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Smart Manhole Toxic Gas Identification and Alerting System-Implementation

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Abstract: A canny city is a forthcoming goal to have cleansing agent and better comforts for society. Most of the metropolises implemented the underground drainage system to maintain hygiene, healthy and fortification of cities. If they flop preserving the drainage system, clean water may get contaminated with drainage water might lead risky diseases. So, cleaning the drainage system is very important. Even nowadays sewage systems are cleaned by manually. Sewer gas remains an amalgamation of poisonous and harmful gases are collected in sewage systems. In this project we proposed a system to detects harmful chemicals and toxic gases by using a set of gas sensors like MQ-02, MQ-03, MQ-06, MQ-07 SENSORS are incorporated with Arduino nano and LCD display to identify toxic gases in system and then intimate the sewage workers about toxicity of gases before entering the manhole. We used sprinkler mechanism for detoxification treatment. If toxicity of gases exceeds threshold level actuator mechanism triggers sprinkler.

Keywords: Ammonia, Methane, LCD, Sensors, Sprinkler Mechanism

I. INTRODUCTION

Drainage systems are very important in large cities where millions of people live, since they're known as the basis of land dryness due to excess and unused water. To maintain its proper functioning, drainage conditions need to be monitored. Today's drainage system is not computerized, so it is difficult to determine if a blockage is occurring at a particular location. Worker may have to enter inside the manhole to perform tasks such as cleaning, repairs, inspections, etc. Sometimes, due to the waste those drainage lines can produce various gases like methane (CH4), carbon monoxide (CO), which are harmful and can cause serious health problems when inhaled by humans in great quantities, and these problems are generally faced by drainage workers. As organic materials, industrial effluents, and sewage matter decompose, they produce different chemical mixtures. Sewer gases may include hydrogen sulphide, ammonia, methane, esters, carbon monoxide, sulphur dioxide, and nitrogen oxides. The gases from sewers can also cause severe fires or explosions in addition to the usual disturbances like odours and health effects. The Wisconsin Department of Health Services says sewer gas is a mixture of toxic and non-toxic gases, depending on the source. It is created when household and industrial waste decomposes, and it smells like rotten eggs. In addition to hydrogen sulphide and ammonia, this gas contains several other highly toxic components. Hydrogen sulphide induces nausea, headaches, dizziness, drowsiness, and drowsiness when exposed to small amounts of it. Hydrogen sulphide may cause people to lose their sense of smell at high concentrations. Sewer gas may be fatal to humans at high concentrations of methane. Methane reduces the capacity of the air to carry oxygen and causes people to suffocate. If a person is exposed to terribly low oxygen on centrations, he or she will experience headaches, dizziness, nausea, and eventually, deafness. Death will occur directly once a person has been exposed to such low oxygen concentrations.

The main purpose of this project is to develop an effective device which detects the toxic gases and notifies the concentration level of the gases via message.

- It is portable hand-held device that displays the range of toxic gas concentration.
- By using this device sewage workers safety can be ensured in real time.

Overview of project:

An underground drainage system is a vital component of urban infrastructure. It is considered the city's lifeline. The majority of underground drainage is managed manually, so it is difficult to maintain a functioning underground drainage system in such large cities; government personnel also find it difficult to locate the exact manhole facing the problem. There are several components to underground drainage, including sewerage system, gas pipeline network, water pipeline network, and manholes. This project detects hazardous gases and saves sewage workers life.

Objectives of project:

Following is a list of the main objectives of this project:

- To develop an electronic device that measures the toxicity of the hazardous gases present in the sewage.
- To intimate the workers about the toxicants and to acquire the safety precautions before entering into the manhole.
- To use Sprinkler mechanism, provided with resource chemical for detoxification treatment.

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- To obtain an effective low cost and flexible solution for condition monitoring and infrastructure management in the city.
- In real time, sensors measure the gas threshold and update it through the Internet of Things.
- Helping contractors, owners and workers avoid gas poisoning during drainage work.

II. LITERATURE SURVEY

L. K. Hema, Velmurugan S, Suriya. Pa, R. Indumathi **[1]** proposed a system that included integrated sensors interconnected with microprocessors and LCD displays for monitoring toxic gas emissions. It recognizes the scale of toxicants and then intimates the workers to acquire the safety precautions before entering manhole. Here they have used MQ-04, MQ-07, MQ-137 gas sensors are used for detecting dangerous gases. In order reduce the dangerous gases they have used sprinkler mechanism. Device applications include toxic gas detection, alerting & minimizing gas concentration levels for safe working conditions. A detoxification agent has been found to be effective in reducing the most prevalent gases in the sewage manhole.

