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IoT-Based Gas and Smoke Detection System using Blynk application with Automatic SMS and Alarm Notifications

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Abstract
The Internet of Things (IoT) has revolutionized safety and security by providing innovative solutions to critical challenges. Gas leakage, a dangerous chemical from petroleum, can cause health issues and disrupt workspaces. To prevent such accidents and maintain a clean air environment, a monitoring gas leakage detector system is proposed. The system uses a NodeMCU ESP8266 Wi-Fi microcontroller and a combustible gas sensor (MQ-2) to detect the presence of propane, butane, and Liquefied Petroleum Gas (LPG). The sensor's voltage output determines gas concentration, and the ESP8266 sends data to the blynk application. This system aims to maintain a clean and safe workspace. The IoT-based gas and smoke detection system uses sensors and a mobile app to monitor premises remotely. It sends SMS alerts to users and authorities in case of incidents and activates audible alarms to the users. This system enhances security by reducing risks and reducing the need for manual monitoring, making it a significant step towards safer environments.

Keywords**:** Internet of Things, Nodemcu ESP8266, Gas Leakage, MQ-2 Sensor, Blynk, Smoke.

1. Introduction

It is essential to be aware of potential dangers in human life, including those that could cause harm or even death. A gas leak, such as one caused by Liquefied Petroleum Gas (LPG), poses a significant threat to homes and lives. Propane, butane, and saturated and unsaturated hydrocarbons make up LPG, which is widely used for industrial and domestic fuel, heating, and lighting, among other things. The increasing demand for energy resources, which are derived from nature, has led to a growing demand for LPG leakage. However, leaks can lead to serious fire accidents and an increase in casualties. Therefore, a system is needed to identify and prevent LPG leaks, ensuring the safety of individuals and the environment. Liquefied Petroleum Gas (LPG) is a non-renewable natural resource that plays a crucial role in human life in industry and households.

The LPG is a hydrocarbon gas liquefied at low pressure and temperature for storage, transportation, and handling [1]. It consists of propane (C3H8) and butane (C4H10), or a mixture of both. The MQ-2 sensor and IR flame sensor receive LPG gas input, which is processed by the ESP8266 NodeMCU microcontroller to send notifications to the Blynk application on Android phones.

The paper investigates the performance of an IoT-based smart liquefied petroleum gas leakage detector system designed with the ESP8266 NodeMCU Module, focusing on sensor response and distance response. Our goal is to create a gas leak detector that is connected to the Internet of Things using the ESP8266 NodeMCU Module. Furthermore, the paper developed a computer program that acts as an automatic supervisor in remote areas to detect gas leaks. The simple gas leak detector uses a buzzer and text messages to communicate with users. Wi-Fi and IoT technology are used to broadcast messages about the leak to stakeholders. The system continuously monitors the environment for any leakage, allowing devices to communicate directly without human intervention. The system is powered by the Blynk application.

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2.0 Gas and Smoke Detector Alarm

Gas detectors detect the presence of gases in the atmosphere and surroundings. Using this gadget, the user can detect combustible gas leaks and receive an alarm to alert them. Residents nearby are alerted, giving them the option to leave or take action to prevent the incident from happening [2]. The process of gas leak detection utilizes sensors to locate potentially hazardous gas leaks [3]. A dangerous chemical is often detected by these sensors and an audible alarm is sounded to alert people to the danger. The smoke detector is part of a fire alarm system that emits audible or visual alarms to detect smoke locally. Security devices trigger fire alarms, detecting and stopping smoking in fields, reducing home fire risk. Functional smoke alarms simplify precautions for some homes.

