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SMART IoT DEVICE FOR SEWAGE GAS MONITORING AND ALERT SYSTEM

REVANTH M.S
Final Year, ECE
SSN College of Engineering
Kalavakkam, Chennai.

SANJAY S
Final Year, ECE
SSN College of Engineering
Kalavakkam, Chennai.

YASWANTH REDDY PUTA
Final Year, ECE
SSN College of Engineering
Kalavakkam, Chennai.

DR B.S. SREEJA
Associate Professor, ECE
SSN College of Engineering
Kalavakkam, Chennai.

***Abstract*—**

This paper aims to design a system to measure and analyze the real-time levels of toxic gases and alert the workers. This project attempts to device an IOT technology that shall detect the 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. The measured gases level are uploaded to firebase. If levels exceed beyond threshold, it shall send an alert on the connected mobile devices of the authorized people who are remotely located in the job. If sewage is about to overflow it can be informed to the officials through SMS message. An android application was developed and integrated with the designed system for monitoring purposes.

Keywords – Sewage, IOT, ThingSpeak, Safety, Firebase Android Application

I. INTRODUCTION

Sewage environment IoT device and IoT platform to monitor poisonous gas has been proposed as a solution to help the sewer workers who put their lives risk. Because of these poisonous gases, the death rate of sewer workers has increased in the recent years. The lack of treatment of sewage after crossing dangerous levels leads to the deaths of thousands of sewage cleaners throughout the year from accidents and various diseases such as hepatitis and typhoid that occur due to sudden or sustained exposure to hazardous gases. Septic tanks are devices which are found commonly in different types of localities, ranging from residential areas to largely developed industrial areas to provide solutions for treatment of sewage wastes.

Sewage gases generally arise from the natural decomposition of sewage and their mixtures formed by slurries which leads to the production of toxic wastes that release hazardous gases. These gases can be lethal if inhaled in high concentrations or for a prolonged period of time. Septic tank gases are primarily constituted of methane, carbon dioxide, ammonia, hydrogen sulphide and traces of carbon monoxide.

In order to evaluate the gases which are present in sewage environment, sensors have been used to analyse the amount of hazardous gas and send an alert. The hazardous gases like hydrogen sulphide, methane and carbon monoxide emitted from sewage are sensed by gas sensors every moment and updated when it surpasses the normal grade. The project aims at designing a prototype for monitoring a sewage plant or septic tank in real-time for keeping a check on concentration levels of gases. The designed system can be installed in various sewage facilities, both rural and urban. The system can be made to work properly in both domestic as well as industrial plants, by changing small specifications of design. For accessing the ppm concentrations, an user-friendly android application was developed with multiple facilities integrated.

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The death rate of sewage workers has been increased day by day. Even by such understated estimates, the NCSK identified 817 sewer workers' deaths since 1993 from 20 states. By official estimates, Tamil Nadu recorded 210 deaths, Gujarat recorded 156, followed by UP and Haryana with 77 and 70 deaths, respectively.

Reason for the deaths include:

1. Forcing the workers by the supervisors
2. Unawareness about the poisonous gases present in sewage system.

II. EFFECTS OF HARARDOUS GASES:

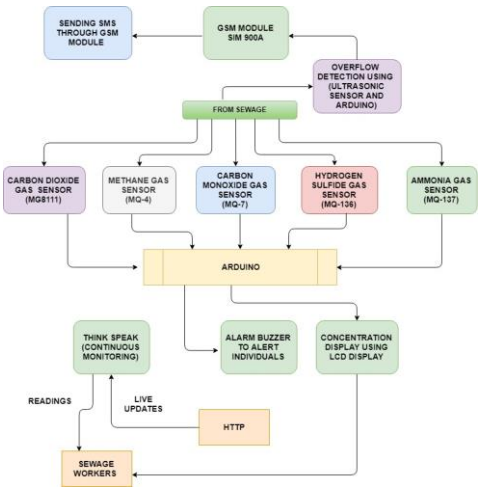
Toxic effects of H2S	
Concentration	Symptoms
0.13 ppm	Minimal detectable odor
4.6 ppm	Easily detectable, moderate odor
10.0 ppm	Beginning eye irritation.
27 ppm	Strong unpleasant odor but not intolerable
100 ppm	Coughing, eye irritation, loss of smell after 2-5 min
200 – 300 ppm	Marked eye inflammation, rapid loss of smell, respiratory tract irritation, unconsciousness with prolonged exposure
500 – 700 ppm	Loss of consciousness and possible death in 30 to 60 min
700 – 1,000 ppm	Rapid unconsciousness, stopping or pausing of respiration and death
1,000 – 2,000 ppm	Immediate unconsciousness, death in a few minutes. Death may occur even if person is moved to fresh air

Toxic effects of carbon monoxide	
25 ppm	TLV exposure limit for 8 hours (TWA)
200 ppm	Possible mild frontal headaches in 2-3 hours
400 ppm	Frontal headaches and nausea after 1-2 hours.
800 ppm	Headache, dizziness and nausea in 45 min. Collapse and possibly death in 2 hours
1,600 ppm	Headache and dizziness in 20 min. Unconsciousness and danger of death in 2 hours
3,200 ppm	Headache and dizziness in 5-10 min. Unconsciousness and danger of death 30 min.
6,400 ppm	Headache and dizziness in 1-2 min. Unconsciousness and danger of death 10-15 min
12,800 ppm	Unconsciousness immediately, danger of death in 1-3 min.

TOXICITY OF AMMONIA AT DIFFERENT CONCENTRATIONS

AMMONIA (PPM)	TOXIC EFFECT	EXPLOSURE DURATION
25	Odor detectable by most persons	For eight hours exposure
50	No adverse effect	For eight hours exposure
100	No adverse effect for average workers	Deliberating exposure for long duration not advisable.
400	Immediate nose and throat irritation	No serious effect for 30 to 60 mins
700	Immediate eye irritation	-Do-
1700	Convulsive coughing severe eye, nose and throat irritation.	Could be fatal after 30 mins
2000-5000	Causes burns blister strangulation asphyxia & ultimate death	Could be fatal after 15 mins
5000-10000	Respiratory spasm rapid asphyxia	Fatal within mins

III. BLOCK DIAGRAM



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IV. METHODOLOGY

The proposed model has been divided into two parts.

1. **CONCENTRATION DETERMINATION OF HAZARDOUS GASES**
2. **DATABASE UPLOAD & DEVELOPMENT OF USER-FRIENDLY MOBILE-APP.**
3. **ALERTING THE WORKERS AND OFFICIALS**

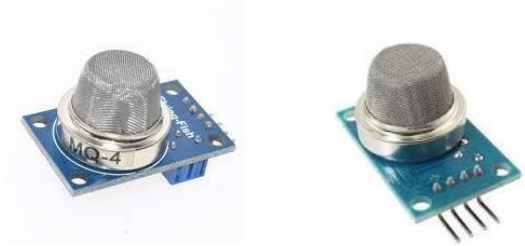
1) CONCENTRATION DETERMINATION OF HAZARDOUS GASES

In the proposed system we use various gas sensors inclusive of **MQ4** (Methane sensor) **MQ7**(Carbon Monoxide sensor), **MQ135**(Ammonia Sensor), **MQ136**(H2S Sensor) & **MQ811**(Co2 Sensor) for detecting the presence of hazardous gases in sewage. The sensor produces a wide range of values which are emitted from sewage to the controlling kit. The calibration of these sensors is done by defining resistor networks to make them usable for industrial and domestic utilization.

