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Sewage Gas Monitoring and Alerting System

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***Abstract*—sewage systems is an important part of an urban infrastructure, however they also create a disaster risk for health and safety with the build-up of toxic gases such as methane (CH_4) and carbon monoxide (CO). These gases can cause fatal accidents, explosions, and serious respiratory illness in workers exposed to them. Our idea is to make Low cost, high efficiency, small size, portable device over long distances. The system is integrated with a microcontroller and a RF433 module, allowing continuous data transmission for monitoring. By processing sensor data and setting threshold-based alerts, the system ensures timely warnings of hazardous gas buildup, thereby enhancing worker safety and reducing potential environmental contamination. The proposed system provides an efficient, cost-effective, and scalable approach to sewage monitoring. There are two parts that make up this system, a transmitter and a receiver. The transmitter unit, which consists of gas sensors (MQ4, MQ135 and MQ7) along with a microcontroller board (Arduino) and a wireless communication module (RF). These sensors continuously monitor gas concentrations, and when the detected level exceeds the pre-set safety limits, the unit activates an alarm. The data is then sent wirelessly to the receiver unit, located in monitoring area. The data received on the receiver unit gets processed and warnings are generated in the form of buzzer alarms and indicator LEDs. The system is coupled with a GUI-based application that can be used as a remote monitoring of gas levels and real-time alerts.**

***Keywords*— Arduino nano, MQ-4, MQ-7, MQ-135, RF433MHz**

I. INTRODUCTION

Sewage transport wastewater from residential, industrial and commercial areas, they are a vital part of infrastructure. Nevertheless, in such environments, dangerous gases like methane (CH_4), hydrogen sulfide (H_2S), ammonia (NH_3), and carbon monoxide (CO) tend to build up, presenting significant threats to the health and safety of workers conducting maintenance and inspection activities. Long time exposure to such toxic gases can lead to suffocation, poisoning, explosions and death. An automated real-time monitoring system is thus required to detect dangerous gas concentrations and issue warnings to prevent accidents. The project proposes the Sewage Gas Monitoring and Alerting System, to construct a cost effective and efficient embedded system, which is designed with needs to detect hazardous gases in sewage environment.

Gases such as methane (CH4), carbon monoxide (CO) and carbon dioxide (CO2) are asphyxiant gases, which mean they have a tendency to displace oxygen from a place. Due to the presence of these gases in the sewer it has very low level of oxygen.SO, the greater the presence of these gases, lower the availability of oxygen, Which will lead to suffocation. To avoid such cases gas levels has to be continuously monitored.

In case gas levels are above the safe limit, it activates both audible (buzzer) and visual (LED) indication to alert workers and supervisors, thereby designing a mechanism which prevents accidents in advance. The key aims of this project are to implement a multi gas detection system, use wireless communication for transferring the information in real-time and to use alert mechanism for immediate alert. This unit should be a low power, compact, cost-effective and scalable embedded system which can be applied at large scale in municipal sewage systems, industrial wastewater plants and in any confined spaces where the accumulation of toxic gas may pose a threat. This project is important as it ensures workers' safety, automates the detection of hazardous gas and provide a continuous measure model to the system at low cost. Automating the detection process, keeping humans away from the risk.

II. SYSTEM DESCRIPTION

A. Arduino Microcontroller Board

Arduino is a widely used microcontroller board for beginner level electronics project due to its huge online resources. Arduino nano has size advantage over Arduino uno, which is also a microcontroller board but quite big in size. Though Arduino nano is small in size, it can function identical to uno

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version of it. The primary processor used in it is ATmega328 microcontroller, it is a low power consuming microcontroller. Interfacing external devices through serial communication is supported by the chip with UART TTL (5V), I2C (TWI) and SPI. It operates on 5V with clock speed of 16MHz. Inputs from the gas sensors are given through analog pins of the Arduino nano. Due to its ease of serial communication data can be read easily at the receiver end. Power consumption is also low, so our kit can be efficiently operated as an battery powered device.

B. MQ-135 Air Quality and Hazardous Gas Sensor

MQ-135 is preferred gas to monitor the overall quality of the air. It can be used to detect gases like ammonia (NH_3), sulfur dioxide (SO_2), benzene (C_6H_6), carbon dioxide (CO_2) which are common gases that causes danger in a sewer. The sensor detects various chemicals that are present in air and varies the voltage accordingly with respect to the amount of gas in the environment. This sensor operates at 5V, it can detect gas concentration from 10 to 1000ppm.