2.1 Components Required

The construction and implementation of an IoT-based detector for Fire, Gas and Smoke leakages with Nodemcu microcontroller are facilitated by these components.

i. MQ2 Sensor
ii. Buzzer
iii. Zero PCB board

2.1.1 MQ2 Gas Sensor

This study uses MQ-2 gas sensors (Figure 1) to detect gas leakage at home so that a wireless alert can be sent to the user. The MQ-2 gas sensor is a commonly used gas sensor module for detecting various gases and air quality in different applications. It is widely used in projects related to air quality monitoring, gas leakage detection, and industrial safety. The MQ-2 sensor is capable of detecting a range of gases, including methane (CH_4), Propane (C_3H_8), Carbon Monoxide (CO), Hydrogen (H_2), and smoke, among others. It operates on the principle of chemical reactions between the target gas and the sensor's sensitive layer. The MQ-2 Gas Sensor Module monitors indoor air quality and early fire detection by displaying values on an OLED display and Blynk IoT platform, alerting mobile phones if safe levels are reached.

Figure 1: MQ2 Sensor

2.1.2 Buzzer

A beeper or buzzer (Figure 2) is a device that converts audio signals into sound, typically powered by DC voltage, and can produce various sounds like alarms and music depending on its design.

Figure 2: Buzzer

2.1.3 Printed Circuit Board (PCB)

(PCB) Printed Circuit Boards (figure 3) are electronic assemblies that use copper conductors to create electric connections between components, providing mechanical support for devices in enclosures. It's a non-conductive material with printed or etched conductive lines.

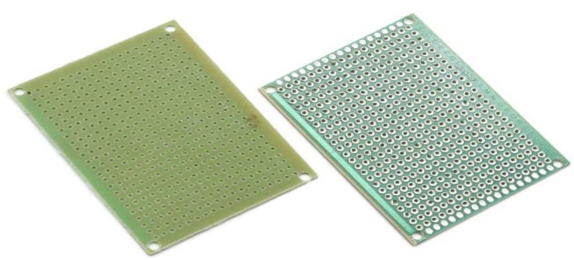


Figure 3: PCB Board

2.1.4. Related Works

Nandy *et al.* [5] presents a smart gas monitoring system for urban areas using IoT technology to ensure safety and timely alerts. The primary objective of their work is to develop a system that can monitor gas levels in urban areas, detect anomalies or gas leaks, and provide real-time alerts to ensure public safety. The authors' focus on using IoT for gas monitoring and safety in urban areas is commendable, as it addresses a critical concern. The work addresses a real-world problem concerning urban safety, where gas leaks can have severe consequences. Using an infrared camera and machine vision to find methane leaks from natural gas was looked into by [6]. The researchers [3] looked into a better way to find cellular gas leaks in the city.

Sampaolo *et al.* [8] study into how to find methane, ethane, and propane using a small quartz-enhanced photoacoustic sensor and a single band-to-band cascade laser. Khan *et al.* [9] explores an innovative approach that combines IoT technology with deep learning techniques for gas detection and alerting. The objective of this work is to develop an advanced gas detection system that leverages both IoT and deep learning technologies to improve accuracy and reliability in gas detection and alerting.

Xia *et al.* [10] conducted an investigation on a methane sensor with Parts-Per-Trillion (ppt) level sensitivity detection using a mid-infrared band laser cascade and a long lane multipath cell. A study by [6] looked into a fiber optic multipoint methane remote sensor device that uses pseudo-differential detection. The LPG leakage detection system is built using Proteus software and Blynk smartphone app, enhancing the detection process [11].

Vidya *et al.* [12], developed a gas detection system that sends SMS alerts to corresponding individuals or family members when a leakage is detected through a gas sensor. The system also measures the weight of an LPG cylinder, alerting the user if the cylinder's weight is less than 10kg or 0.5 kg, and automatically books the cylinder for the dealer. A gas leakage detection system was developed to alert humans to toxic gas leaks via SMS, utilizing Arduino UNO and SIM900 GSM/GPRS gateway for communication [13]. Koushanfar *et al.*

Jolhe and Potdukhe [2] developed a system to measure the amount of gases in ppm and percentage, aiming to protect the human body from toxic gases and hazardous elements in the atmosphere. The system uses Arduino Uno R3, nRF24L01Plus Wireless Transceiver Module, and MQ2 gas sensor, with results monitored using Arduino IDE serial monitoring. The study uses Nodemcu microcontroller which has a built-in Wi-Fi, facilitating seamless connectivity, and cost-effectiveness which make perform better than the existing works. Also, the design system is a real-world and not prototype as in the case of the review works, in addition, the design system make use of multiple notifications to the user. Overall, NodeMCU stands out for its wireless capabilities, making it a preferred choice for modern applications emphasizing connectivity and internet-based functionalities.