Chandraprabha R, Ashwini C.V, Dharani M, Harshitha G, Kruti Mohan **[2]** proposed a system, with an IOT based real time alert is sent to the managing station via email when a manhole crosses the threshold values. This helps reduce the health hazards of manual scavengers that clean the underground drainage and also benefits the public. In this system they have used flow sensor, float horizontal sensor, Temperature sensor, ultrasonic sensor, Gas sensor. The proposed method involves developing a system for monitoring drainage and manholes using IOT technology. It monitors atmospheric temperatures, toxic gas releases, blockages, overflows and manhole lid positions. Monitoring sensors detect when levels reach a predetermined maximum level, and send a signal to the controller, which then communicates with the IoT network to send a notification to the municipal corporation.

A. Vellingiri, K. Dharni, M. Arunadevi, R.L. Aravind Lal **[3]** After achieving the threshold levels of each gas sensor, the proposed system will alert the user through LCD display. Heart rate sensors calculate the range of the pulse rate and then alert the user via IoT via notification when the range is abnormal. In this paper they have used carbon monoxide sensor, Heart beat sensor, hydrogen sulphide sensor, methane gas sensor. Sensors will be installed in the smart drainage system to detect blockages, floods and gases. The system's intelligence will identify the blockage and supply the location and other details for further action. The Health Department will be alerted if the levels of these gases surpass a threshold value using the alert system, which will allow them to take all the necessary actions.

Pushpakumar R, Rajiv S **[4]** this system will detect the level of gas inside the drainage manholes, it will help workers to get an idea about the situation before they enter the manholes. This greatly helps workers and safety before entering the manholes and it will sense the level of the gas inside. In addition, the smart safety devices are cost-effective, fast, and would enable information to stream both to the concerned department and to the emergency department. Moreover, the smart safety devices would help the worker understand the gas levels and the indicator lights at a basic level of proficiency. Smart device can be implemented and used indifferent parts of the world in order to monitor the overflow of sewage water.

V.D Ambeth Kumar, D. Elangovan, G. Gokul, J. Praveen Samuel, V.D. Ashok kumar **[5]** proposed a system, like Embedded systems are designed using a microcontroller and the internet of things to detect and monitor hazardous gas leakages, which prevents human lives from being endangered. Due to the calibration process followed, the system is extremely accurate and can simultaneously detect multiple gases. The sensor data is continuously uploaded to a database and then compared with the reference data. The IOT system is also used to monitor heartbeat of a worker. An alert message is sent to a nearby health centre so that the worker can be rescued in an emergency. However, its primary disadvantage is network reliability.

Gaurang Sonawane, Chetan Mahajan, Anuja Nikale, Yogita Dalvi **[6]** propose system that will be able to monitor all of these things in real time, allowing us to take appropriate action in case of a specific drainage problem. IoT applications for monitoring drainage in metropolitan cities are presented in this paper to provide smart and real-time drainage monitoring systems. Using various sensors, such as gas detection, water level monitoring and blockage detection, they can monitor the state of a drainage system in real time and identify its problems. A smart and real-time drainage system can be designed with the help of this paper for monitor in gas well as troubleshooting.

R. Vijayalakshmi, Dr.D. Sengeni **[7]** proposed system It contains sensors, GSM technology and a buzzer, which will alert when someone steps into the manhole. It can be monitored in Real Time with data being acquired by the system and displaying it on LCD, LED, and Buzzer. The validation of the digital inputs is based on this, and a simulation software is used to perform the validation. The measurements are made by different sensors and then processed and controlled by ARM microcontroller (LPC 2138) based on embedded C code and alerted by the workers under work by using various alert systems. We are going to measure different levels of gas using switches, and for alert LEDs. We are also going to detect obstructions in drainage channels, and we're going to measure employees' heart rates as well.

Yash Narale, Apurva Jogal, Himani Choudhary, S.P. Bhosale **[8]** proposed system explains how a water wise system is used and how a leakage defect is detected in a sewer pipeline by detecting leaks. Various functions are described for the maintenance and monitoring of underground drainage systems. The created system monitors the water level, atmospheric

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temperature, water flow, as well as harmful gas emissions. A sensor system can detect when drainage is blocked and water is overflowing. The sensor sends information to the managing station by way of the transmitter, which is situated nearby.

