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# Monitoring the Leakage of Gases in Work Site by Using A Robot Car

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**ABSTRACT**

*Suitable safety measures are crucial, as they are increasingly important in today's society. The findings of this research result in improvements to the current factory safety setup. The study's primary goal was to create a microcontroller-based dangerous gas (butane) detecting and alerting system. If the concentration of these gases rises over the safe threshold, an alarm will sound, and a text message (SMS) will be sent to the appropriate person via the GSM. Quicker response time and more precise identification of an emergency make this automated detection and warning system preferable to the traditional manual method.*

***Keywords:*** *Hazardous gas, Robot, Arduino UNO, Gas Sensor, Butane.*

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## I. Introduction

The air quality they breathe inside and outside affects people's health. Overpopulation, Industrialization, excessive use of transportation, etc., can all contribute to air quality that falls short of acceptable outdoor levels [1].

Individuals may be employed in various settings, including a chemical plant, an oil refinery, a mining operation, etc. That's why emissions of volatile organic compounds or other potentially dangerous gases impact indoor air quality in the workplace. Therefore, interior air pollution may pose a more significant threat to human health than outdoor pollution, yet few realize this [2, 3].

These days, gas leaks can be detected in various settings, from factories to private homes. Dangerous mishaps have been witnessed due to gas leaks. Gases that include mainly non-hydrocarbon chemical components, such as propane and butane, are extremely hazardous or highly combustible [4].

Efficient air quality monitoring is essential for reducing exposure to harmful primary pollutants. Workers' health might deteriorate from prolonged exposure, and deadly accidents or explosions can result from poisonous fumes. It is impossible to eliminate the use of toxic gases in industrial settings, despite their hazard. Therefore, it is crucial to keep an eye on these factors to provide a secure environment for people to live in. Therefore, the system is more expensive since it requires many sensor configurations to monitor these gases at various locations. In addition, a system that can be employed in areas where employees cannot go or where the leakage gases are too toxic for safety must be developed [4, 5].

There is often much toxic gas leaking out of chemical factories. Methane ($CH_4$), nitrogen dioxide ($NO_2$), and hydrogen sulfide ($H_2S$) are examples of colorless, odorless, tasteless, combustible, and lighter-than-air hazardous gases that are difficult to detect [6, 7].

To protect the health of maintenance employees, who are frequently near a wide variety of dangerous chemicals due to the complex structure of chemical facilities [8, 9], it is crucial to identify harmful gases that have spilled.

Conventional gas detecting/monitoring stations in chemical facilities have also been set up during the past several decades [10, 11]. However, their limited detection range is a result of their stationary position.

Large gas monitoring systems incorporating several gas detectors have also been shown to recognize gas types; nevertheless, the price is costly [12,13].

To address these issues, we introduce a self-driving robot automobile that can detect harmful gas emissions at a manufacturing facility.

Therefore, creating a low-cost, highly effective robot for detecting gas leaks is necessary to enhance the robot's mobility and productivity. In addition, these robots need the flexibility to adjust to varied conditions and respond appropriately without constant human oversight. This is achieved through the use of sensors [14, 16].

**1.1 Effects of Butane Exposure**

However, when butane is present in the air, it may be breathed because it is a gas. And it's inherently odorless and colorless, which makes it even more deadly. It's also quite combustible; sparks from a match, a lighter, or even static electricity may set it ablaze. Butane has a flammability index of 1.6%-8.4% when combined with air, making it a potentially explosive combustible gas. People working near it are in grave danger.

Direct exposure to butane gas is associated with a wide range of potentially fatal health problems. Aggression, disorientation, despair, and even asphyxiation are all potential side effects. However, inhaling isn't the only way butane may harm you. As a liquid, it might irritate the skin or the eyes.[1, 7].

**1.2 Implementing Butane Gas Sensors to Support Workplace Safety**

Since butane exposure and flammable gas leak hazards are so significant, it is crucial to check for this gas in any area where concentrations might be high enough to cause harm or danger of igniting. The sensors detect the presence of butane and provide the data to the user in either part per million or as a percentage of the lower explosive limit (LEL). The worker can take appropriate safety measures [3, 5].