3.0 Methodology

3.1 Circuit Diagram for IoT Smoke and Gas Detector

The IoT Smoke and Gas Detector circuit diagram (figure 4) interfaces the MQ-2 sensor with the ESP8266, connects VCC and GND to 3.3 Volt and GND pins, connects the OLED VCC pin to NodeMCU, and connects an LED anode and cathode pins.

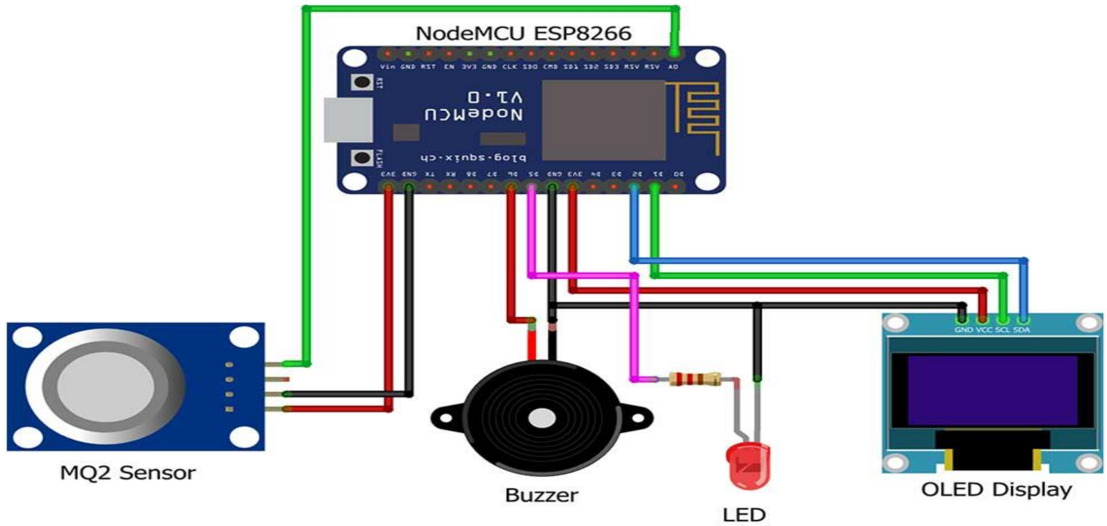


Figure 4: Circuit Diagram: IoT Smoke and Gas Detector [4]

This paper uses 500 Parts Per Million (PPM) as a threshold value, triggering a notification on a mobile device when smoke exceeds this value. To detect combustible gases and smoke, the MQ-2 sensor was utilized. The MQ-2 sensor generates a voltage signal in response to its detection of the amount of gas or smoke in the atmosphere. When the amount of smoke or gas is high, the output voltage is high; conversely, when it is low, the output voltage is low. The study uses a 500mV threshold sensor, with a 5V trigger for smoke/gas level alerts.

The algorithm and flowchart are illustrated in figures 5 and 6. Having set the threshold voltage to 500mV (figure 5), the gas sensor (MQ-2) sensor the smoke/gas and if the sensor value is less than the set threshold value, the blynk application send a message "No gas detection" to the user mobile number, but if the sensor smoke/gas is above the set threshold, the user is notified with the message "Smoke/Gas Detection". This is illustrated in figure 6 pictorially.

