International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 7 July 2023, pp: 226-230 www.ijaem.net ISSN: 2395-5252

Intelligent Robot for Hazardous Gas Detection

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Date of Submission: 05-07-2023 Date of Acceptance: 15-07-2023

ABSTRACT:
In recent years, the automation of life science laboratories has seen significant advancements with the integration of mobile and stationary robots. This project focuses on the development of a robot capable of detecting hazardous gases in the surrounding environment. The main goal of the robot is to identify dangerous gases and map their GPS coordinates onto a navigation terrain in real-time. This information is then transmitted wirelessly to a remote device, enabling the exploration and identification of the gas types, which holds great potential for effective disaster management. The robot features a gas detection sensor module, a human detection sensor, a GPS system, and obstacle detection sensors, all seamlessly integrated into a cohesive system. In the event that hazardous gases are detected, the robot is programmed to emit an alarm sound. Additionally, an intelligent human detection system and obstacle avoidance mechanism have been implemented to ensure safe navigation of the robot. The robot has undergone testing in uneven terrains to accurately identify the presence of hazardous gases, including carbon dioxide, liquefied petroleum gas, and vaporized alcohol gas, in comparison to ambient gases, in real-time. The design of this robot incorporates embedded automation and Internet of Things (IOT) technologies.

I. INTRODUCTION:

Manholes pose a significant danger due to the buildup of gases. Tragic deaths have occurred in the past when workers entered manholes without proper testing and ventilation. Therefore, it is crucial to analyze the gas composition and take precautions before entering these confined spaces. There are three types of hazardous situations that can be found in sewer manholes or confined spaces: explosive gases (like methane), toxic gases (such as hydrogen sulfide, ammonia, and carbon monoxide), and a lack of oxygen. Methane, generated by decomposing sewer matter, is highly flammable and can cause violent explosions even with a small spark. An area with 10,000 ppm of methane is considered highly explosive. Hydrogen sulfide is produced in stagnant or septic sewage and can reach concentrations of up to 6000 ppm. Breathing is inhibited above 600 ppm, as the gas fills the lungs. Carbon dioxide (CO2) and carbon monoxide (CO) are generated through the oxidation of hydrocarbons inside manholes. Carbon dioxide is produced when there is sufficient oxygen, but in oxygen-deficient conditions, incomplete reactions lead to the production of carbon monoxide. Presence of carbon dioxide above 10,000 ppm and carbon monoxide above 40 ppm is highly dangerous. Ammonia, a natural byproduct of biological waste, is commonly found in manholes. Levels above 25 ppm can have adverse effects on the human body. Therefore, it is crucial for workers to check for the presence of these toxic gases and ensure they are within safe limits before entering a manhole. Unfortunately, no such system is currently available. The increasing demand for robots in various fields indicates that in the near future, robots and unmanned machines will predominantly handle dangerous activities that endanger human life. Advanced countries have already made substantial investments in intelligent robotic systems for various operations and applications. A mobile robot equipped with advanced sensor technologies can gather environmental information and be used for surveillance purposes instead of relying on a human operator. Human beings find it challenging to identify hazardous gases in manholes due to their colorless nature. Existing gas monitoring systems can only detect gas distribution in fixed locations, whereas there is a need to dynamically collect gas distribution information over an area. A mobile robot with gas sensing capabilities holds promise in

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overcoming these limitations. This project aims to develop a Manhole Hazardous Gas Detection Robot with a smart navigation system to address these challenges.

IOT AS AN APPLICATION

The use of the Internet of Things is worth mentioning and applies to this device as a whole. For example, the Internet of Things (IOT) can be described as connecting everyday objects such as Smartphone's, televisions, sensors, buzzers, emails, sirens, and actuators to the Internet. The Internet allows devices to technically interconnect and enable new forms of communication. Successful development of Hazardous gas leak detectors will help to detect Hazardousgas leaks efficiently, and save lives and property. Hazardous Gas leaks are dangerous to personnel and industrial activities. Rapid detection and warning minimize the risk of gas leaks.

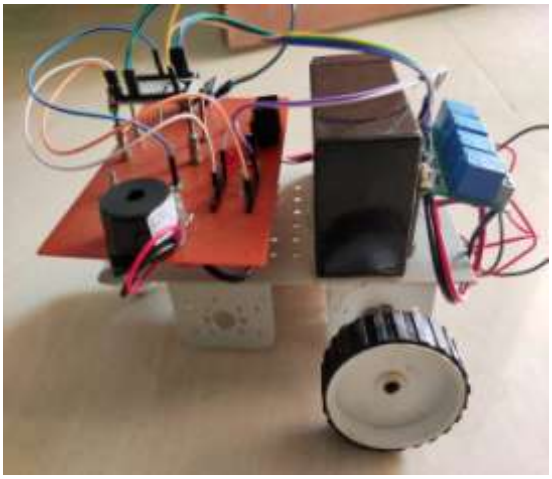

Fig1 : Model of Project

II. LITERATURE SURVEY:

[1] Title: A Mobile Robot for Hazardous Gas Sensing
Published: 2020 International Conference on Computational Performance Evaluation (Compel), July 2–4, 2020
Authors: Taniya Das, DhrubaJyotiSut, Vishal Gupta, Lakhani Ghani, PriyankaKabotie, Nayan M. Kabotie

This paper presents the development of a robot capable of detecting hazardous gases in the environment. The robot is equipped with gas sensors, human detection sensors, a GPS module, and obstacle detection sensors. It can navigate through obstacles, transmit real-time information about detected hazardous gases and human presence, and map their GPS locations. The collected data can be sent to a remote hand-held device for further analysis, which is beneficial for disaster management. The researchers achieved an average accuracy of 98% in gas classification using a neural network-based classifier.

