IOT Based Gas Pipe Leakage Detection Using Robot

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Abstract- *In many sectors, the risk of combustible gas leakage is a major safety problem. The repercussions of such a leak might be serious, resulting in explosions and flames. Gas leak detection and tracking are vital for ensuring the safety of employees and equipment. Designing a wheeled robot model for flammable gas leakage tracking can be extremely advantageous in this scenario. This robot is capable of navigating hazardous settings and effectively detecting and tracking gas leaks. The proposed system is a wheeled IOT-based robot that can move around and identify gas leaks with the use of fire and gas sensors. When a gas leak is discovered, the robot's buzzer sounds an alarm and sends the location of the leakage. A motor driver and motor for mobility are also included in the robot. The wheeled robot model for tracking flammable gas leakage is a valuable tool for guaranteeing safety in hazardous areas. The robot can aid by identifying potential risks associated with gas leaks and it is lowered by using this IoT-based gas pipe leakage detecting robot. The system allows for early detection, quick response, and effective prevention, all of which lead to improved safety, reduced environmental impact, and higher efficiency in gas pipeline management.*

Keywords- Wheeled robot,Flammable gas leakage, Gas sensor, Fire sensor, Node MCU, Buzzer, Motor driver, Motor, Hazardous environment, Safety.

I. INTRODUCTION

Gas pipe leaking is a severe safety hazard in a variety of sectors and residential settings. Gas leaks may cause catastrophic catastrophes, resulting in property damage, injuries, and even death. Timely identification and reaction to gas leaks is critical to protecting the safety of people and the environment. With technological improvements, the Internet of Things (IoT) has emerged as a potent instrument to solve this dilemma. By combining IoT and robots, we can create an efficient gas pipe leakage detection system that improves the speed, precision, and reliability of gas leak detection. The goal of this project is to develop and build an IoT-based gas pipe leak detection system utilising a robot. The system will use a variety of sensors, communication protocols, and robotic capabilities to continually monitor gas pipes and identify any symptoms of leaking. It will send real-time notifications and allow for quick reaction to reduce the hazards connected with gas leakage. The integration of IoT and robots will provide a holistic solution that will improve the efficiency and efficacy of gas leak detection. The significance of this technology rests in its potential to revolutionise the detection and management of gas line leaks. Manual examination is time-consuming, labour-intensive, and prone to human error in traditional techniques of gas leak detection. We can automate the detection procedure by using a robot outfitted with IoT technology, allowing for continuous monitoring and speedy identification of leaks.The suggested gas pipe leakage detection system will include a robot as the mobile platform for gas leak detection. The robot will be outfitted with wheels or tracks for locomotion and will travel the pipeline network to assess various parts. The robot will be outfitted with very sensitive gas sensors capable of identifying the presence of dangerous gases such as natural gas or propane. These sensors will be carefully positioned to cover various portions of the pipeline. The gas sensors on the robot will be linked to an IoT gateway device, allowing wireless communication with a central control system. The IoT gateway will receive data from sensors and communicate it to the control system in real time.When a gas leak is discovered, the control system sends out real-time notifications and initiates required reaction steps.

EXISTING SYSTEM

The current approach makes use of stationary gas detectors deliberately positioned in regions prone to gas leaks. These detectors constantly monitor the environment for the presence of dangerous gases such as flammable gases, poisonous gases, and oxygen deprivation. The detector data is transferred to a centralised control panel, which analyses it and gives real-time alarms and notifications in the event of a gas leak. The system also includes data logging and analysis functions for historical data review and preventative maintenance. It is frequently used to protect the safety of employees, facilities, and the environment in sectors like as oil and gas, petrochemicals, manufacturing, and wastewater treatment plants.

PROPOSED SYSTEM

1. **Mobility and Flexibility:** Unlike stationary gas detection systems, the proposed system employs a robot that can move on wheels, increasing its mobility and flexibility. The robot can navigate complicated networks of gas pipes, reaching out to remote or difficult sites for accurate gas leak detection.

2. Real-Time Monitoring: The suggested method enables real-time communication between the robot and a centralised control system by utilising IoT technology. As a consequence, gas leak detection procedures may be watched, analysed, and sent in real time. Operators can get instant alerts and notifications, allowing for swift action and mitigation.

