup is a major environmental concern. The cleaning process of drains and sewers comes with their own set of hazards like contracting illness, constant chemical exposure, direct contact and handling of dirty waste. Working conditions of these sanitary workers have remained unchanged over a century. These health hazards include exposure to harmful gases such as methane and hydrogen sulfide, cardiovascular degeneration, musculoskeletal disorders like osteoarthritic changes and intervertebral disc herniation, infections like hepatitis, leptospirosis and helicobacter, skin problems, respiratory system problems and altered pulmonary function parameters. The toxicity of gases in sewage is now impossible to quantify. Also, contractors take advantage of uneducated needy workers and use them to clean manholes without any safety equipment in order to cut prices. So, the project SEWER GUARD aims to develop an information and communication ecosystem that can recognize a variety of gases, clearly sense the change in intensity due to depth and correlate that to the time it gets inhaled by the worker. The gas levels are measured by MQ series sensors. It will send an alert to the sewer cleaner and authorized people who are remotely located in the job, if the levels exceed the threshold. The authorities can be notified by SMS message if sewage is likely to overflow. To monitor the system, an android application is created and integrated with it and data stored on cloud.**
Sewer Guard will CORRELATE, CALCULATE and COMMUNICATE the gas intensity, depth and time inhaled for the worker to quickly come out before it gets dangerous or fatal

Keywords **– Sewage, Carbon mono-oxide sensor IoT, Methane gas sensor, Sewage monitoring, Arduino Uno, pm2.5**

I. INTRODUCTION

When it comes to maintenance, monitoring, and inspection, these approach points~~ to it~~ are an essential consideration of any sewage system. Urban areas have an underground drainage system, which the city's municipal corporation is responsible for maintaining. If sewage is not effectively maintained, the groundwater becomes contaminated, resulting in the spread of infectious diseases.

This contributes to the protection of public health and the prevention of water contamination caused by sewage impurities. This facility also serves as a new source of water that may be used for irrigation, industrial purposes, and other uses. Recycling sewage-treated water decreases the usage of fresh water, hence lessening the problem of water scarcity. The process of eliminating impurities from wastewater known as ‘sewage' is known as sewage treatment. [1]

Sewer gas is a complex, generally obnoxious smelling mixture of toxic and nontoxic gases produced and collected in sewage systems by the decomposition of organic household or industrial wastes, typical components of sewage. [2]

Sewer gases may include hydrogen sulfide, ammonia, methane, esters, carbon monoxide, sulfur dioxide and nitrogen oxides. Improper disposal of petroleum products such as gasoline and mineral spirits contribute to sewer gas hazards. Sewer gases are of concern due to their odor, health effects, and potential for creating fire or explosions. [2]

For the prevention of gas poisoning, a greater understanding of the risks in the environment is required. These gases must be monitored in order to detect a significant increase in the usual level of effluents and take corrective action.

So in this prototype we will make a system which uses different Sensors that have been utilized to analyze the amount of hazardous gas present in the sewage environment and send an alert in order to evaluate the gases present in the sewage environment.

II. LITERATURE SURVEY

1. Phattaleeya Mabpa-IEEE-2017

Sanitary sewage overflows (SSOs) are caused by a variety of factors, including sewer blockages, which cause significant environmental damage and property loss. In this current study to reduce the danger of SSO problems, there is a way to detect and monitor pipeline blocks using acoustic analysis to determine whether the pipeline is blocked and how much it is blocked. It has been proposed, that a vibrating speaker is ~~normally~~ affixed to the tube as a sound source. By measuring the shift in the pipe's resonance frequency, a microphone on the other side of the pipe detects a blockage.

2. Muragesh SK and Santhosha Rao-2017

The Internet of Things (IoT) is a network of physical objects and communication devices that are linked together by sensor networks to enable automatic connections and activities between the real world and information systems. The Internet of Things was born because of computers' capacity to access data on objects and devices without the need for physical involvement, but programming may overcome input limits. Cost, accuracy, and other considerations all play a part in extracting human data. It's a precarious circumstance. The Internet of Things (IoT) relies heavily on sensor networks.