[2] Title: Smoke and LPG Gas Detection Robot with Wireless Control by Solar Energy
Published: Journal of Engineering Sciences, Vol 13 Issue 06, June/2022
Authors: Mrs. D. Divya, B. Jyothika Reddy, K. Bhargav Reddy, L. SaiLohith

This project focuses on developing a robot that can detect gas leaks and potential fire accidents, particularly in kitchens and bedrooms. By utilizing sensors and wireless communication, the robot can detect gas leakage or fire events and notify the relevant authorities promptly. The system raises an alarm and sends notifications to the authorities if it detects gas leakage within a suggested distance. This early detection and notification system aims to minimize potential damages to life and property.

[3] Title: Hazardous Gas Detection and Alert System
Published: Journal of Emerging Technologies and Innovative Research (JETIR), May 2019, Volume 6, Issue 5
Authors: Shruthi U N, Varshini AV, Vidya M A, Vinutha B J, Manjunatha B

This paper addresses the need for an effective monitoring system to detect hazardous gases, such as carbon monoxide, hydrogen sulfide, and methane, in manholes. The proposed system incorporates gas sensors that can detect these gases and trigger an alert through a buzzer when their levels exceed the threshold. Additionally, the system sends a message to the authorized officer using IoT technology, ensuring timely actions can be taken to prevent health issues or accidents.

[4] Title: A Hardware Implementation of Hazardous Gases Detection Using Robot
Published: International Journal of Engineering Trends and Technology (IJETT), Volume 67, Issue 7, July 2019
Authors: AshwiniKumari P, Byregowda B K, Vijayakumara Y M, Ravikumar H R, Dr. S N Sheshappa, Pradeep Kumar S

This project aims to develop a hazardous gas detection system using a robot to prevent accidents caused by gas explosions. The paper highlights the importance of detecting hazardous gases, especially during repair work or maintenance operations. By

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implementing the robot-based system, the authors intend to safeguard people from potential explosions and accidents caused by the release of gas and welding residues.

