



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 3, March 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

 9940 572 462

 6381 907 438

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Securing CNG Powered Vehicles an IOT Approach to Gas Leak Detection and Alerting

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ABSTRACT: This project addresses the safety aspect by proposing an Internet of Things (IoT) solution for the early detection of CNG gas leakages in vehicles. The system utilizes an MQ-4 gas sensor interfaced with an Arduino Uno microcontroller and a GSM module for wireless communication. The gas sensor continuously monitors the ambient gas levels, and if a gas leakage is detected, the system triggers immediate alert via SMS and email. This project contributes to the broader goal of leveraging IoT technologies to create smarter and safer transportation solutions, ensuring the sustainable and secure integration of alternative fuels in the automotive industry.

KEYWORDS: CNG gas leakage, Arduino UNO, Servo motor, GSM,

I. INTRODUCTION

Gas leaks in CNG-powered vehicles pose various hazards, including the risk of fire or explosion, environmental pollution, and health concerns for occupants and bystanders. Detecting gas leaks in a timely manner is crucial to mitigate these risks and prevent potential accidents. Traditional gas leak detection systems often rely on manual inspections or MQ sensors, which may not provide real-time monitoring or comprehensive coverage. In contrast, leveraging the Internet of Things (IoT) technology offers a more sophisticated and proactive approach to gas leak detection and alerting in CNG-powered vehicles. Implementing an IoT-based approach to gas leak detection and alerting in CNG-powered vehicles requires careful consideration of factors such as sensor placement, communication protocols, data security, and regulatory compliance. There are different ways of detecting gas leakage in which there has been existing CNG detector which only sound at the alarm and when there is a leakage in which a microcontroller activate the alarm and send a message through SMS and there is still improvement that could be made to the existing ones, when there is a leakage using servomotor automatically opens the car window then the CNG gas dissolved in air.

II. RELATED WORK

Gas leak detection systems have been a subject of extensive research and development, particularly in the context of enhancing safety measures in various industries, including transportation. While traditional methods such as manual inspections and MQ sensors have been widely used, the integration of Internet of Things (IoT) technology has opened up new possibilities for more effective and proactive approaches to gas leak detection and alerting in CNG-powered vehicles. Several studies have investigated the application of IoT in gas leak detection across different domains, providing valuable insights into the design, implementation, and performance of such systems. For instance, research in industrial settings has explored the deployment of wireless sensor networks for continuous monitoring of gas leaks in factories and refineries, demonstrating the feasibility of real-time detection and response capabilities. Gas leak detection systems have been a subject of extensive research and development, particularly in the context of enhancing safety measures in various industries, including transportation. While traditional methods such as manual inspections and standalone sensors have been widely used, the integration of Internet of Things (IoT) technology has opened up new possibilities for more effective and proactive approaches to gas leak detection and alerting in CNG-powered vehicles.

In the automotive sector, there has been growing interest in leveraging IoT solutions to enhance vehicle safety and performance. While early research primarily focused on remote diagnostics and predictive maintenance, recent studies have started to address specific challenges related to gas leak detection in CNG-powered vehicles. These

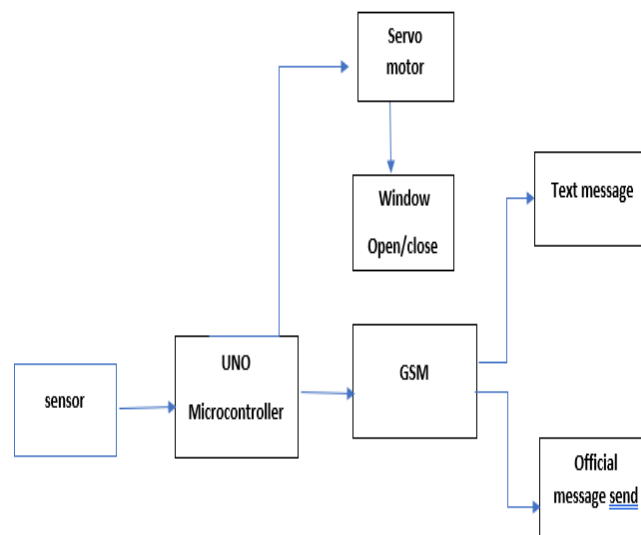
studies have highlighted the importance of sensor placement, communication protocols, data analytics, and integration with onboard systems in developing robust and reliable gas leak detection solutions.

Furthermore, efforts have been made to standardize and regulate gas leak detection technologies, particularly in industries where the consequences of leaks can be severe. Organizations such as the International Organization for Standardization (ISO) and the American National Standards Institute (ANSI) have developed guidelines and standards for the design, testing, and certification of gas detection systems, providing a framework for ensuring the effectiveness and reliability of these technologies.