The sensor consists of housing made of steel under which the sensing element has been placed and protected. Mentioned sensing element is subjected to current flowing through connecting leads, this current is called heating current. Heating is important in case of sensors using metal oxides as sensitive elements, it helps to enhance the sensitivity. Humidity can cause negative effects on the readings obtained. By heating, activation energy for chemical reaction of gas molecules and sensing material is provided. Response and recovery time is reduced, meaning sensor reading can return to its base line quickly after detecting the gas. MQ-135 is an 4-pin sensor module which can produce both analog and digital signal from their respective pins.

C. MQ-7 Carbon Monoxide Gas Sensor

Gas sensor which is specifically designed for detect carbon monoxide (CO). MQ-7 sensor also uses tin dioxide, which has low conductivity in atmospheric air but changes when exposed to CO gas. This change in conductivity is calibrated for correct readings.

D. MQ-4 Methane Gas Sensor

The MQ-4 module can detect gases like Methane, CNG Gas. It can detect methane, Natural gas concentrations anywhere from 300 to 10000 ppm. A crust made of plastic and stainless-steel net holds the sensor, which is made up of a micro AL2O3 ceramic tube, a Tin Dioxide (SnO2) sensitive layer, a measuring electrode, and a heater. The heater creates the ideal working environment for sensitive components. The wrapped MQ-4 has six pins, four of which are used to fetch signals and two of which provide heating current

E. RF433MHz Transmitter/Reeciver Module

A wireless communication system that operates in 433 MHz radio frequency range. It consists of two parts, transmitter and receiver by which data is transmitted from one point to another. Transmitter part will send the data in digital format by modulating using amplitude-shift keying (ASK), on the receiver part it will get demodulated and convert it into real data. Due to its reliability data transmission can be done without any major loss, ensuring real time monitoring. Its is less power consuming, because of that we can utilize it efficiently with the battery power.

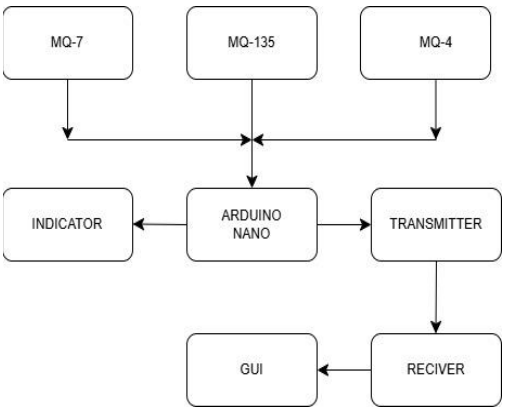
Data can be transmitted over 50-100m, varies with level of obstacles present between the transmission units. This whole module operates between 3-12V.

III. EXPERIMENTAL SETUP

The Sewage Gas Monitoring and Alerting System was designed in assembly and tested in both controlled environment and real-time operation to evaluate its performance in the experimental setup. The system comprises two main components: a transmitter unit (sensor node) and a receiver unit (monitoring system).

The transmitter unit is based inside sewage systems or other closed areas where gas may accumulate. The device comes with multiple gas sensors (MQ-135, MQ-7 and MQ-4), which are capable to detect toxic gases like methane (CH_4), hydrogen sulfide (H_2S) and carbon monoxide (CO). HC-05 Bluetooth Module: Data communication within gas sensor is established using HC-05 Bluetooth module which facilitates serial communication with Arduino Uno (microcontroller) as well as any wireless device such as mobile application. This data is processed by the microcontroller to determine if the gas levels surpass the set safety limit. If the concentration of gas is high, the system triggers an alarm mechanism, a buzzer and an LED indicator, thus alerting the workers near it. A wireless communication module (Wi-Fi/Bluetooth/GSM/LoRa) also sends real-time data to the monitoring system for remote supervision.