III. METHODOLOGY

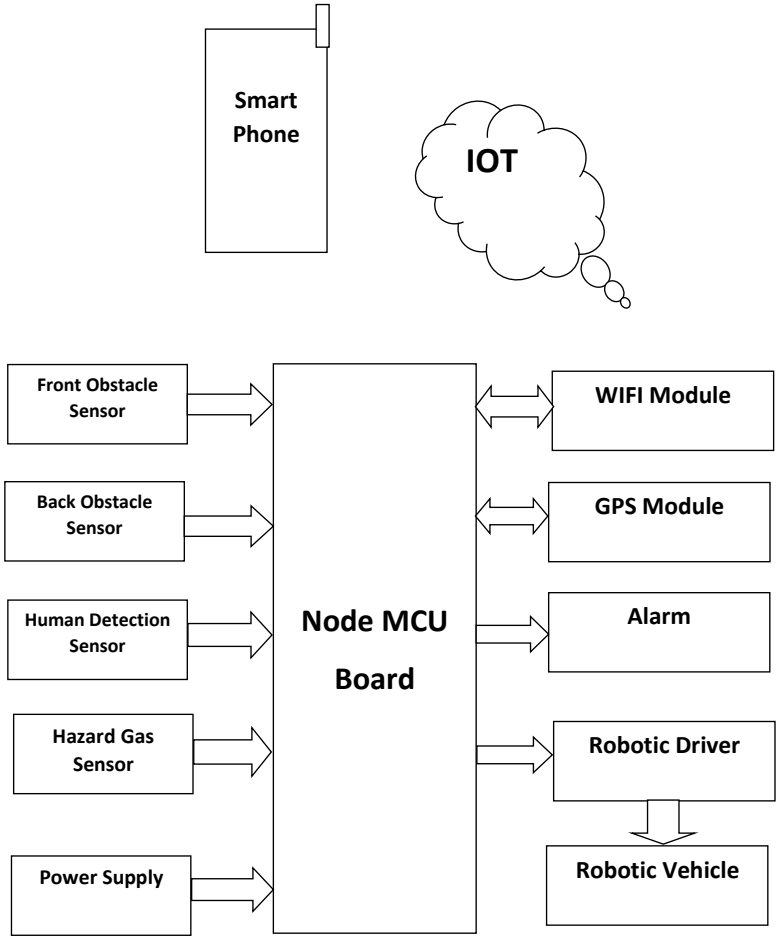

Fig 2 : Block Diagram

The basic design flow of this project involves the following components: Node MCU board, front obstacle sensor, back obstacle sensor, human detection sensor, hazardous gas sensor, power supply, WIFI module, GPS module, alarm, robotic driver, robotic vehicle, and smartphone. Different types of hazardous gases are detected by the hazard gas sensor, which sends the data to the Node MCU board for calculating the dangerous gas levels. The human detection sensor is used to detect workers in the manhole area, while the obstacle sensors help in avoiding collisions while operating the robotic vehicle. The GPS module is utilized to obtain the latitude and longitude coordinates of the location where hazardous gases are detected. This information is then updated and transmitted to a remote location smartphone for mapping the location. The robotic vehicle system is controlled using a smartphone, enabling remote operation. The Node MCU board serves as the central component of the project, responsible for the automation of the robotic system and monitoring various parameters. An intelligent alarm system is implemented to alert workers when hazardous gases are detected. The WIFI module facilitates the transmission and reception of information from the smartphone using IOT protocol network.

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IV. FLOWCHART

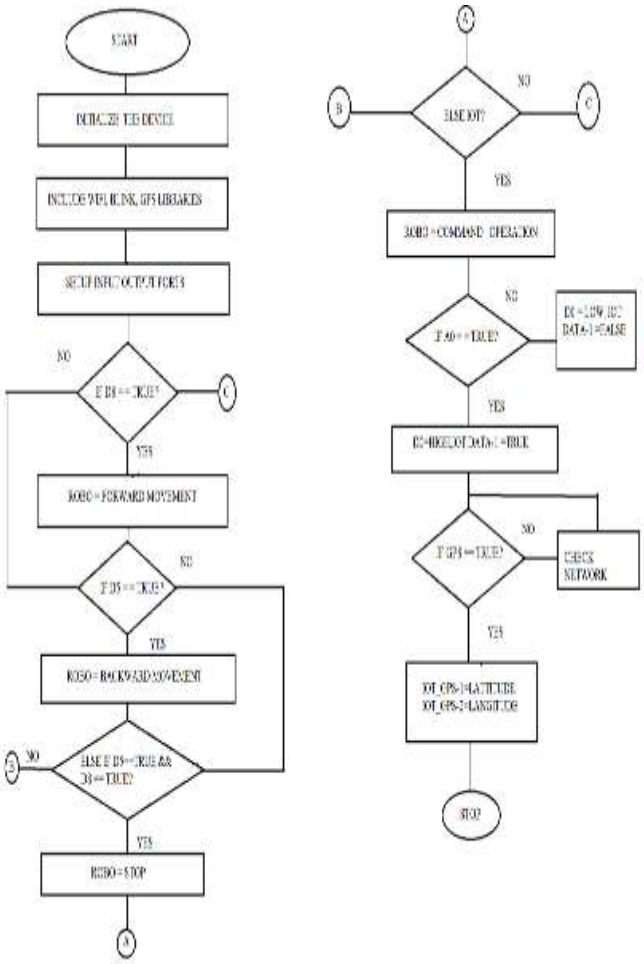

Fig 3 : Flowchart

• Once the program starts all the devices and including WIFI, blink, GPS libraries, setup i/p and o/p ports all are get initiated.
• Initial condition is stored in a variable called C.
• If the object is detected with the help of back obstacle sensor D8(D8==TRUE), The Robo will be moves in a forward direction, otherwise it going to check for next condition.
• If the object is detected with the help of front obstacle sensor D5(D5==TRUE), The Robo will be moves in a backward direction, otherwise it going to check for next condition.
• If object is detected at both forward and backward direction (D8==TRUE AND D5==TRUE) The Robo become stationary and these moment will be stored in a variable called A.
• If there is no object detected at both forward and backward direction these activity stored in a variable called B
• If the network is interfaced with IOT, Robo will start's it's command operation, otherwise Robo will go back to its initial condition (C).
• If Any hazardous gas detected(A0==TRUE) then D0 becomes high and IOT data_1(blink data) becomes true.
• If there is no hazardous gas detected(A0==FALSE) then D0 becomes low and IOT data_1(blink data) becomes false and again go back to check the same condition.
• At last system will check for whether GPS is detected or not, if the GPS detected it stores the IOT_GPS-1=latitude and IOT_GPS-2=longitude then after putting this data into the location finding applications like google map we can find the exact location of hazardous gas detected then the program will get stop.
• If there is no GPS detected it will check for a network and again will go back to the same condition to check until and unless condition becomes satisfied.

V. RESULT AND CONCLUSION

An intelligent robot system was successfully designed and demonstrated for the detection of hazardous gases in manholes. A human detection sensor was developed and tested, ensuring the safety of workers. The robotic system was equipped with wireless remote control and an automatic obstacle avoidance system, which were both designed and tested successfully. To accurately locate areas with hazardous gases, a GPS module and smartphone were utilized to map the gas distribution. The entire system was monitored and controlled through IoT protocol networks using a smartphone. Furthermore, a hazard gas alert system was designed and successfully tested to ensure the safety of manhole workers.

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