**1.3 Selecting an Optimal Butane Gas Sensor**

The ability to detect potentially dangerous and flammable gases is crucial across various sectors. One of the essential strategies to boost workplace safety and safeguard operations is implementing the appropriate types of fixed and portable gas sensors and detectors. The capacity to accurately detect the presence of butane gas is more important than following any of the various safe handling procedures developed for this gas [7].

Several aspects, such as the environment and applications in which the butane gas sensor will be used:

- Performance: Picking a butane-detecting gas sensor that provides a straightforward readout of the levels is key to getting the best performance.
- Reliability: However, the usefulness of a butane gas sensor depends on the accuracy of the information it provides.
- Cost: The lifetime costs of any sensor or detector are essential since they will play a role in any business decision [2, 7].

This article proposes using a microcontroller-based gas-sensing robot to monitor construction sites for signs of gas leakage.

This research aims to develop a method for safely identifying gas system malfunctions, seeking to stop the buildup of dangerous gases. To ensure worker safety, it's essential to have a way to monitor for gas leaks near a construction site. And to supply said immediately deployable and cost-effective gas detection and monitoring system.

Applications for mobile robots equipped with electrochemical sensors look promising. When deployed, a robot with gas-detection sensors might serve as an electronic detector, locator, and identifier of gases, potentially revealing the presence of harmful gas leaks.

Advantages of the system

1. The time required to carry out the inspection is dramatically reduced, reducing costs.
2. It can quickly locate and prioritize leaks.
3. Easily detect leakages.
4. Send the user a message informing him of the gas leak.
5. The robot is controlled remotely via Bluetooth technology, which increases safety, and accessibility to more places.
6. Effective and easy to use.

This system applies existing technologies from “Bluetooth, microcontroller, and android” operating systems innovatively to develop a roaming robot that plays the role of the human to detect hazardous gases in the polluted zone and Send messages to workers or employees to alert them to avoid any possible disaster if there is any leak, to provide health safety of the workers in the polluted zones.

## II. Related Works

Balendu et al. By 2020 [9], automated vehicles have a wide range of valuable features. The prototype can detect the presence of any barrier in its path. By enhancing a prototype that can be operated from a smartphone, we can see explosions using a variety of sensors, including those that catch gas, temperature, and fire. In 2020 [15], Mahmudul et al. created a robot that can pinpoint the origin of a fire and rush to the scene to put it out. They programmed it to work both autonomously and under remote control. The robot could be remotely operated using a WiFi connection and an Android app.

A portable, self-guided, android-based gas leak detection system was developed by Tanzila Yonus et al. in 2020 [19]. This gadget uses an MQ6 sensor to detect noxious gas flow and a GPS module to pinpoint its source;

an Arduino relays that data to an array of devices—including mobile phones, buzzers, and LCD screens—for further processing. Then, it will notify the appropriate people through mobile devices in time for them to respond appropriately.
Our research led us to create a gas leakage monitoring gadget built on the Android operating system that can be mounted on a robot automobile. And if a gas leak is detected, the device's gas sensor activates an LED, a buzzer, and a GSM alert to workers' mobile phones so they can respond quickly.

## III. Components and Method

Table 1 displays the system's components:

**Table (1) Components used in the study [17, 18, 20]**

| Component | Definition |
|---|---|
| Arduino UNO  | It is an electronic development board that consists of an open electronic circuit with a computer-controlled microcontroller. Arduino is mainly used to design interactive electronic projects that aim to construct environmental sensors. |
| MQ2 (Gas Sensor)  | It is used for gas leakage detecting. It can detect LPG, butane, methane, hydrogen, smoke, and so on. Based on its fast response time, measurements can be taken rapidly. |
| GSM (sima900a)  | This is an ultra-compact and safe wireless module. The SIM900A is a complete Dual-band GSM/GPRS solution in an SMT module that can be embedded in implementations. Featuring industry-standard factors, the SIM900A delivers GSM/GPRS 900/1800MHz achievement for voice, and SMS, in a small form factor and with low power consumption. |
| Wires  | Thin and flexible metal pieces are used for power carriage. |
| DC Motor  | It is a rotary electric motor that converts electrical energy into mechanical energy. It depends on the forces generated by the magnetic fields. |
| Breadboard  | It is a tool used to design and test circuits. It consists of arranging conductive metal clips in a box made of ABS plastic, while each clip is insulated from another clip. |