A. Block Diagram



B. Circiut Diagram

The circuit diagram consists of three main sensors namely MQ-4, MQ-7 and MQ-135 to measure gas concentrations in the surroundings. The Arduino is a microcontroller which acts as a brain for the device and processes the various algorithm to find out the correct values of data to be measured. The methane(MQ-4), carbon mono oxide(MQ-7), carbon di oxide(MQ-135) sensors uses a 5V supply and provides an analog output. This data is read continuously by the microcontroller and it process to get the concentration of

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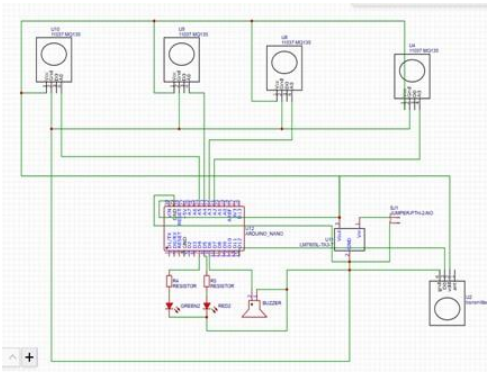
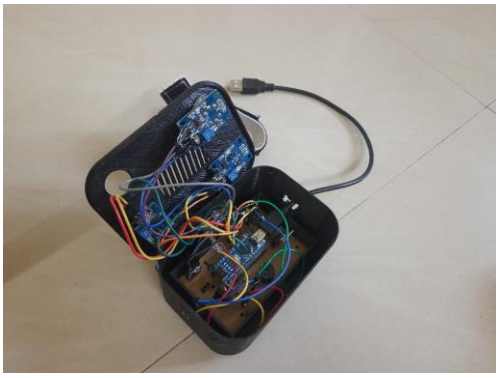
required gases respectively in the surroundings. A buzzer and a led is connected which is the part of the alert system and alerts with the sound in case of emergency.



C. Working and usage

The sewage gas monitoring and alerting system Arduino based system that helps in monitoring hazardous gases in sewage and monitoring the health of a worker working in a sewage plant using embedded boards, sensors. And the device consists of two main units which are the Transmitter Unit (Sensor Node) and Receiver Unit (Monitoring System). This system has two major components, the transmitter unit which is placed in the sewage area to where it detects gases such as methane (CH_4), hydrogen sulphide (H_2S), and carbon monoxide (CO) from its gas sensors (MQ-135, MQ-4, MQ-7). A microcontroller (Arduino Uno/ESP32) reads the sensor data and checks if the gas levels go above a defined threshold.



A microcontroller is present in the receiver unit (monitoring system), where it reads incoming data and displays it on a GUI application. This includes a graphical display of gas concentration readings (the gauge meter), notifications, and historical data. Also is a data logging system for storing gas concentration readings to support compliance reporting and safety audits.

The working principle is a step-wise process, the gas sensors are continuously checking air quality, as well as whenever it finds dangerous gases, it is sent to microcontroller for processing. If the detected levels exceed permissible limits, local alerts (buzzer and LED) are given to protect workers. At the same time, data is sent wirelessly to the receiver unit, which displays real-time gas levels on the GUI application. The logging of gas-sensor concentration data allows the system to keep records for further analysis, as well as ensure that the system is safe to operate in a shared area. If needed, emergency notifications are set off with both cloud and mobile alerting of supervisors.

D. Experimental Results

The Sewage Gas Monitoring and Alerting System was designed in assembly and tested in both controlled environment and real-time operation to evaluate its performance in the experimental setup. The system comprises two main components: a transmitter unit (sensor node) and a receiver unit (monitoring system).

The transmitter unit is based inside sewage systems or other closed areas where gas may accumulate. The device comes with multiple gas sensors (MQ-135, MQ-7 and MQ-4), which are capable to detect toxic gases like methane (CH_4), hydrogen sulfide (H_2S) and carbon monoxide (CO). RF 433Mhz Module: Data communication within gas sensor is established using RF 433 Mhz module which facilitates serial communication with Arduino Uno (microcontroller) as well as any wireless device such as mobile application. This data is processed by the microcontroller to determine if the gas levels surpass the set safety limit. If the concentration of gas is high, the system triggers an alarm mechanism, a buzzer and an LED indicator, thus alerting the workers near it. A wireless communication module (Wi-Fi/Bluetooth/GSM/LoRa) also sends real-time data to the monitoring system for remote supervision.

Real-time data processing, visualization, and also alerting are handled by the receiver unit. It is made up of microcontroller receives data from transmitter unit and transmits it into Graphical User Interface (GUI) application. The GUI also shows gas concentration levels that acts as a gauge meter to indicate current gas level. The system includes a data logging component that logs the gas levels in time frames for analysis and compliance. In the event the gas exceeds safe levels the receiver unit sends an emergency notification via SMS, email or cloud based to be set up to alert the supervisors.