Ritik Sharma, Sayed Abdul hayan [9] developed a monitoring system for underground drainage that uses sensors to monitor sewage overflow, the drainage level, and the concentration of hazardous gases. It transmits the information to the authorities via GSM modules. Water accumulation is prevented by generating early alerts when a blockage begins to develop. It also provides a solution for proper monitoring and provides a solution to keep the city clean, safe, and healthy.

Jyothi Chillapalli, Yogesh. Jadav **[10]** proposed system, to check for blockages, the device offers live video streaming. Video from the Raspberry Pi camera can be used to discover blockages in the sewage system. Possible changes could enhance the overall efficiency of the program. This prototype is designed to be mounted on a chassis so the camera has a broader viewing area, sensors can collect data as the system moves and an alarm/siren will alert the surrounding area. In addition, the values stored in the database in conjunction with the corresponding dates can be used as the input to the machine learning algorithms, thus letting the desired output be obtained.

III. METHODOLOGY

Below figure illustrates the functional block diagram of Manhole toxic gas detection and alerting system shows the sensors that monitor the toxic gases in the manhole for any explosion caused by the toxic gases. The gas sensors are connected to a Microcontroller unit that initiates an alert message after receiving signals from the sensors. The proposed manhole safety system model is used to detect the concentration levels of different toxic gases, such as Methane, Carbon Monoxide, LPG gas, ammonia etc., inside the manhole. Arduino Nano i.e., Microcontroller unit is the principal component which controls the overall operations of the proposed system. It processes the obtained sensor values. The MQ-2 sensor detects gasses like LPG, Alcohol, Propane, Hydrogen, CO and even methane ranging from 200 to 10000 ppm. MQ-3 sensor is used to detect NH3, NOx, gasoline, smoke and vapour anywhere from 25 to 500ppm. MQ-06 sensor detects gases like iso-butane, propane, LNG and LPG ranging from 200 to 10000ppm. MQ-07 sensor detects benzene and CO-gas concentrations anywhere in the range10 to 500 ppm. Push button is used to control the device. Driver is used to support the connection between motor and the control circuit. LCD displays the toxic gas concentration level. A solution bank or reserve is present which consists of mixture of water and hypochlorite in order to detoxify the toxic gases to a favourable working range. A GSM module (SIM800L mini-cellular module) is used to send the toxic gas concentration to the registered user via message.

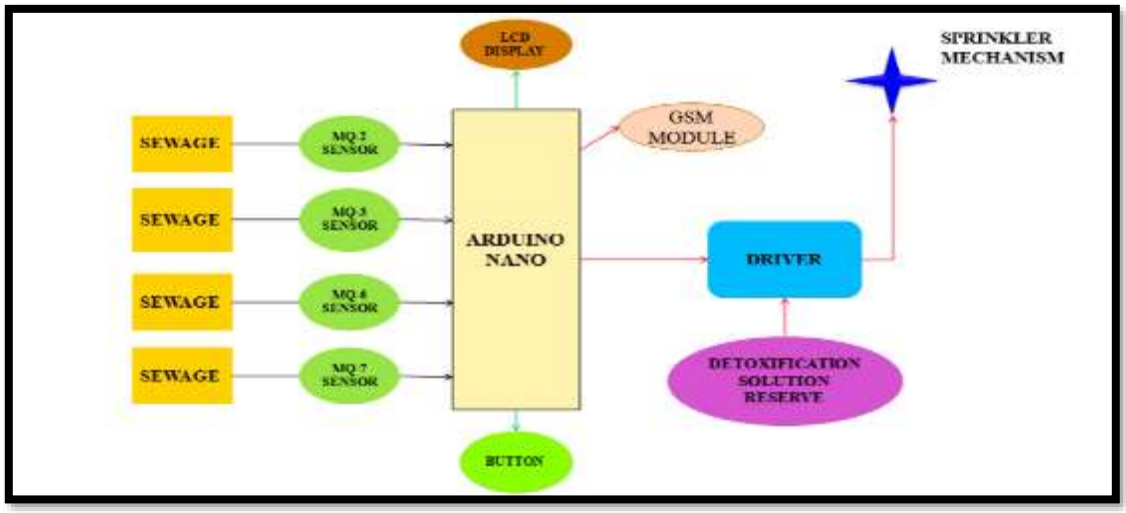

Fig: Block diagram

Flow chart

The flow process of the Manhole toxic gas detection and alerting system is as shown in below flowchart figure. Firstly, the gas sensors and the LCD display initialization is carried out as soon as the detection process starts. Then the sensors start sensing the toxic concentration level of the gases in the sewage continuously Microcontroller unit processes the obtained sensor values in ppm range. If the toxic gas concentration level increases the threshold value, microcontroller unit gives a control signal to the driver. The Driver actuates the sprinkler mechanism. Then the solution present in detoxification solution bank or reserve is sprinkled inside the manhole. As this process happens a message saying the concentration level of the toxic gases is sent t the registered user using GSM module to inform the user about the status. If the threshold value of toxic gas concentration is not crossed then the sensors again continue to sense the concentration of the toxic gases and the process is repeated.

