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Design and Deployment of a Mobile Robot for Industrial Gas Leakage Monitoring

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Abstract:

The Smart Gas Leakage Monitoring Robot detects gas and smoke leakage in industrial and residential spaces and aims to safeguard workers, reducing potential threats. The robot is an innovative wireless device that can monitor, detect, and assess threats in unsafe environments. The robot is driven by Wi-Fi and can be routed to dangerous places where monitoring is unsafe. It is built using MQ2 and MQ6 gas sensors which are sensitive to gas leakage, smoke, and poisonous gases in the immediate environment. An ultrasonic sensor is placed on a rotating servo which is responsible for path planning and obstacle avoidance. The company placed an obstacle avoidance DC geared motor with an L298 driver. To scan the immediate environment and perform real time monitoring, the gas sensors and a visual display unit are built to constantly and immediately assess the gas levels and declare the working condition of the robot. Once a gas is detected which is beyond the determined safety levels, the robot will activate an alarm and inform the surrounding people of the potential threats to avoid the accident and prevent a fire from occurring. The system is a cost-effective, efficient, and simple way for gas leakage detection and monitoring the environment in industries, laboratories, mines, and gas storage areas. The system also enhances industrial safety, limits worker presence in unsafe zones, and provides a smart monitor to embedded systems integrated with IoT technologies.

Keywords *— **Wi-Fi Control, MQ2 Sensor, MQ6 Sensor, Smoke Detection, LPG Detection, Ultrasonic Sensor, Servo Motor, Obstacle Avoidance, L298 Motor Driver, LCD Display, Buzzer Alarm.***

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I.INTRODUCTION

In labs, industrial buildings, and homes, gas leaks can occur and are an extreme threat to safety. Gas leaks can cause fatal accidents and serious injuries to other. Gas leakage detection systems lack the functionality to detect gas leakage systems, and the inspection is done manually where employees are put in harms way. Our product, the Gas Leakage Monitoring Robot Controlled Using Wi-

Fi, helps to solve this issue. The robot is equipped with MQ2 and MQ6 gas and smoke sensors. These sensors are easily placed on a Wi-Fi controlled robot. These sensors continuously take air samples and detect gas and toxic pollutants.

To help with navigating the robot, we equipped the robot with a sensor controlled by a servo controlled motor to help it detect obstacles and help the robot to understand the layout of the surrounding environment. This systems design of gas leak detection systems is made to help the robot safe navigate. The robot movement is controlled with the DC motors and an L298 motor driver module.

LCD shows the current reading of gas concentration and other details. Alarm is generated to alert user about danger in case gas leakage/smoke crosses threshold limit set. The Robot can be controlled and monitored remotely through Wi-Fi control feature.

The built IoT device works as an efficient solution for monitoring dangerous gases and industrial safety by implementing reliability and cost-effectiveness. It reduces user risk, elevates safety and leads the way to modern automation and industrial IoT based monitoring.

II.LITERATURE REVIEW

Various research articles related to gas leakage monitoring robots were reviewed to find out the research gaps.

Pangedaiah Bezawada, Naga Supriya T, Venu Madhavi V and Sai Durga Prasad K. (2024). Presented an “IoT Gas Pipe Leakage Detector Using Solar Based Robot” as an industrial gas monitoring system. The system was designed to monitor gas leakage and environmental conditions by implementing MQ2 gas sensors, ESP32-CAM, DHT11 sensors and Wi-Fi module. The data collected from the gas sensors were sent to IoT application using the internet for remote monitoring and supervision. The authors opined that the system enhances industrial safety by monitoring gas leakage remotely using solar-based robotic technology as it detects gas leakage in real-time and continuously monitors the work environment.

Ibtihaj Abdulwahab Abdulrazzak (2023) Presented “Monitoring the Leakage of Gases in Work Site by Using A Robot Car” as a robotic gas leakage monitoring system. Gas sensors and buzzer alarm systems were implemented to detect harmful gases like butane in the industrial work environment. The research suggested that robotic monitoring system provides faster results when compared to manual inspection systems. The system reduces exposure of humans to harmful gases present in the industries and increases safety measures.

Mrs. D. Diya, B. Jyothika Reddy, K. Bhargava Reddy and Lohith (2022) has presented a project titled “Smoke LPG Gas Detection Robot with Wireless Control by Solar Energy”. The robot is designed to detect the smoke and LPG gas leakage by using Arduino Uno, MQ gas sensors, GSM modules, Bluetooth modules, buzzers and solar powered systems. When there was a gas leakage, the system would sound alarms and send warning alerts to users. The authors concluded that the reliability and efficiency of gas leakage detection systems improved through wireless monitoring and renewable energy integration.