Numerous controlled experiments were carried out in order to verify the working of the system. The initial calibration of the sensors was performed using a controlled exposure to each gas to readjust the sensor for precision. Various concentrations of methane (CH_4) and hydrogen sulfide (H_2S) gas flows were admitted into a sealed chamber, where the responses of the sensors were monitored and compared to standard gas detectors. The gas detection accuracy confirmed by sensor response time measurement and false alarm measurement.

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This was followed by in-field testing in actual sewage environments. The response was studied in environmental conditions, deployed in drainage chambers and confined spaces. RF 433 MHz module was used to test the efficiency of distance of data transmission. To assess the effectiveness of the alert system, researchers simulated high concentrations of toxic gases that activated emergency alerts and measured response times.

The GUI application can be tested for usability and functionality. The interface was meant to be user-friendly, displaying gas levels the supervisors can monitor in real time and receive alerts immediately. We then evaluated the data logging function by saving gas concentration data for multiple days and recognizing trends to understand gas accumulation patterns.

Experimental results showed that the system has the ability to precisely recognize toxic gases, generate fast local fomentations, and send real-time data to outside supervisors. Wireless communication was integrated so that alerts were dispatched even in the most remote of locations. The data logging provided a convenient solution for requests, especially for compliance, safety checks, etc.

In conclusion, The Sewage Gas Monitoring and Alerting System was successfully able to meet all of the experimental objective sets making it a reliable and effective tool for detecting hazardous gases and alerting workers and supervisors in real time. Further integrations could see improved calibration of sensors, predictive modelling of gas levels using AI, or cloud Python & its associated libraries integrated with the equipment to allow for advanced data analytics & remote monitoring.

IV. CONCLUSION

Sewage Gas Monitoring and Alerting System — This is an innovative and practical idea to improve workplace safety by detecting toxic gases in sewage. It uses these sensors to accomplish real time monitoring and real time alerts to the worker and the supervisor. The system helps to prevent tragic, potentially deadly gas-related accidents by ensuring gases like methane (CH_4), hydrogen sulfide (H_2S) and carbon monoxide (CO) are detected early to promote a healthier working environment for sewage workers.

The high accuracy, high speed and low power of the system will enable its application in the industrial and municipal field as a reliable and cost-friendly solution. Standalone GUI application with a gauge meter in the middle for better visualization of gas concentration ozone, CO, CO2. Nor is the visualization of gases easer for supervisors to determine that their environment is safe. The RF433MHz Transceiver unit enables data transmission between the sensor unit and the monitoring system without needing the internet, therefore, is expected to be suitable for remote and underground sewage because no internet can be accessed in that environment.

REFERENCES

[1] Nitin Asthana, Ridhima Bahl, "IoT Device For Sewage Gas Monitoring And Alert System" 1st International Conference on Innovation in Information and communication(ICIICT), 25-26 April 2019.

[2] Umapathi N, Ramya R, Reethi A, Sangeetha M, “Prevention of Gas Poisoning of Sewage Workers using Arm CortexM4”, International Journal of Advanced Research in Management, Architecture, Technology andEngineering (IJARMATE) Vol. 3, Special Issue 5, pp5-9, 2017.

[3] Dr Thangalalakshmi S, Kathiravan A R ”Poisonous Gas Detector with Electrochemical Noise” International journal of Advanced research in Electrical, Electronics and Instrumentation Engineering.Vol 5, Issue 4, 2016.

[4] P Anusha, A Balaji, B Nithyasundari, Yogita Dayanand Patil, S Ravi, "Experimental Evaluation of an Internet of Things Powered Sewage Gas Monitoring and Reporting System using Artificial Intelligence Strategy" IEEE International Conference on Advances in Computing, Communication and Applied informatics(ACCAI), July 2024.

[5] Yae Wang, Jun-qingJi ,Jie Li, Peng Wang, Dongyang Wei ”Analysis of Gases Discharging from Inspection Wells of Urban Drainage System and Its Impacts on the Surrounding Air Quality” School of Environmental and Municipal Engineering Lanzhou Jiaotong University Lanzhou, China.

[6] Pavan Chandra Vishal Chaganti, Koppuravuri sai sukesh, "Smart IoT Solutions for Subsurface Gas Monitoring and Safety in Critical Infrastructures" 2nd International conference on Automation, Computing and Renewable Systems (ICACRS), 11-13 December 2023.

[7] R. Al-Ali, Member,(2018) IEEE, Imran Zualkernan, and FadiAloul, Senior Member, IEEE, “A Mobile GPRS-sensors array for Air PollutionMonitoring” vol.6, pp.410-422.