3. Autonomous Operation: The robot is programmed to operate automatically, reducing the requirement for continual human interaction. It can travel the gas pipeline network on its own, identify gas leaks, and relay data to the control system. This autonomy minimises the need for humans in potentially dangerous areas, guaranteeing safety and efficiency.

4.Multi-Sensor Integration: The proposed system may combine numerous sensors, such as gas sensors, fire sensors, and other applicable sensors, to increase detection capabilities. By combining various sensors, the system may provide a more comprehensive image of the gas leak scenario, allowing for more precise detection and response to potential risks.

5. Compatible with Hazardous Environments: The suggested system's robot and sensors are specifically designed and outfitted to work in hazardous environments such as gas pipelines. They are designed to withstand harsh weather conditions such as high temperatures, high humidity, and possible exposure to dangerous or combustible substances.

METHODOLOGY

The robot equipped with gas sensors and a GPS module is deployed into the gas pipeline network.The gas sensors continuously monitor the surrounding air for the presence of gas leakages. Sensor data is collected and transmitted wirelessly to a central control unit or cloud-based server. The control unit analyses the received sensor data to detect abnormal gas concentrations. If a gas leakage is detected, the system triggers an alarm or notification to alert the authorized personnel.The GPS module tracks the robot's location in real time, providing accurate positioning information. Gas leak incidents are mapped and visualized on a geographical map, allowing responders to locate and assess the affected areas. The robot navigates through the pipeline network autonomously or under manual control, inspecting different sections. This working methodology enables continuous monitoring of the gas pipeline network, early detection of gas leakages, accurate mapping of incidents, and efficient response to gas-related emergencies.

II. MODULES

A. Gas Sensor Module

Gas sensors are specialised sensing technologies designed to detect and quantify the concentration of gases. Based on their technology, the sensors use various operating principles. When a gas sensor is exposed to the target gas in the environment, its active element interacts with the gas molecules, resulting in a chemical reaction or physical change. This contact changes the electrical characteristics of the sensing device, such as resistance, voltage, or current, resulting in a signal that shows the presence and concentration of the gas. An integrated electronic circuit within the sensor processes and amplifies the sensor's output signal. This circuit transforms the analogue signal to digital format for further analysis and transmission.

B. Flame Sensor Module

Flame and infrared light sources with wavelengths ranging from 760 nm to 1100 nm can be detected by the flame sensor. It employs the LM393 comparator chip, which provides a clean, consistent digital output signal with a 15-mA driving capability. This flame detector is suitable for use in fire alarms and other fire detection systems. It is built around the YG1006 sensor, which is a fast and sensitive NPN silicon phototransistor. The sensor is sensitive to infrared radiation due to its black epoxy. A sensor may be an excellent addition to a firefighting robot, acting as a robot eye to locate the source of the fire. When a flame is detected by the sensor, the Signal LED illuminates and the D0 pin goes low.**C.**

C.Motor Driver Module

A motor driver is a device that connects a microprocessor or control system to an electric motor. It transforms low-power control impulses into high-power outputs capable of driving and controlling the speed, direction, and torque of the motor. The motor driver includes power electronics circuitry that manages the motor's current and voltage needs. It often contains transistors or MOSFETs that can swiftly turn on and off, giving fine control over the motor's behaviour. Additional features such as built-in protection mechanisms, current monitoring, and speed control techniques may be included in the motor driver. The motor driver controls the power provided to the motor by receiving control signals from the microcontroller or control system, allowing for accurate and efficient motor operation.

D. Microcontroller Module

The data from the gas sensor and other pertinent sensors is read by the Node MCU through GPIO pins. After collecting sensor data, the NodeMCU analyses it locally using its embedded microcontroller, performing real-time data analysis and decision-making. The NodeMCU provides wireless access to local networks or the internet via its built-in Wi-Fi capabilities, allowing it to relay sensor data to a central server or cloud platform. It talks with the server using HTTP or MQTT protocols, guaranteeing reliable data delivery. In the case of a gas leak, the NodeMCU can create alerts or notifications, setting alarms, sending messages to authorised employees through email or mobile applications, and activating additional safety procedures.

E. GPS Antenna

The inclusion of a GPS antenna into the IoT-based gas pipe leak detection project employing a robot provides significant benefits to the system. The idea obtains the capacity to track the robot's precise location in real time by integrating a GPS antenna. This location data allows the system to track the robot's movement, trace its journey, and precisely establish its position inside the gas pipeline network. The GPS data may be layered into a geographical map, allowing gas leakage situations to be mapped and responding personnel to have a clear knowledge of the impacted region.