Design and implementation, which include:
The gas leak was detected using an MQ2 sensor, and the microcontroller was used to verify that the sensor's outputs were within acceptable parameters.
-MQ2 is connected to the GND of Arduino Uno, then the Arduino to D0 powers the bell when gases are sensed where it is connected to the output pin.
-The GSM was linked with Arduino.
-A Bluetooth unit HC05 was connected to the Arduino. It was used to control Android using an Android phone and joined the DC motor to the driver L293D linked to Arduino. A 6-volt Battery was also used to power the motor. All parts were connected between Arduino UNO 5V and GND.
The connection of the system with the Arduino UNO is shown in figure1.

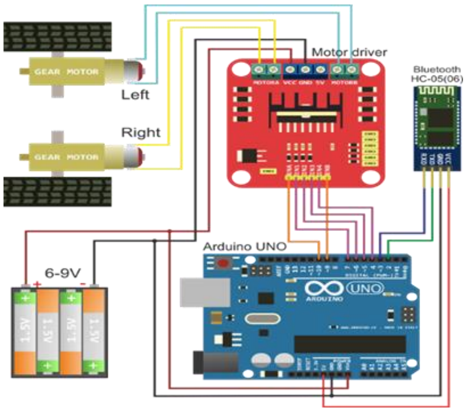


**Figure. 1 Connection of the system with Arduino UNO**

The second step is the robot car's design; for this, we used a chassis similar to that shown in Figure 2 and attached two dc motors to the front and back.
The front motor controls the car's steering, which means the vehicle may turn to the left or right. The vehicle's forward and reverse motions are accomplished using a motor mounted on the vehicle's rear side. The system is controlled by an Arduino UNO and a Bluetooth module that accepts commands from an Android device.

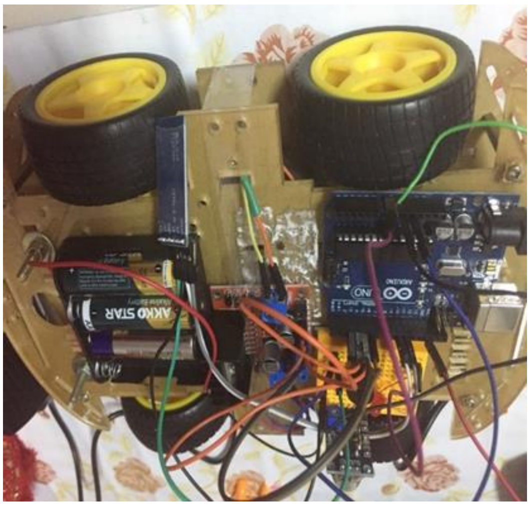

**Figure.2 Robot Car**

The Android phone is connected through Bluetooth. Here, all it takes to move the vehicle in any of the four directions is a tap of a button on an Android phone. In this case, an Android phone is a transmitter, while a Bluetooth module installed in the automobile acts as the receiver. The built-in Bluetooth on an Android phone will send a command to the vehicle, which will proceed in the specified path.
"MQ2 sensor was connected to the Arduino, so if gas was sensed, the bell rang and sent a message to the worker's mobile".

"Figure 3 shows the block diagram of the system."

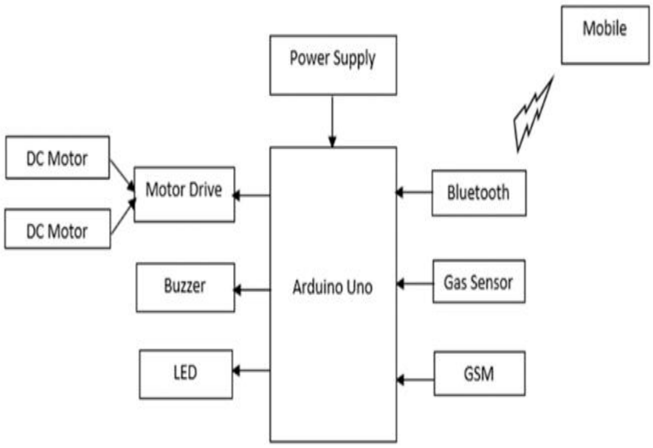


**Figure. 3Block diagram of the study**

## IV. Implementation of Software

The MQ-2 gas sensor was proposed for use in the system that would be implemented using the software. When dangerous gases are discovered, signals are sent to the Buzzer, which lights up an LED and sends a warning to nearby cellphones. The system's flowchart is seen in Figure 4.