3. IoT Based Sewage Monitoring System

The goal of this work is to measure and analyse harmful gas levels in real time. To ensure the safety of workers operating in such hazardous settings. This project aims to create an IoT system that will detect humidity, temperature levels, and gas mixtures, sensing each type of gas to measure its level while keeping track of the above parameters' real-time dynamic changes. It will send an alarm on the connected mobile devices of the authorised personnel who are remotely located in the job if the levels exceed the threshold. If a clog occurs, the situation can be monitored using live video streaming.

4. Toxic gas detection using IOT Sensors

Coal combustion, oil for electricity and transportation, and emissions from industry and refineries are the principal sources of hazardous gases. Volatile organic compounds, which comprise a variety of substances that have negative health consequences, are commonly found in air pollution. In recent years, sensors with high VOC sensitivity have been deployed; this study highlights the most recent improvements in harmful gas sensors. Furthermore, the updated analytical data demonstrates the efficacy of existing harmful gas prediction systems as well as an improvement in data validation techniques to improve accuracy.

III. IN-DEPTH RESEARCH

According to official statistics in India, 110 people lost their lives during sewer cleaning in 2019. Similarly, there were 68 deaths in 2018 and 193 in 2017.

In December 2013, The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act was notified by the Central Government of India and is binding on all states.

This act says that the process should be executed with machines due to the dangers of gasses present in the sewers.

However, contractors take advantage of uneducated needy workers and use them to clean manholes without any safety equipment in order to cut prices

The following figure shows-No of deaths as per year in India

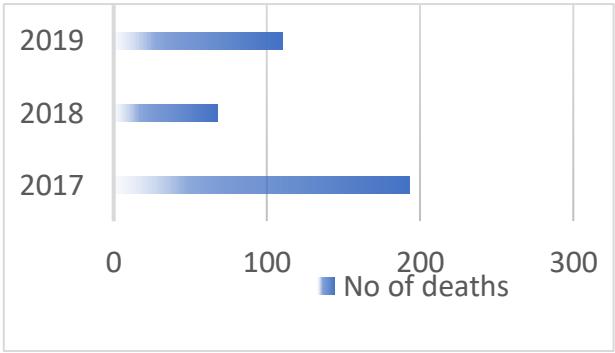

fig-1 No of death of sewer workers w.r.t year

IV. EFFECT OF SEWER IN INDIA

The fatality rate among sewage workers has been steadily rising. Even by such low numbers, the government has reported 914 deaths of sewer workers in 21 states. Official figures show that Tamil Nadu had 213 deaths, Gujarat had 153, the nation capital had 98 cases, Rajasthan (18), Punjab (17), Andhra Pradesh (16), West Bengal (13), and Bihar (8). Chhattisgarh reported just one case followed by Madhya Pradesh and UP and Haryana had 104 and 70 deaths, respectively.

The following are some of the causes of death:

1. Supervisors forcing workers to do things they don't want to do

2. Ignorance about the presence of harmful gases in the sewage system

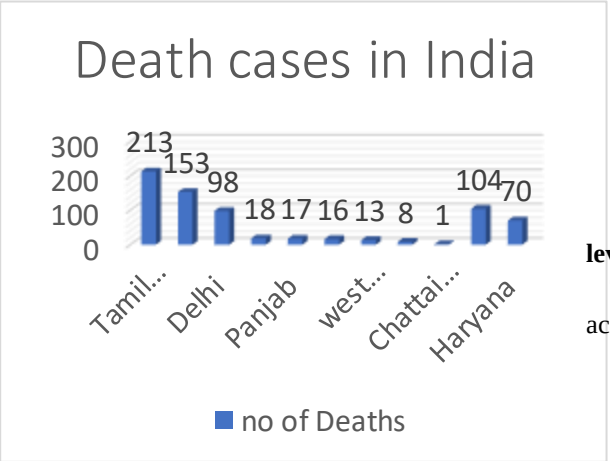

Fig-2 Death cases in India

V. Effect of HAZARDOUS GASES

Sewer gas is a complicated mixture of harmful and benign gases that can exist in different concentrations depending on the source. It is created when home and industrial trash decomposes.