F. Buzzer

A buzzer is a modest yet effective component for adding sound to our project/system. Because of its tiny and compact 2-pin shape, it may be readily utilised on breadboards, Perf Boards, and even PCBs, making it a popular component in many electronic applications. This buzzer may be utilised by simply connecting it to a 4V to 9V DC power supply. A basic 9V battery can also be utilised, however a controlled +5V or +6V DC supply is suggested. The buzzer is generally connected to a switching circuit that turns the buzzer on and off at the desired time and interval.

G. Battery

A twelve-volt battery is made up of six single cells connected in series, yielding a fully charged output voltage of 12.6 volts. A battery cell is made up of two lead plates, one positive covered with lead dioxide paste and one negative composed of sponge lead, with an insulating substance (separator) in between. This is a 12V 1.2AH Sealed Lead Acid Rechargeable Battery. Our Power-Sonic or equivalent valve controlled sealed lead acid batteries require minimal maintenance, are lightweight, durable, and cost effective. It features a high discharge rate, a wide operating temperature range, a long service life, and a deep discharge recover.

ARCHITECTURE

A. System Architecture

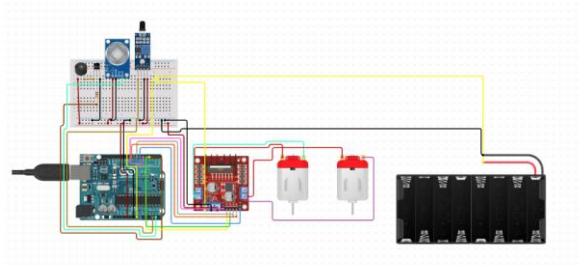

Fig:1

B. Block Diagram

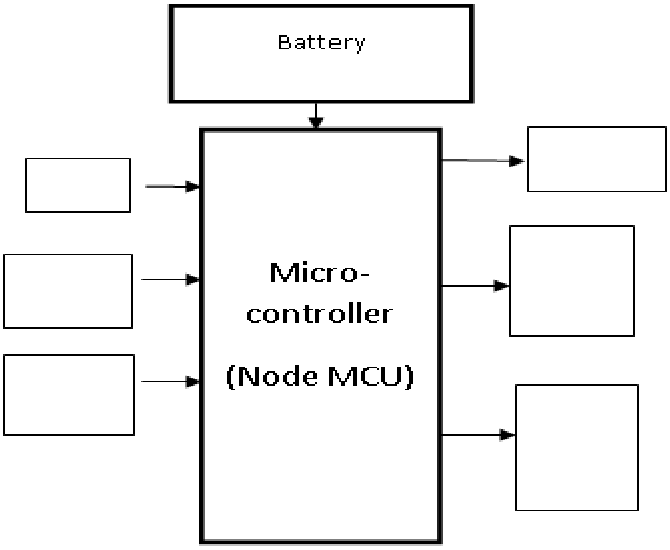

Fig:2

III. RESULT AND SCREENSHOTS

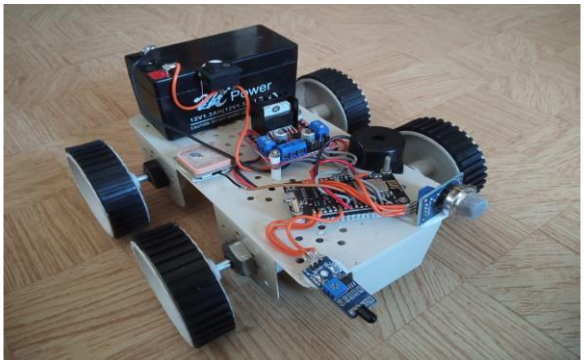

Fig:3(Model)