Algorithm 1: Gas and Smoke Detection

Require: MQ-2 Sensor Value

1. Threshold_voltage = 500 mV
2. Smoke/Gas_level = MQ-2 Sensor value
3. **If** (Smoke/Gas_level <= Threshold_voltage) **then**
4. Return 5V to the buzzer
5. Send message "No Smoke/Gas Detection" to the user
6. **Else**
7. Send message "Smoke/Gas Detection" to the user
8. Return 0V to the buzzer
9. **End-if**

Figure 5: Algorithm for Gas and Smoke Detection

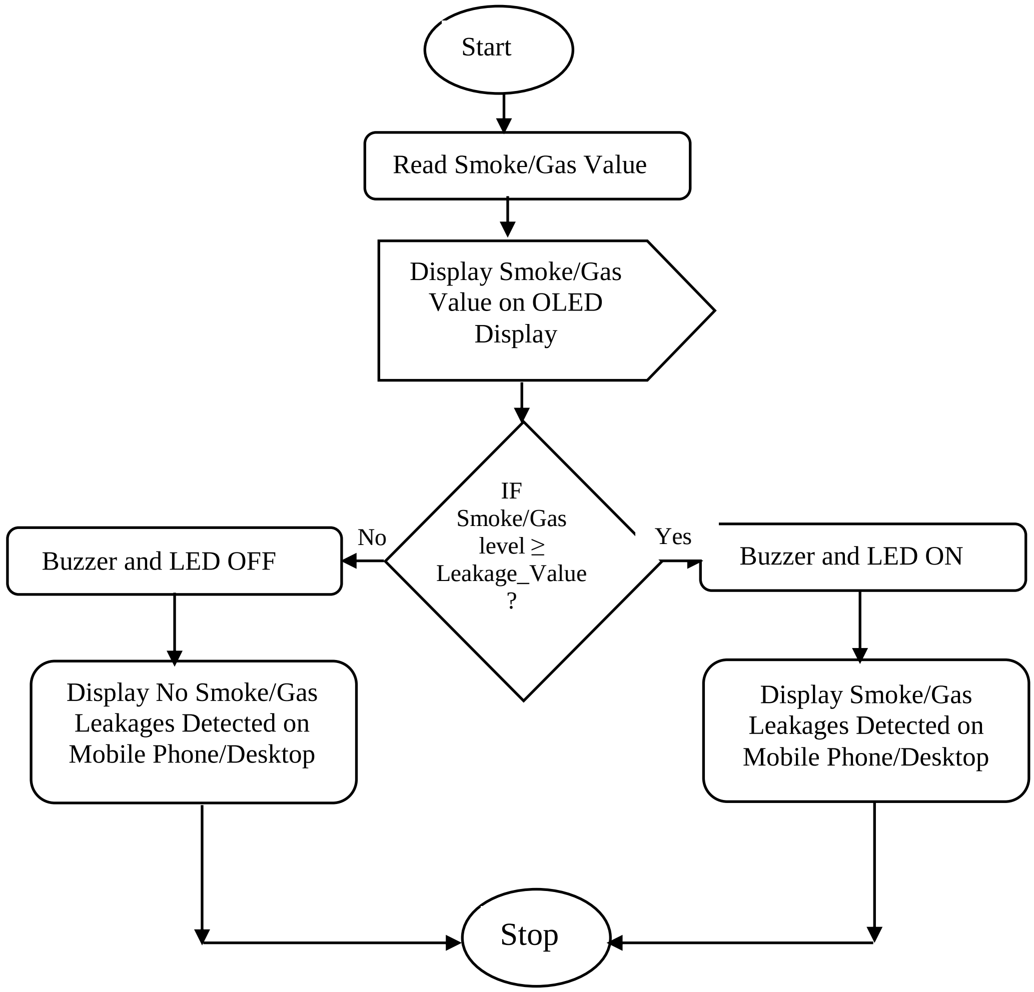


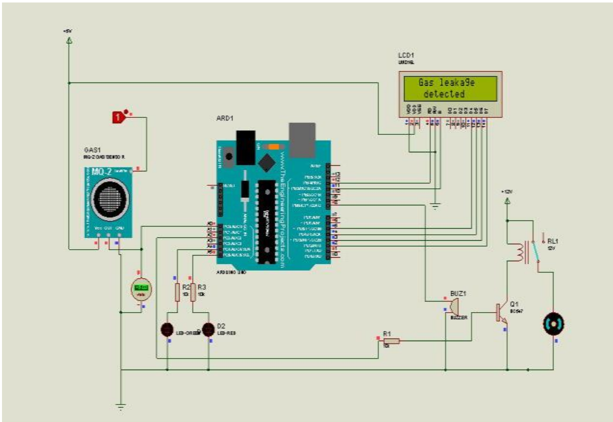
Figure 6: Flowchart for detection of Gas and Smoke