Hydrogen sulphide and ammonia are two highly hazardous components of sewage gas. Methane, carbon dioxide, sulphur dioxide, and nitrous oxides are all found in sewer gas. Chlorine bleaches, industrial solvents, and gasoline are also commonly found in municipal and privately-owned sewage treatment systems.

5.1. Effect of H2s according to Concentration level in PPM:

The following figure shows- Effect of H2s according to Concentration level in PPM

0.13 ppm	Minimal detectable odour
4.6ppm	Easily detectable, moderated odour
10.0ppm	Beginning eye irritation
27ppm	Strong unpleasant odour
100ppm	Coughing,loss of smell after 2-5 mins
200-500 ppm	Make eye inflammation, rapid loss of smell
500-700 ppm	Loss of conscioues and possible death in 30-50 mins
700-1000 ppm	Rapid unconscienced, stopping respiration of death
>1000	Death in few minutes

Fig-3 Effect of H2s

5.2. Effect of Co according to Concentration level in PPM:

The following figure shows- Effect of Co according to Concentration level in PPM

25ppm	TVL exposure limit for 8hrs
200ppm	Frontal headaches in 2-3 hr
800ppm	Headache, dizziness and nausea in 42 mins
1600 ppm	Danger of death in 2hrs
3200ppm	Unconsciousness and death 30 mins
6400 ppm	Death in 15 mins
12800 ppm	Death in 1-3mins

Fig-4 Effect of Co

5.3. Effect of NH3 according to Concentration level in PPM:

The following figure shows- Effect of NH3 according to Concentration level in PPM

25 ppm	Odour detectable
50 ppm	No adverse effect
100 ppm	No adverse effect
400 ppm	Immediate nose and throat irritation
700 ppm	Eye irritation
1700 ppm	Death in 35 mins
2000-5000 ppm	Death in 15mins
5000-10000 ppm	Death within mins

Fig-5 Effect of NH3

Effect of NH3, Co and H2s w.r.t Intake breathing:

1. If the concentration of NH3 is less than 100 ppm, then intake breathing at a rate of 12 to 20 breaths per minute will happen. If your blood concentration is higher than 1700 ppm, take 6 to 7 breaths per minute.

2. If the concentration of Co is less than 800 ppm, then intake breathing at a rate of 12 to 20 breaths per minute will happen. If your blood concentration is higher than 6400 ppm, take 7 to 8 breaths per minute.

3. If the concentration of H2S is less than 100 ppm, then intake breathing at a rate of 12 to 20 breaths per minute will happen. If your blood concentration is higher than 500 ppm, take 6 to 7 breaths per minute.

VI. Proposed System

Without suitable protective gear the worker is left vulnerable to both gas and infectious material. Many of the workers entering the sewers have no training, no knowledge and absolutely no awareness and are picked up to execute the cleaning work as a daily wage earner.

Without adequate measurement tools, numerous other gases present in the sewer such as methane and carbon monoxide may also cause issues.

This results in the stratification of the gases based on density. Lighter gases such as methane will rise to the higher areas of the sewer. Methane is less dense than breathable air and therefore displaces oxygen, thus is considered to be more dangerous in enclosed spaces.

This is a specially designed affordable, economical and portable helmet that monitors and correlates the depth and density of various gases. It also times and alerts the worker on how much time he should abort the job based on the number of breaths he takes.