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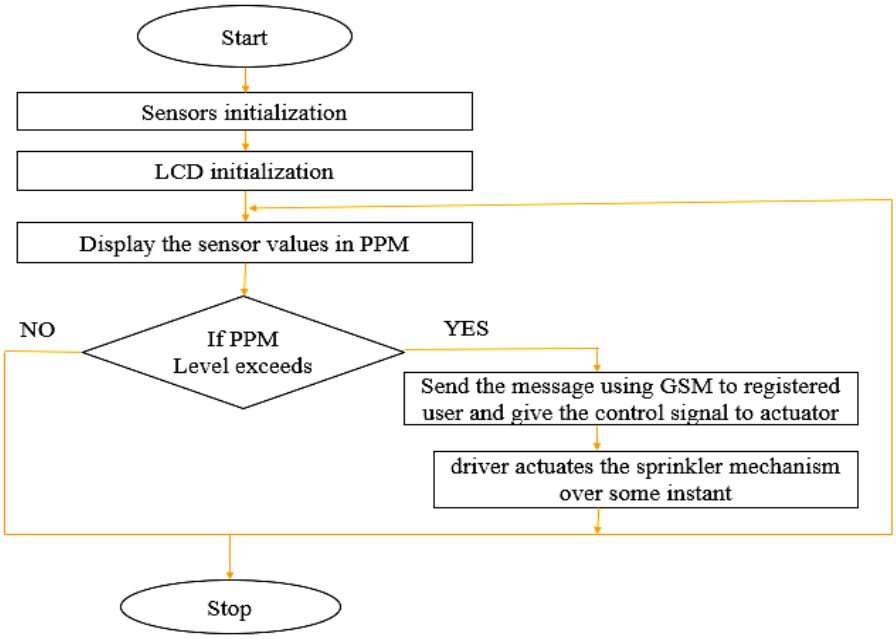

Fig: Flow chart

ALGORITHM:

- START
- Power up hardware.
- Initialize hardware module.
- Arduino Nano senses Sensor values.
- Toxics concentration is displayed on the LCD display.
- MQ2 sensor checks for gases like LPG, CO, Propane, Alcohol and Hydrogen.
- MQ3 sensor checks for gases like NH3, NOx, Alcohol, Benzene, Smoke and CO2 levels.
- MQ6 sensor checks for gases like LNG, Propane, LPG and Iso-Butane.
- MQ7 sensor checks for gases like CO and Benzene concentrations.
- When threshold levels of these sensors increase, intimation is given to the system via navigation button.
- By using GSM, the toxics concentration is sent.
- If any of the sensor's threshold level exceeds through GSM, the toxics concentration is sent to the authorized person.
- Sensors continuously check the toxics concentration.
- Toxic concentration level will be displayed on LCD.
- STOP.

IV. HARDWARE AND SOFTWARE COMPONENTS

HARDWARE USED

MQ-02 SENSOR

MQ-2 gas sensor has strong vulnerability to LPG, Propane, and Hydrogen and also it is used to Methane and other ignitable steam, with cheap cost and suitable intended for various applications. This sensor is respectable sensitivity to Ignitable gas in wide range. It is a semiconductor sensor type. It is portable gas detector. It ranges from 200 to 10000 ppm. It works for 5V DC voltage and draws around 800mw. Productivity voltage of this gas sensor rises with concentration of gas.

MQ-06 SENSOR

It is used in gas leakage sensing equipment's. This type of sensor will perceive LPG, Propane, LNG, Iso butane and it will detect the clamour of alcohol, smokes and fumes. It has features like long life, simple drive circuit, low compassion to smoke & alcohol, high for isobutane, LPG & propane. It can be used in industrial applications. It is also called as LPG sensor (LPG stands for liquified gas sensor). It will give fast response i.e., one of the best features. It ranges from 200 to 10000ppm.