Gargi N R, Ann Merlin Binu, Ashiga Suresh, Devika Vijay and Jinu P Salimudeen in 2019 suggested a system called "An Intelligent Gas Leakage Detector Smart Alert and Prediction using IoT. "This system used MQ sensors and IoT controllers to keep track of gas levels and send alerts through the internet. The researchers found that their system can give warnings help respond faster and make industrial and home environments safer. Most existing systems only detect gas leaks. Send alerts. Fewer systems can control Wi-Fi avoid obstacles scan 180 degrees show real-time data and move around like a robot at once. The proposed Gas Leakage Monitoring Robot tries to solve this problem by providing a effective and smart solution for monitoring hazardous gases and keeping industries safe. The robot aims to improve

safety, in domestic environments by integrating these features. The Gas Leakage Monitoring Robot is designed to provide alert notifications and improve response time

III.PROJECT PROTOTYPE

Fig. 1 Gas Leakage Monitoring Robot

The hardware prototype of the proposed Gas Leakage Monitoring Robot is displayed in the figure above. The robot comprises of MQ2 and MQ6 gas sensors for smoke and gas detection, an ultrasonic sensor mounted on a servo motor for obstacle detection, an LCD display for monitoring the gas levels and an L298D motor driver module to control the movement of the wheels. The robot is powered by rechargeable batteries and can be monitored and controlled via Wi-Fi. The buzzer system warns of an emergency if there is a harmful gas leak.

IV.WORKING METHODOLOGY

The Gas Leakage Monitoring Robot is used to detect harmful gases and smoke in hazardous environments, and it can move safely and monitor in real time. The system consists of gas sensing technology, wireless communication, obstacle detection and automatic alert system for industrial and domestic safety. The robot is mainly used with MQ2 and MQ6 gas sensors that constantly check the surroundings for the presence of smoke, LPG, methane and other combustible gases. MQ2 sensor is used for smoke and gas detection and MQ6 sensor is highly sensitive to LPG and propane gas leakage. The sensors are constantly feeding the microcontroller with analog data to be analyzed.

The entire system is controlled by an Arduino microcontroller that acts as the central processing unit of the robot. Arduino keeps on reading data from the sensors and processes the info in order to understand if the gas concentration exceeds the predefined threshold value of safety. The robot is wireless and is controlled remotely by Wi-Fi communication technology. The robot can be controlled and monitored remotely via Wi-Fi module by mobile devices or monitoring systems. This allows it to be used in dangerous environments without direct human interaction and improves access.

The robot movement is controlled by DC motors that are connected to an L298 motor driver module. This module controls the direction and speed of the wheels. The robot can move forward backward left and right smoothly. This means the robot can inspect areas very efficiently. The robot also has a sensor. This sensor is used to detect obstacles and scan the environment. The ultrasonic sensor is mounted on a servo motor. This servo motor can rotate up to 180 degrees. The servo motor rotates the sensor all the time to scan for obstacles in directions. If the robot detects an obstacle within a distance the robot will change direction automatically. This helps the robot avoid a collision and continue to monitor everything. The robot also has an LCD display. This display shows information in time such as the levels of gas, in the air if there are obstacles and system alerts. The LCD display helps people see what is going on in the environment when the robot is working.

Whenever gas leakage or smoke is detected the system immediately alerts users with a buzzer alarm. The alarm helps prevent accidents, fire hazards and people getting hurt from gases. The robot works by checking the air for gases,

scanning the environment, avoiding obstacles, communicating wirelessly, sending emergency alerts. All these technologies together make a smart, affordable and reliable system for keeping industries safe and monitoring bad gases. The robot uses a battery making it easy to move around and use for monitoring. Its compact design lets it move through paths, pipelines and hazardous areas easily. This robot is more intelligent and effective, than methods because it combines gas sensing, obstacle detection, wireless communication, movement and alert systems.

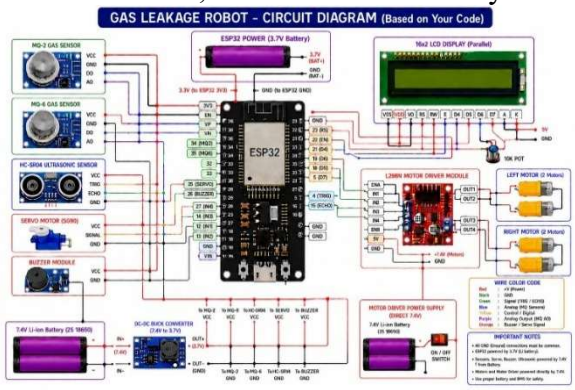

Fig. 2 Gas Leakage Monitoring Robot (Circuit Diagram)

V.CONCLUSION

The industrial safety and monitoring system is a thing but it can be made even better. We can add technologies to make the industrial safety and monitoring system more efficient, safe and automatic. We can improve the way the safety and monitoring system detects obstacles with LiDAR and computer vision technologies. The industrial safety and monitoring system can even be turned into a robot that can automatically fight fires and respond to emergencies. To make the robot run longer we can use energy systems and high-capacity rechargeable batteries. The industrial safety and monitoring system can be made to detect types of toxic and combustible gases with multi-gas sensing technology. Some other features we can add to the safety and monitoring system are: Voice alert systems that can speak different languages, Mobile applications that let us monitor and control the robot, Drone-based gas monitoring for areas that're hard to reach, Automatic data logging with report generation. The safety and monitoring system can also be connected to smart fire alarm and sprinkler systems. It can monitor temperature, humidity and air quality with sensors. We can even use swarm systems to monitor industrial plants at the same time. All these upgrades can make the industrial safety and monitoring system more reliable, intelligent and suitable for industries. The industrial safety and monitoring system will be more efficient and safe, with these improvements. The industrial safety and monitoring system can really help prevent accidents and make industries a safer place to work.

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