VII. Technical Solution

Sewer Guard - An alarm system for gas intensity, manhole depth and time

Sewer Guard calculates the intensity of different gasses, will also check how deep the worker is going inside the manhole and will correlate both with the number of breaths the worker takes. Depending on the hazardous gas type, its intensity will continuously alert the worker through earphones on the time he has to retrieve or abort the task.

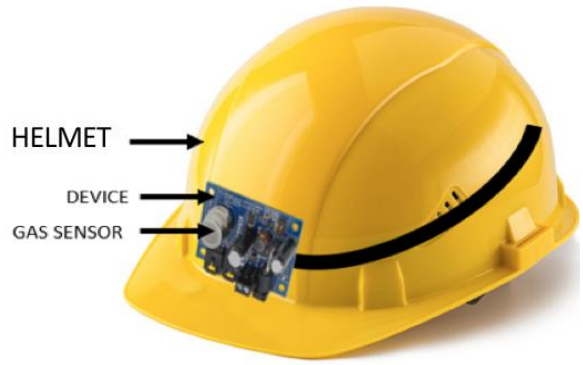

Fig-6 proposed project representation

The proposed technology is based on the Internet of Things (IoT), which helps monitor hazardous gasses contained in sewage.

The Sewer Guard will calculate the intensity of Methane Gas, Carbon Monoxide, hydrogen sulfide, ammonia, carbon dioxide, nitrous oxide and correlate with the time the worker can stay inside the manhole at that depth. The circuit and the program calculate the threshold value of the gas with the number of breaths the worker will inhale and therefore send an alarm for the time that he needs to abort the task

VIII. Need of Sewer Guard

1. It would automate manhole inspections, lowering the danger of mortality from poisonous gas inhalation and drowning.
2. It would generate real-time data that could be analyzed to discover the link between various variables such as depth and the presence of gases.
3. It is cost effective because it proactively maintains the operation of the entire sewage system, minimizing the maintenance costs of wear and tear, which would have occurred if none of the nodes (manholes) were to handle influx above a threshold capacity.
4. It could provide a more intelligible and graphical depiction of data, allowing for a better understanding of the sewage system's state using data from multiple sensors.

IX. Block Diagram

The Arduino Microcontroller, Bluetooth, the sensor network, and the server stations are all shown in the block diagram.

Hazardous gas leaks that rely on chemicals to operate. The latest information technology breakthroughs, such as the Internet of Things, can be used to quickly identify and monitor gas leaks.

The Arduino UNO board serves as the brain of the system, which is powered by an ATmega328 IC and coupled to a variety of sensors. MQ-2, MQ-7, MQ-135, Mq-136, and Pm2.5 are gas sensors that can continually monitor ambient factors.

To detect gases such as ammonia, methane, carbon monoxide, hydrogen sulphide, and carbon dioxide, MQ-2, MQ=7, MQ-135, and MQ-136 sensors are employed.

Through the Arduino IDE software, the Arduino translates analogue values to digital values and the board functions according to a set of instructions.

If the level of gases rises above the normal level, an alarm is triggered immediately via the internet's particular receiver area. The data collected by the sensor is kept in the cloud, where it may be processed and analyzed to improve safety rules.