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MQ-07 SENSOR

Delicate material of this gas device is SnO2 that with lesser physical phenomenon in clean air. It builds finding by technique of cycle high and temperature, and detects CO once temperature heats 1.5V. The sensor's physical phenomenon is advanced together with the gas concentration rising. When hot temperature heats 5 V, it scours the other gases adsorbed under low temperature. This type of sensor has high compassion to Carbon Monoxide. The device may be familiarized detect totally different gases contains CO, having low cost and suitable for various applications. It ranges from 10 to 500 ppm.

MQ-3 SENSOR

The MQ3 sensor is a type of metallic oxide semiconductor (MOS). This sensor is also called a chemical sensor, since it detects changes in resistance in a material under sensing. In order to prevent explosions, it is encased in two layers of fine stainless-steel mesh referred to as an anti-explosion network. MQ-3 sensor is used to detect NH3, NOx, gasoline, smoke and vapour anywhere from 25 to 500 ppm.

GSM MODULE

A GSM module is a hardware component that uses GSM mobile telephone knowledge to provide a data link to a remote network. Mobile system for global communication, also known as GSM. SIM800L is a mini cellular component which allows for GPRS communication, sending and getting SMS and receiving voice calls. It is low cost; small track device and quad band frequency backing make this module perfect for any project that require long range connectivity. After relating power module speeds up, explorations for network and login automatically. It will supply voltage from 3.8volts to 4.2 volts. It has module size of 25*23 mm. GSM module also called as GSM modem.

It has advantages like no roaming charges for international calls, suitable network for robust features, worldwide connectivity. It uses narrowband TDMA and FDMA technique for transmitting and receiving signals. For most of the IOT projects GSM module will be used to send messages for contacts.

ARDUINO NANO

Arduino NANO is a microcontroller board based on ATmega328 developed by Arduino.cc. The clock will be generated with a constant voltage and precise frequency. These boards have been introduced for students and non-technical users, but now Arduino boards are used extensively in industrial projects. Arduino boards were originally designed for embedded systems, robotics, and automation projects. This is the smaller version of the Arduino Uno, which gives it almost similar functionality. The Nano runs on 5V, and its input voltage ranges from 7-12V. It contains 14 digital pins, 8 analog pins, 2 reset pins, and 6 power pins. There is one disadvantage of using Arduino Nano, which is that it does not come with a DC power jack, so you cannot supply power from batteries. Mini USB is used to connect the board to a computer instead of standard USB.

Microcontroller	Atmega328p/Atmega 168
Operating Voltage	5V
Input Voltage	7 – 12 V
Digital I/O Pins	14
PWM	6 out of 14 digital pins
Max. Current Rating	40mA
USB	Mini
Analog Pins	8
Flash Memory	16KB or 32KB
SRAM	1KB or 2KB
Crystal Oscillator	16 MHz
EEPROM	512bytes or 1KB
USART	Yes

Table: Arduino Nano specifications

LCD DISPLAY

An LCD is a liquid crystal display. LCD is finding greater use as it replaces LEDs (seven fragment LEDs or other multi section LEDs), due to the accompanying reasons:

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1. LCD costs are declining.
2. LCD can display numbers, characters, and designs.
3. Incorporating an invigorating controller into the LCD, thereby alleviating the CPU of the duty of reviving the LCD. The LCD must be revivified by the CPU to continue showing information.
4. The ability to program characters and designs easily.

Pin no	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V(4.7V-5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	VEE
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/Write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8	8-bit data pins	DB1
9	8-bit data pins	DB2
10	8-bit data pins	DB3
11	8-bit data pins	DB4
12	8-bit data pins	DB5
13	8-bit data pins	DB6
14	8-bit data pins	DB7
15	Backlight VCC (5V)	Led+
16	Backlight Ground (0V)	Led-

Table: Pin Functions of LCD

Code (Hex)	Working of LCD commands
1	Clear display screen
2	Return home
4	Decrement cursor (shift cursor to left)
6	Increment cursor (shift cursor to right)
5	Shift display right
7	Shift display left
8	Display and cursor off
A	Display Off, Cursor on
C	Display on, Cursor off
E	Display on, Cursor blinking
F	Display on, Cursor blinking
10	Shift position of cursor to left
14	Shift position of cursor to right
18	Shift entire display towards left
1C	Shift entire display towards right
80	Force cursor to beginning from first line
C0	Force cursor to beginning from second line
90	Force cursor to beginning from third line
D0	Force cursor to beginning from fourth line
38	2 lines and 5×7 matrix (8-bit mode)
28	2 lines and 5×7 matrix (4-bit mode)
N	Next line
T	Tab
R	Enter