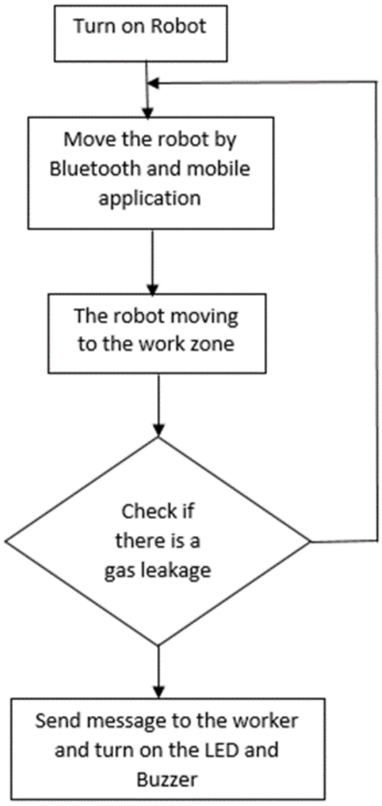


**Figure. 4 Flow Chart of the study**

## V. Results and Discussion

The research aims to improve worker safety in high-risk settings like manufacturing facilities.
This system may detect gases in industrial areas to protect people from harm; it has a faster reaction time than manual approaches, and it can be set up anywhere we need to know whether a gas leak is there.

When detecting potentially dangerous gases, the gas sensor is an integral part of the gas leak detection system.
This research discovered butane gas using a technology specifically developed to identify such potentially dangerous gases. Different signals and data kinds are processed in this system.
The gas leaking at the construction site may now be sensed and detected by the intelligent vehicle robot linked to the alarm system.
The robot vehicle routing system and the gas leakage detection algorithm were validated through a battery of tests. Figure 5 shows the light signal and bell ringing (LED and BUZZER were turned on) when a gas leak occurs, together with a warning message sent to a worker's mobile device through GSM to quickly contain the leak and prevent injury.
The gas search method was found to be effective in a practical setting.

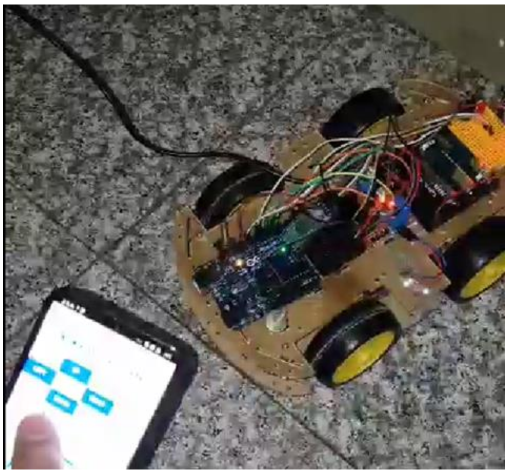

**Figure. 5 The led and buzzer will turn on and warning message via GSM was send to the worker's mobile when a gas emitter is rounded**

## VI. Conclusions

A gas sensor employing active detection techniques and a robotic platform outfitted with control features for use in inspection activities in industrial contexts have been presented in this study as components of a gas detection mobile robot.

The suggested system's key benefit is the employment of a low-cost robotic platform that allows for the distant sensing of gas leaks.

When the MQ2 sensor is detected, the robot uses GSM to contact the appropriate personnel and activates an alarm and lights, indicated by this LED. This prototype detects the presence of toxic gases and can be used in high-risk settings.

We could accurately define the complete detection system and assess its performance through radiometric modeling. Leakage simulations using butane detection demonstrate the efficacy of the suggested approach with lower detection thresholds.

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