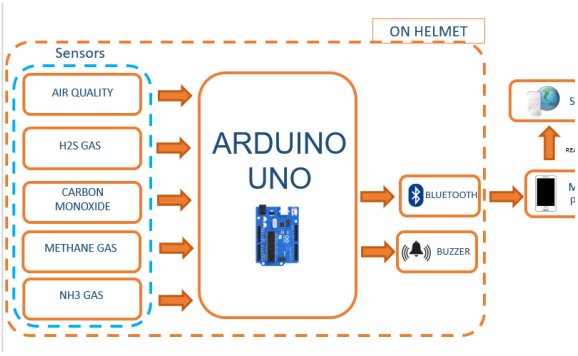

Fig-7 Block diagram of Sewer Guard

X. Flow Diagram

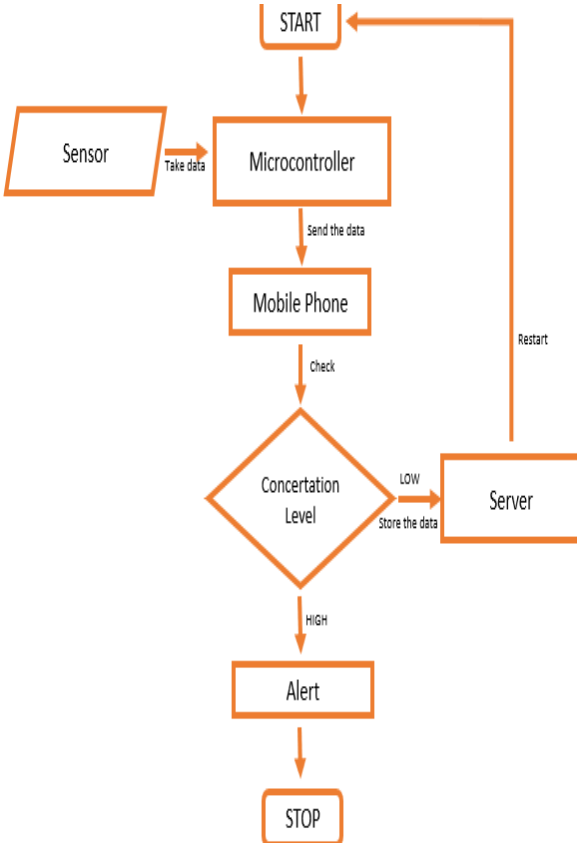

Fig-8 Flow diagram of circuit

We are attaching multiple sensors to sense the presence of dangerous gases in the surrounding environment.

Sensors giving input to the Arduino controller. Through Arduino embedded programming we will check concentration level and presence of gases and value of detected gases will be sent by Arduino via Bluetooth. Using hardware Bluetooth module which we have attached at Arduino side helps to send value of gases to Mobile application and mobile will receive same data with inbuilt Bluetooth module Concentration level Threshold will get verify by Mobile app and Mobile app will give alert when the concentration of danger gases is more than normal level. Live data log will be saved at server side.

XI. List of Components

Following of components, we have used in circuit-

SR NO.	NAME OF COMPONENTS	QUANTITY
1	Arduino nano	1
2	Bluetooth	1
3	MQ135 sensors	1
4	MQ136 sensor	1
5	MQ2 Sensor	1
6	MQ7 sensor	1
7	Dust sensor	1
8	220Uf capacitor	1
9	150-ohm Resistor	1
10	Connecting wires	20
11	Battery with battery cap	1

Fig-9 list of components

XI. Hardware Description

The Figure shows the Circuit module of the proposed system in which the results are taken by these hardware components.

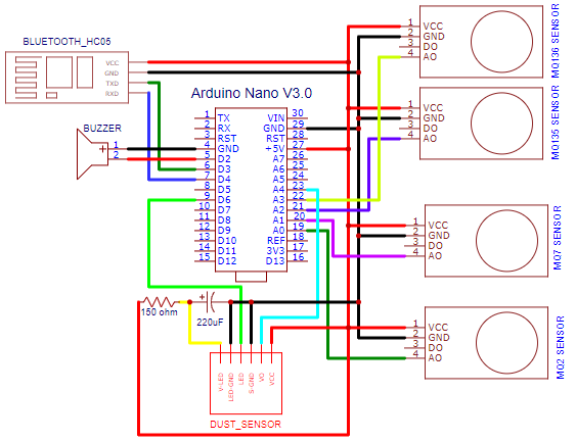

Fig-10 Circuit diagram of circuit

1.Arduino Nano:

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It has the same functionality of the Arduino Duemilanove, but in a

different package. It lacks only a DC power jack and works with a Mini-B USB cable instead of a standard one.