Table: 16*2 LCD commands

SOFTWARE USED

ARDUINO SOFTWARE (IDE)

An Arduino IDE (integrated development environment) is cross platform software application (for Windows, macOS, and Linux) written in Java, which is derived from the IDE for the language Wiring and Processing. It works with an Arduino controller to write, compile, and upload code to the board. The Arduino code editor offers features such as cutting, pasting, searching, replacing, automatic indenting, brace matching, syntax highlighting, and one-click compiling and uploading. Besides the interface, it also features a message box, a text console, a tool bar with buttons for common functions, and a hierarchy of operation menus. Projects can be verified and compiled, with a code error log displayed at the bottom. It is implemented using ARDUINO Software 1.8, which is compatible with the Arduino IDE for C and C++.Arduino has support for the languages C and C++ in the IDE.

Advantages are Inexpensive, Open-source hardware; don't need external programming (Burner), Easy to program, Open-source software, User-friendly IDE software that operates on any operating system.

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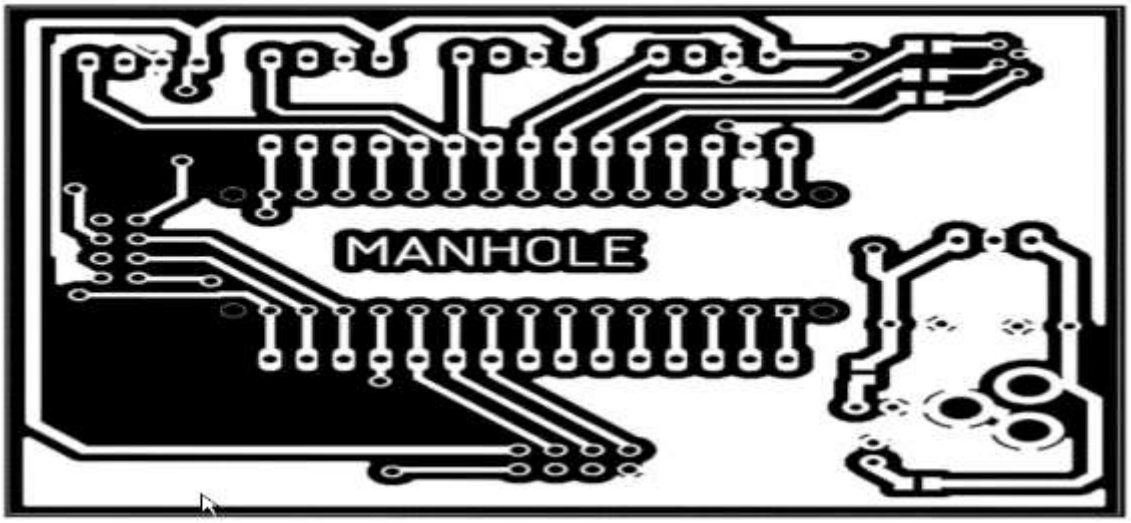

Fig: PCB SCHEMATIC

Embedded C

We come across embedded systems on a daily basis, including mobile phones, washing machines, and digital cameras, that are powered by embedded C programming. Embedded software is associated with each processor. In the proposed system, embedded C language is used to program the microcontroller. A programming language written in C and associated with particular hardware architecture is known as embedded C. An Embedded C is extension of the C language with a few additional headers. These headers may vary from controller to controller. The embedded system designer must be familiar with hardware architecture in order to write programs. Embedded C programs control and monitor external devices, using the same syntax and semantics as the C programming language, such as main functions, declaring data types, defining variables, loops and functions. It permits addressing hardware devices, fixed-point arithmetic operations, and accessing address spaces, for example, from standard C Programming Language.