In the context of CNG-powered vehicles, some manufacturers and fleet operators have already begun implementing IoT-based gas leak detection systems as part of their safety protocols. These initiatives have shown promising results in terms of improving response times, reducing the risk of accidents, and enhancing overall vehicle security.

III. DESIGN AND TECHNIQUES

This paper will solve the problem for not only detects any leakage of the CNG gas but removes automatically the leaked gas to prevent from fire accidents and it also send a official message and automatically open/close a window.



IV. PROPOSED SYSTEM

Install high-quality gas sensors in critical areas of the vehicle ,including the engine compartment, fuel lines, and passenger cabin. Implement sophisticated algorithms to analyze sensor data in real-time. Utilize wireless communication protocols such as Wi-Fi, cellular, or satellite for remote monitoring and response coordination. In lude backup power sources such as secondary batteries or capacitors to maintain functionality during primary power failures. By implementing this solution, gas vehicles can effectively detect and respond to CNG leaks, ensuring the safety of vehicle occupants and minimizing environmental risks associated with gas leaks

V. GAS SENSOR

This module includes gas sensors installed in key areas of the vehicle to detect CNG leaks. Sensors should be highly sensitive and capable of detecting even small concentrations of CNG. Continuously monitors the surrounding air for CNG presence and generates sensor data. A gas sensor is mainly used to detect multiple gasses in the atmosphere. It is a device that responds to the concentration of gasses in the environment where it is installed. The device works by creating a potential difference by altering the material's internal sensor's resistance

VI. ALERTING

This module triggers visual and audible alerts upon detecting a CNG leak. Activates warning indicators to alert vehicle occupants and nearby individuals of the presence of a gas leak. Implement an alerting system that notifies the vehicle owner or operator, as well as designated authorities, in case of a gas leak. Notification system a combination of software and hardware that provides a means of delivering a message to a set recipients. A system that allows alert messaging, machine -to-person communication that is important or time sensitive.

VII. HARDWARE DESCRIPTION

7.1 ARDUINO UNO

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. In primary focus intelligent gas leakage detector using Arduino is only possible for detecting the harmful gaseous and alert the people. Gas leakage is a serious problem and nowadays it is observed in many places like residences, industries, and vehicles like Compressed Natural Gas (CNG), buses, cars, etc..



7.2 GSM MODULE

GSM(Global System for Mobile Communications, originally Groupe Special Mobile), is a standard developed by the European Telecommunications Standards Institute (ETSI). It was created to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones and is now the default global standard for mobile communications – with over 90% market share, operating in over 219 countries and territories.

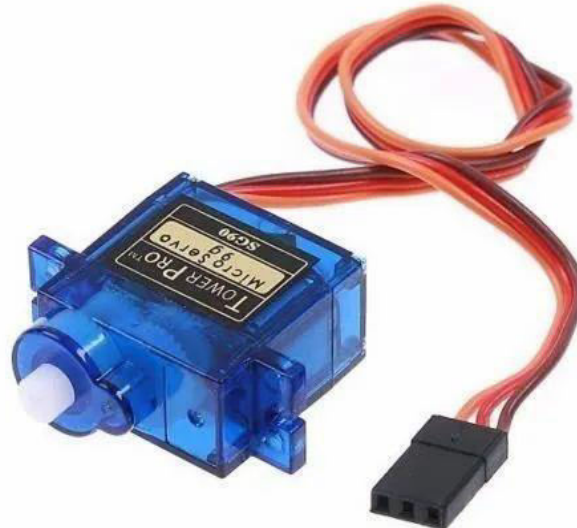
7.3 MQ4 SENSOR

MQ-4 - Methane, CNG Gas. As a natural gas sensor, the MQ-4 Natural Gas Sensor is a fast and reliable sensor with a high sensitivity to natural gas and methane, also good sensitivity to propane and butane. This natural gas sensor has a long life and low cost and is widely used for gas leak detection.



7.4 SERVOMOTOR

servo motor is an electromechanical device that produces torque and velocity based on the supplied current and voltage. A servo motor works as part of a closed loop system providing torque and velocity as commanded from a servo controller utilizing a feedback device to close the loop. Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation (PWM), through the control wire. There is a minimum pulse, a maximum pulse, and a repetition rate. A servo motor can usually only turn 90° in either direction for a total of 180° movement. The servo motor is used to close the gas pipe valves. This device ensures safety and prevents suffocation and explosion due to gas leakage.



7.5 POWERSUPPLY

vehicle Battery: Most modern vehicles, including those powered by CNG, have a 12V battery system. You can tap into this battery system to power the IoT devices. This method is straightforward and doesn't require additional power sources. However, you need to ensure that the power draw from the IoT devices doesn't significantly drain the vehicle's battery, which could affect its performance or cause starting issues.