The nano is a microcontroller board based on the ATmega328M. The Arduino Nano can be programmed with the Arduino Software (IDE). Select "Arduino Nano" from the Tools > Board menu (according to the microcontroller board).

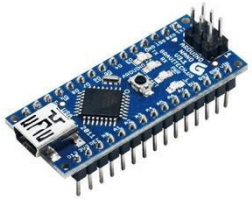

Fig-11 Arduino Nano

2. Gas sensors:

A gas sensor is an electronic component that detects the presence or concentration of gases in the environment. The sensor produces a corresponding potential difference based on the gas concentration by changing the resistance of the material inside the sensor, which may be detected as output voltage.[4]

MQ-2 - Methane, Butane, LPG, smoke
MQ-3 - Alcohol, Ethanol, smoke
MQ-4 - Methane, CNG Gas
MQ-5 - Natural gas, LPG
MQ-6 - LPG, butane gas
MQ-7 - Carbon Monoxide
MQ-8 - Hydrogen Gas
MQ-9 - Carbon Monoxide, flammable gasses
MQ131 - Ozone
MQ135 - Air Quality (CO, Ammonia, Benzene, Alcohol, smoke)
MQ136 - Hydrogen Sulfide gas
MQ137 - Ammonia
MQ138 - Benzene, Toluene, Alcohol, Acetone, Propane, Formaldehyde gas, Hydrogen
MQ214 - Methane, Natural gas

Fig-12 List of MQ series

1.MQ2 sensor:

The Gas Sensor (MQ2) module is useful for detecting gas leaks (home and industry). It can detect H2, LPG, CH4, CO, Alcohol, Smoke, or Propane, among other gases. Measurements can be conducted as soon as feasible based on the high sensitivity and quick reaction time. A potentiometer can be used to modify the sensor's sensitivity.[3]

Fig-13 MQ2 Gas sensor

2. MQ7 sensor:

The sensitive material of the MQ-7 gas sensor is SnO2, with lower conductivity in clean air. It detects using the cycle of high and low temperature and detects CO at low temperature (heated by 1.5V). The sensor's conductivity is higher along with the gas concentration rising. When the temperature is high (heated by 5.0V), it will clean other gases absorbed under low temperatures. Please use a simple electro-circuit, convert change of conductivity to correspond to output signal of gas concentration MQ-7 gas sensor has a high sensitivity to Carbon Monoxide. The sensor could be used to detect different gases contains CO, it is at low cost and suitable for different applications

.

Fig-14 MQ7 Gas sensor

3. MQ135 Sensor:

Air quality sensor for detecting a wide range of gases, including NH3, NOx, alcohol, benzene, smoke, and CO2. deal for use in the office or factory. MQ135 gas sensor has a high sensitivity to Ammonia, Sulphide, and Benzes steam, also sensitive to smoke and other harmful gases. It is at low cost and particularly suitable for Air quality monitoring applications. [3]

Fig-15 MQ135 Gas sensor

4. MQ136 Sensor:

Sensitive material of MQ136 gas sensor is SnO2, which has lower conductivity in clean air. When the target Hydrogen sulfide gas exists, the sensor's conductivity is higher along with the Hydrogen sulfide concentration rising. Please use a simple electric circuit, convert change of conductivity to correspond to the output signal of gas concentration.

MQ136 gas sensor has a high sensitivity to Hydrogen sulfide, Low sensitivity for other combustible gases. It is at a low cost and suitable for different applications. [3]

Fig-16 MQ136 Gas sensor

3. Dust sensor:

The sensor has a tiny six-pin connection interface, it comes with a connector when you usually buy it. The sensor generates an analog output signal on pin5- Vo, it does not require any external components for operation and requires only a 3.3V supply, making it easy to interface with the Arduino board. [8]

Pin out and working of Dust sensors:

Fig-17 Dust sensor

The dust sensor uses an optical sensing method to detect dust. A photosensor and an infrared light-emitting diode which is known as an IR LED are optically arranged in the dust sensor module. The photo-sensor (PT) detects the reflected IR LED rays which are bounced off the dust particles in the air.