OVERALL SCHEMATIC

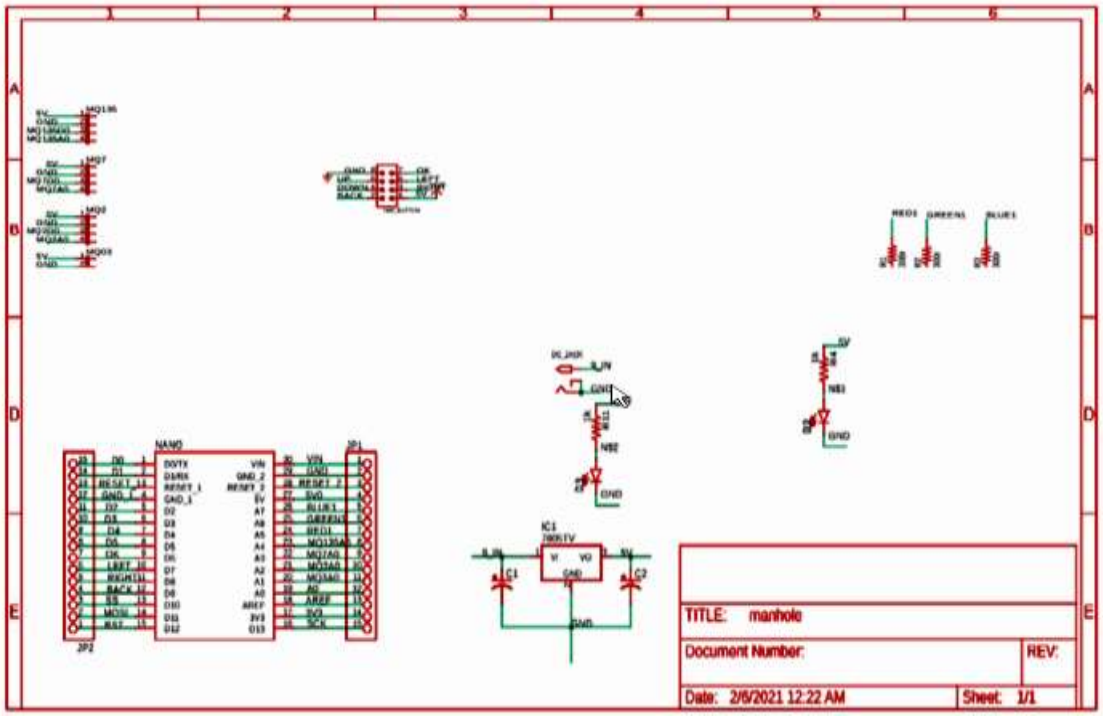

Fig: SCHEMATIC

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V. RESULTS AND FURTHER WORK

MODEL SET-UP

The proposed model for Manhole toxic gas detection and alerting system helps in measuring the toxic gas concentration causing severe health issues to the sewage workers. MQ-2, MQ-3, MQ-6 and MQ-7 sensors detect gasses like NH3, NOx, LPG, CO and even methane gas concentrations. When threshold levels of these sensors increase, intimation is given to the system via navigation button. By using GSM, the toxics concentration is sent. If any of the sensor's threshold level exceeds through GSM, the toxics concentration is sent to the authorized person. Sensors continuously check the toxics concentration thereby helps in ensuring sewage workers safety.