Direct Connection to Vehicle Electrical System: Instead of drawing power directly from the vehicle's battery, you can connect the IoT devices to the vehicle's electrical system. This method allows for a more stable power supply and can ensure that the devices receive power even when the vehicle is turned off. However, it requires careful installation to avoid interfering with the vehicle's electronics and wiring.

Solar Power: If continuous power is required without relying on the vehicle's electrical system, solar power can be a viable option. You can install solar panels on the vehicle's roof or exterior to harness solar energy and charge batteries that power the IoT devices. This method is particularly useful for remote monitoring applications or situations where the vehicle is parked for extended periods.

Battery Backup: Regardless of the primary power source chosen, it's essential to have a battery backup system in place to ensure continuous operation in case of power interruptions or vehicle shutdown. This could be in the form of rechargeable batteries or secondary power sources like power banks.



EXISTING SYSTEM

Existing systems for CNG (Compressed Natural Gas) gas leak detection and alerting typically involve a combination of hardware and software components designed to detect gas leaks and notify relevant stakeholders promptly. While specific systems may vary in their design and implementation, here are some common components and approaches found in existing CNG gas leak detection systems:

Gas Sensors: These are the primary components responsible for detecting gas leaks. Gas sensors are installed at strategic locations in CNG storage and distribution systems, including storage tanks, pipelines, and engine compartments of vehicles. These sensors continuously monitor the surrounding environment for the presence of CNG and trigger alerts when gas concentrations exceed safe levels.

Detection Technologies: Various detection technologies are used in gas sensors, including electrochemical, semiconductor, infrared, and catalytic sensors. Each type of sensor has its advantages and limitations in terms of sensitivity, accuracy, response time, and environmental conditions.

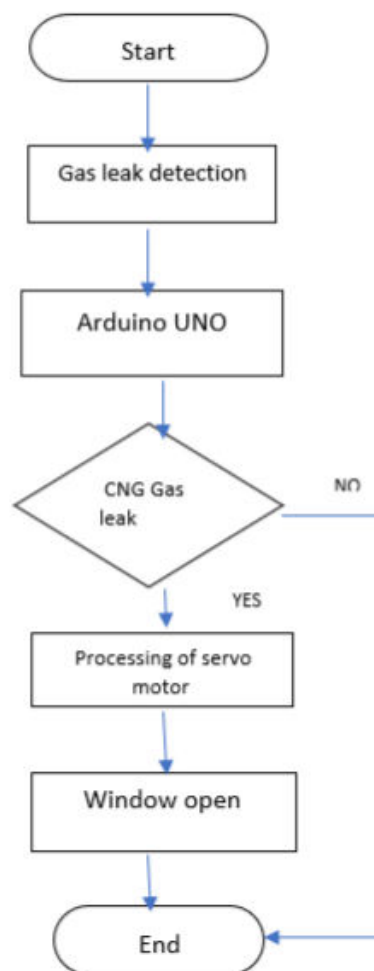
Control Units: Control units or monitoring systems receive signals from gas sensors and process the data to determine if a gas leak has occurred. These units may be integrated into centralized monitoring systems or installed locally at the site of gas storage or usage. Control units often include alarm systems to provide audible and visual alerts in the event of a gas leak.

Communication Systems: Communication systems enable the transmission of alerts to relevant stakeholders, including facility operators, emergency responders, and regulatory authorities. Common communication methods include wired connections, wireless networks (such as Wi-Fi or cellular), and dedicated communication protocols for industrial applications.

Alerting Mechanisms: Alerting mechanisms notify personnel of gas leak through various means, including audible alarms, visual indicators (such as flashing lights or digital displays), and remote notifications (such as email, text messages, or automated phone calls). Some systems may also include integration with building management systems or safety control panels to automate emergency responses.

Data Logging and Analysis: Many gas leak detection systems include data logging capabilities to record gas concentration levels over time. This data can be used for analysis, trend monitoring, compliance reporting, and troubleshooting purposes. Advanced systems may incorporate data analytics algorithms to identify patterns, anomalies, or potential sources of leaks.

VIII. FLOW CHART



IX. CONCLUSION

In conclusion, implementing an IoT approach to gas leak detection and alerting in CNG-powered vehicles offers significant advantages in enhancing safety and minimizing risks associated with gas leaks. By integrating sensors, data processing algorithms, and communication modules, such a system enables real-time monitoring of CNG levels and immediate response to potential leaks.



The deployment of gas sensors within the vehicle's engine compartment and CNG tank, coupled with continuous data analysis, allows for early detection of gas leaks. When a leak is detected, the system triggers an alert mechanism, notifying vehicle operators, fleet managers, and emergency services as necessary. Furthermore, the integration of GSM modules facilitates the transmission of text messages or official alerts to designated recipients, ensuring timely communication and appropriate action. Additionally, the use of servo motors enables remote control of valves to mitigate the impact of gas leaks, preventing potential accidents or hazards.

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