COMPONENTS USED:

i. Arduino:

ii. **GAS SENSORS:**



These sensors are calibrated based on the datasheet by finding the RS/R0 Ratio which is the main element for the measurement of gases by the gas sensors. At first these sensors are calibrated in fresh air and measured R0. Then these sensors are subjected to various gases and Rs is determined which is used for getting the ppm from the graph available in the datasheet.

2) DATABASE UPLOAD & DEVELOPMENT OF USER-FRIENDLY MOBILE-APP:

A user-friendly mobile application was developed with login & register features. The ppm levels of the gases are displayed in the mobile application. The variation of the gases are plotted from ThingSpeak Iot Platform. The data collected from gas sensors are uploaded to firebase and ThingSpeak through serial communication using Nodemcu which uses Wi-Fi connection. GSM Module can also be used if Wi-Fi is not required.

COMPONENTS USED:

i. Nodemcu:

ii. GSM Module:

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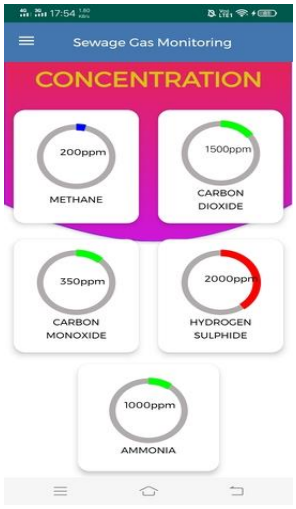
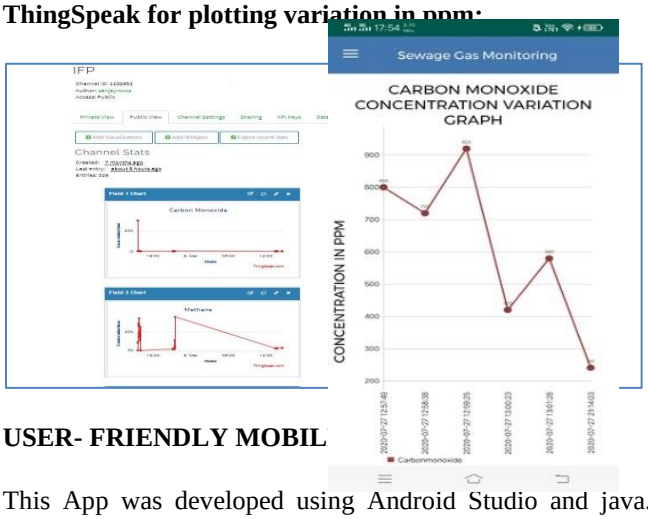
Firebase for data upload:



ThingSpeak for plotting variation in ppm:



USER- FRIENDLY MOBIL

This App was developed using Android Studio and java. The data is displayed which gets changed in real time as the sensors will upload the gas concertation in real time. This app is made multi-lingual which consists of Tamil, Hindi and English language so that people can understand easily. The safety limit of gases is also displayed in this mobile app.

The variation of the gases is plotted for each given delay which gets updated automatically as the sensors upload the data to ThingSpeak,

Three different colors blue, green and red are allotted for low, medium and high concentration of gases.

III. ALERTING THE USERS

i. GSM SIM900A Module: It is a chip used to establish communication between a mobile device or a computing machine and a GSM or GPRS system.

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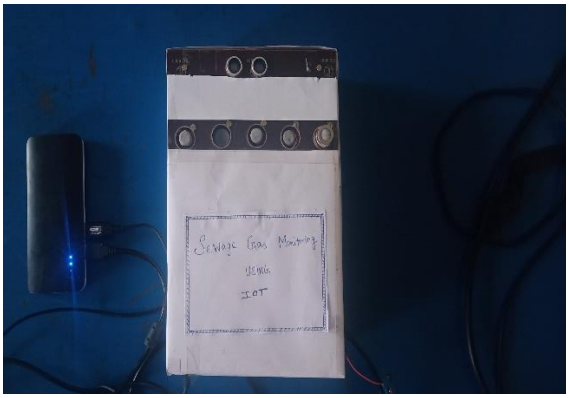
ii. Ultrasonic Sensor: It measures the distance to an object using ultrasonic sound waves, using a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

The Ultrasonic Sensor integrated with Arduino is used for sewage overflow detection. This will continuously monitor the sewage level so that the overflow can be prevented in advance.