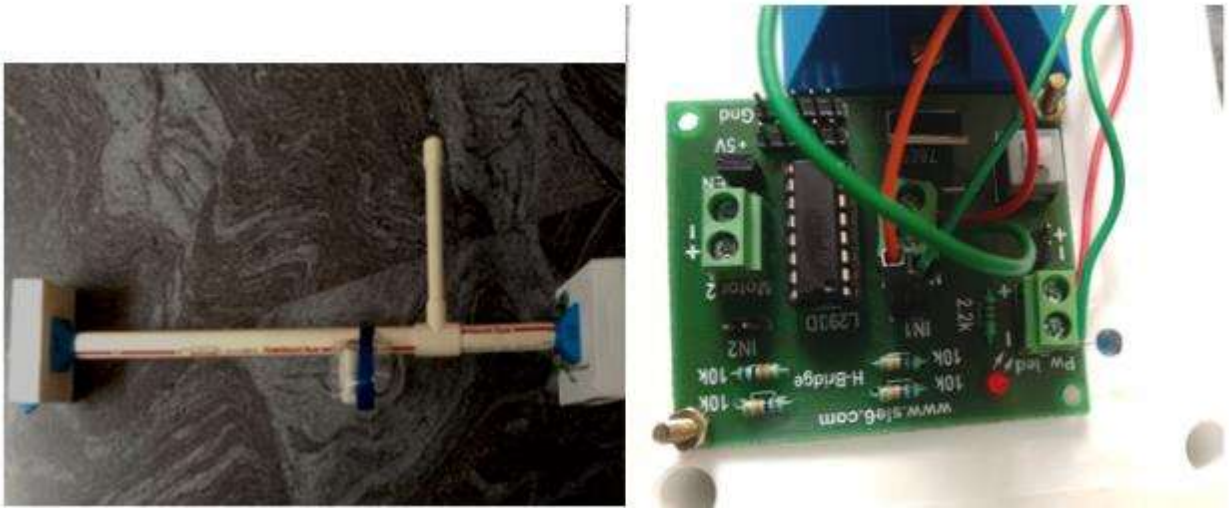

Fig: System Design Overview

Fig: System Design

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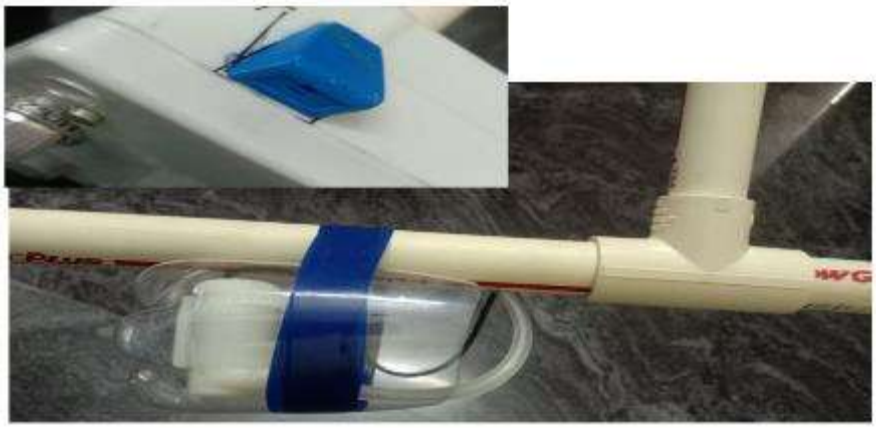

Fig: System Design Sprinkler Set-Up

SYSTEM OUTPUT

The system consists of various sensors such as MQ-2, MQ-3, MQ-6 and MQ-7 which senses toxic gases such as Methane, Ammonia, Carbon Monoxide, LPG gas, benzene, butane etc.,. The microcontroller unit processes these values and if it crosses the threshold value a message is sent to the authorized user and sprinkler mechanism is initiated as to detoxify these harmful gases to obtain the favourable working range for the sewage workers. After the detoxification process again the sensed values indicating detoxified level of the gases is notified to the authorized user via message.

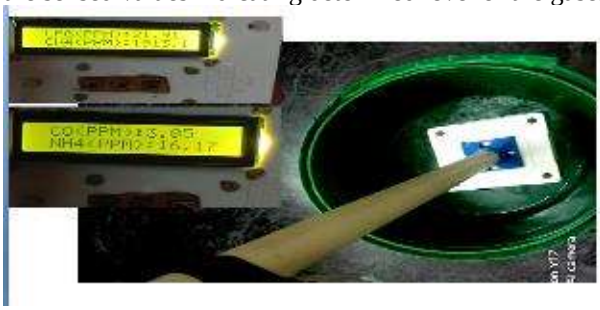

Fig (a): Toxic concentration of the gases before detoxification

Fig (b): Message alert received on the phone of authorized user before detoxification.

Fig (c): Sprinkler Mechanism for detoxifying the toxic gases.

Fig (d): Message alert received on the phone of authorized user after detoxification.

Here in the above Fig (a) it shows the toxic concentration of the gases before detoxification. In the fig (c) Sprinkler Mechanism for detoxifying the toxic gases is shown as above. In fig (b) the message alert received on the phone of the authorized user before detoxification can be observed as shown. The message alert is sent using GSM which shows the toxic gas concentration level that is obtained when threshold levels of the sensors increase, the toxics concentration is sent. Fig (d) shows Message alert received on the phone of authorized user after detoxification.

FURTHER WORK

As a part of this project, toxic gases present in sewage are monitored and alerted to manual scavengers when they exceed a certain limit. Here four sensors are used to detect the gases and Arduino nano is the heart of the system which controls the entire system. The sensor values are got through messages in our phone. The smart drainage monitoring system helps

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the sewage cleaners when the gas level is above the specified limit. It reduces the risk of death among sewer workers. Furthermore, a camera can be added to get live visuals of the process.

VI. CONCLUSION

The Internet of Things has grown incredibly popular in recent times due to its various applications, which have surfaced way for a safer, smoother, and easier way to live. The issue of sewage cleaning is one of the major concerns and challenges of the matter, despite the existence of several techniques. IOT applications for monitoring drainage systems in metropolitan cities are described in this paper. A major purpose of this device is to detect toxic gases, to alert and to minimize gas concentration levels for good working conditions. When the gas level exceeds the threshold limits, the predominant gases present in the sewage manhole are likely to be reduced with a suitable detoxification agent using a sprinkler mechanism.

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