OUTPUT SCREENSHOTS

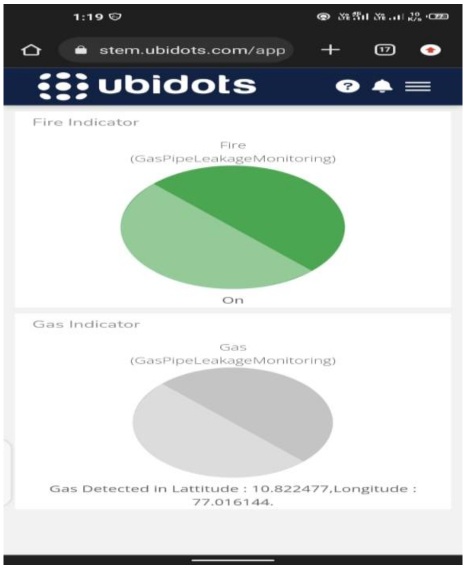

Fig:4(Output 1)

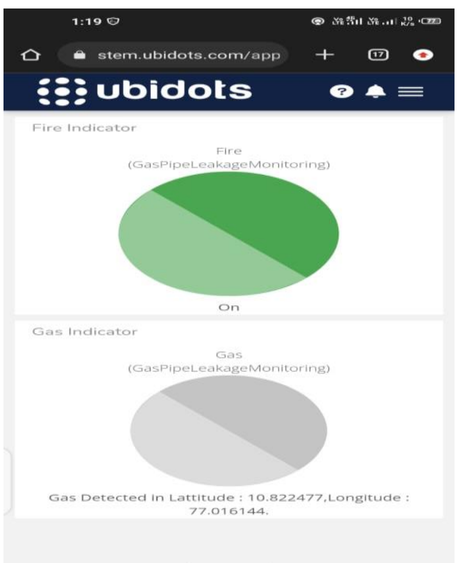

Fig:5(Output 2)

IV. CONCLUSION

The IoT-based gas pipe leakage detection project utilizing a robot has proven to be an effective and innovative solution for ensuring gas pipeline safety. The integration of IoT technology and robotics has allowed for real-time monitoring and detection of gas leaks, enabling timely response and mitigating potential hazards. The use of a robot equipped with gas sensors has provided enhanced mobility and accessibility, enabling comprehensive coverage of the gas pipeline network. The project has demonstrated the feasibility and practicality of utilizing IoT and robotic systems for gas leak detection, highlighting their potential in enhancing safety measures in various industrial and residential environments.

REFERENCES

[1] Ambeth, K. V. D., 2016, ‘Human security from death defying gases using an intelligent sensor system’, Sensing and Bio-Sensing Research 7(2016),107-114.

[2] Naik, R. N., Reddy, P. S. N., Kishore, S. N., & Reddy, K. T. K., 2016, ‘Arduino Based LPG gas Monitoring & Automatic Cylinder booking with Alert System’, IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), 11(4) ,6-12.

[3] Katole, K. R., Bagade, V., Bangade, B., Soni, A., Kamde, H., 2016, ‘Hazardous Gas Detection using ARDUINO’, IJSTE - International Journal of Science Technology & Engineering, 2(10),534-538.

[4] Agarwal, A., & Vyas, S. (2018). IoT based gas leakage detection and real-time monitoring system. In 2018 International Conference on Computing, Power and Communication Technologies (GUCON) (pp. 1474-1479). IEEE. doi: 10.1109/GUCON.2018.8675424

[5] Marandi, R., & Kumar, S. (2017). Design of IoT-based gas leakage detection system using Arduino. In 2017 International Conference on IoT and Application (ICIOT) (pp. 1-6). IEEE. doi: 10.1109/ICIOT.2017.8353522

[6] Zhang, X., Zhao, Y., Zhang, L., Chen, Y., & Chen, G. (2018). A wireless gas leakage monitoring system based on IoT. In 2018 15th International Computer Conference on Wavelet Active Media Technology and Information Processing (pp. 66-69). IEEE. doi: 10.1109/ICCWAMTIP.2018.8486247

[7] Kulkarni, A., & Teja, T. R., 2014, ‘Automated System for Air Pollution Detection and Control in Vehicles’, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 3(9),12196-12200

[8] Yan, H. H., & Rahayu, Y., 2014, ‘Design and Development of Gas Leakage Monitoring System using Arduino and ZigBee’, Proceeding of International Conference on Electrical Engineering, Computer Science and Informatics(EECSI2014),

[9] Manna, S., Bhunia, S. S. & Mukherjee, N., 2014, ‘Vehicular Pollution Monitoring Using loT’, IEEE International Conference on Recent Advances and Innovations in Engineering (ICRAIE- 2014), May 09-11, 2014, Jaipur, India,1-5.