The GP2Y1010AU0F module can sense the tiniest particles in the air, which lets it detect even cigarette smoke. A high output pulse from the sensor is triggered whenever it detects dust.

[5]

4.Buzzer:

A piezo buzzer is a type of electronic device that's used to produce a tone, alarm, or sound [9]

Fig-18 Buzzer

X. METHODOLOGY

The circuit and the program calculate the threshold value of the gas with the number of breaths the worker will inhale and therefore send an alarm for the time that he needs to abort the task

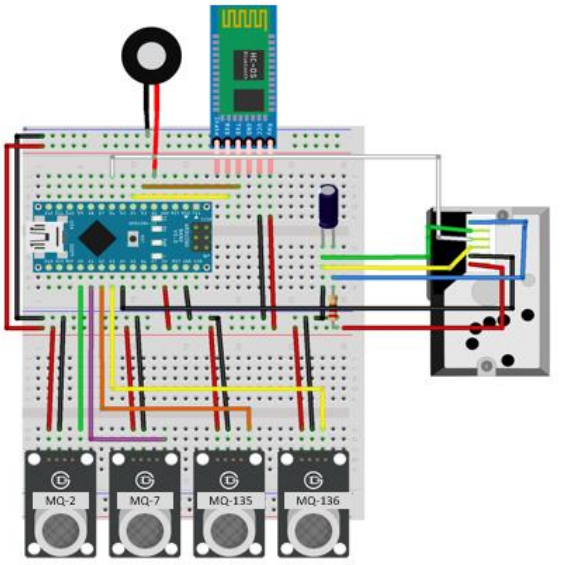

Fig-19 Breadboard diagram

A sensor node with five gas sensors that sends the necessary information about the drainage system's hazardous gases. Methane will be detected by the MQ-2 sensor, whereas ammonia toxicity will be detected by the MQ-137 sensor. MQ135 will be

used to evaluate air quality (CO2,NH3,NO2), whereas MQ136 will be checked with hydrogen sulfide. Furthermore, the MQ-7 sensor will detect the presence of carbon monoxide.

The sensor generates a wide variety of readings that are sent from the sewage to the control system. To make these sensors usable for industrial and home use, they must be calibrated by defining a resistor network.

VCC and GND of Gas sensors is connected to +5V and GND of Arduino Nano

Analog pins of MQ2,MQ7,MQ135 and MQ136 are connected to A0,A1,A2 and A3 respectively

Positive pin of buzzer is connected to Digital pin 2 of Arduino and negative of buzzer is connected to GND

Dust sensors have six sensors pins- Vcc,V0,GND,LED+,LED- and v-LED.

The VCC of the Dust sensor is +5v of Arduino nano. The GND and LED- of dust sensor is GND of Arduino.V0 pin of Analog pin A4 of Arduino and LED is connected to D6 of Arduino nano.

For transmitting and receiving the data we will use the HC-05 bluetooth module, which has 4 pins- Vcc, GND TX and RX.

The TX of Bluetooth is connected to the D3 pin of Arduino nano. Rx Bluetooth is connected to the D4 pin of Arduino nano.