Using the GSM module, the sewage overload condition can be informed to the respective officers through SMS. The buzzer will be in function when the ppm concentration increases beyond the threshold.

V. INTEGRATION AND TESTING:

The end product integrated with all the components and mobile application is as follows:



Testing in waste water treatment plant:

This device is tested in sewage treatment plant and the result obtained is showed below. There is a variation of gases in ppm when compared to atmospheric ppm than in sewage.

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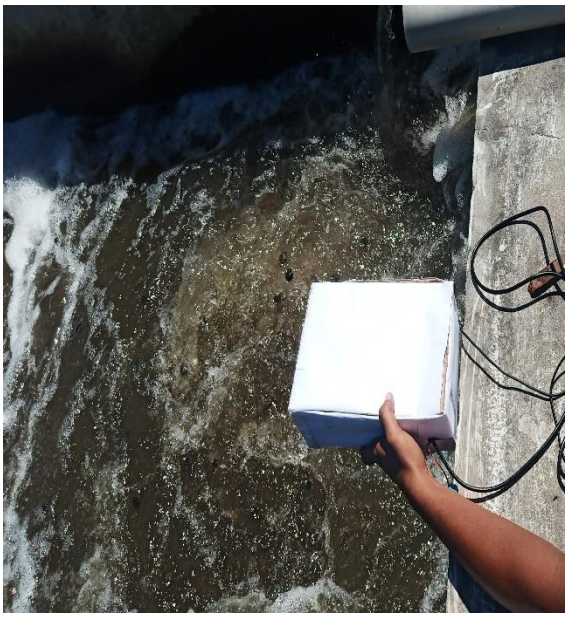

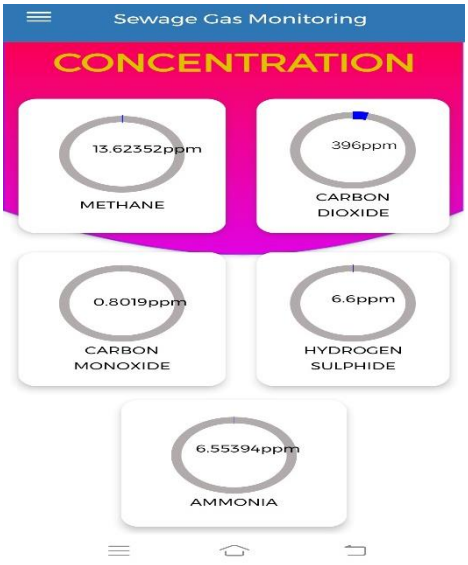

VI. CONCLUSION:

The proposed system will help sewage workers to protect their lives from risk and harmful disease. According to recent news updates, many sewage workers lost their lives while doing their job by coming across the high concentration of such poisonous gases, which once inhaled led to serious health issues.

This proposed system with advanced technology based on IoT will significantly impact the lives of sewage workers. Moreover, by introducing new functionalities like location services, tracking and modified alert system, this design can serve a great social cause.

Previously proposed system involves manual sampling for sewer gas analysis at decided intervals of time. This did not take into account several factors like water pump condition, gas retention and damage to facility which altered sewer conditions occasionally. It is tough to capture the fluctuation in gas concentration if manual charting is done, and is also harmful for the engineer installing systems repeatedly to be exposed to such areas. This is a serious limitation, which is overcome by online monitoring. This also captures values which vary from site to site and this type of sampling is feasible for long-term quantification of gas concentration across extensive sewer networks.

This project will be able to aid the Department of Health and Sanitation, and help to fulfil a social cause for the country.

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