XII. INTEGRATION AND TESTING

1.All of the project's requirements were completed, and the circuit has been turned on to check for any unusual changes in the physical parameters. If any changes occur, the sensors detect them and send the information to the microcontroller, which then takes appropriate action.[6]

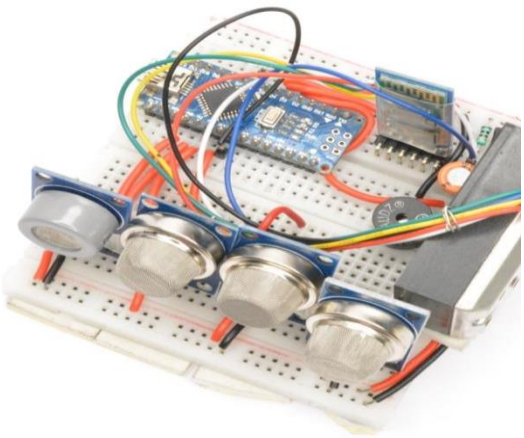

Fig-20 Hardware implementation

2.A mobile application that detects and sends an alarm to an authority figure.

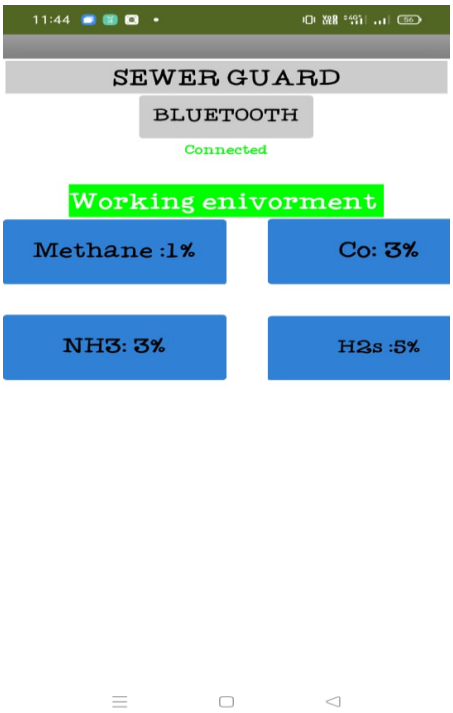

Fig-21 mobile Application

3.All real-time data will then be saved on the server.

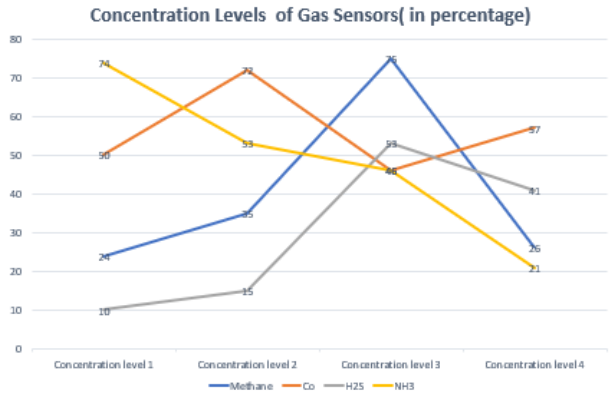

Fig-22 Real time data stored in server

XIII. RESULT

To detect the harmful gas levels present in the sewage system, Gas Sensor MQ-2 and MQ-6 are interfaced with Arduino UNO.

Fig-23 Demonstration of Sewer Guard prototype circuit

The gas readings are analysed and detected using the C programming language in the Arduino IDE software. The results of the analysis are sent to a mobile phone and saved on a server. After all of the data has been gathered, analysed, and processed, it will be much easier to avert any gas-related dangers. [7]

XIV.CONCLUSION

The Sewage Workers' Safety System is critical in saving the lives of the workers. Even though numerous approaches exist, sewage cleanup remains a big challenge. This proposed system is an IoT-based microcontroller-based safety solution for sewage employees. This device is designed in such a way that the relevant parameters may be calculated and monitored for worker safety. [7] The technology finds a critical use in sewage systems. The proposed methodology aids in preventing workers' abrupt accidents while cleaning and aids in keeping society clean. The device aids in the monitoring of sewage water overflows, keeping society clean. The device aids in the monitoring of sewage water overflow.

XV. ACKNOWLEDGEMENT

I would like to acknowledge the help provided by the

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