4.0 Result and Discussion

Table 1 presents the results of the simulation and implementation of the gas detection unit in this paper. If the system detected any gas above the predefine value, then it send text messages (Figure 9), call the user (Figure 10), as a notification, and display "Gas Leakages detected" on the user mobile app and at the same time turn the LED light to "RED" (Figure 7b). The user Mobile App will display "No Gas Detected" if there is no gas leakage, and the LED light will turn to "BLUES" (Figure 8b).

Table 1: The Simulation Testing Results and Findings.

S/N	Conducted Test	Findings
1	There is Leakages of Gas	Gas leakages detected (Figure 7a & b)
2	No Leakages of Gas	Gas leakages not detected (Figure 8 a & b)
3	SMS Notification	Implementation of SMS Messages (Figure 9)
4	Call Notification	Implementation of Call Logs (Figure 10)



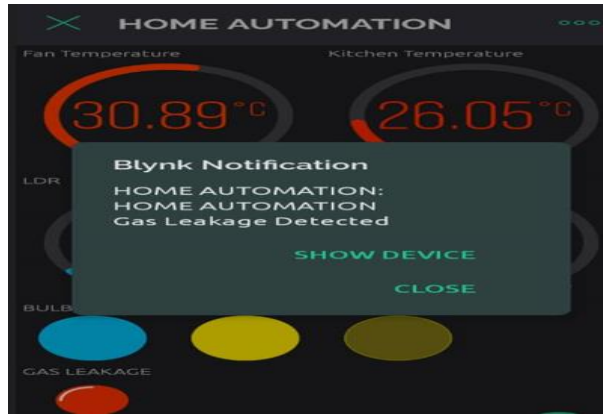
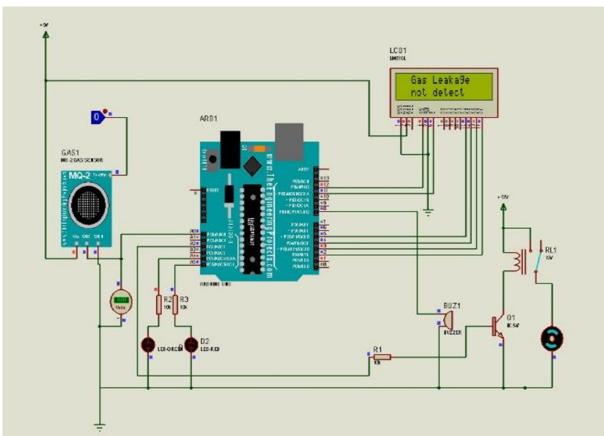


Fig. 7(a). Circuit for Leakages of Gas

Fig. 7(b). Circuit for detection of Gas Leakage



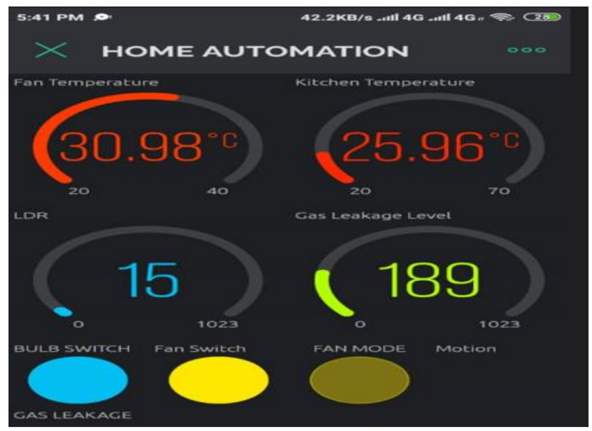
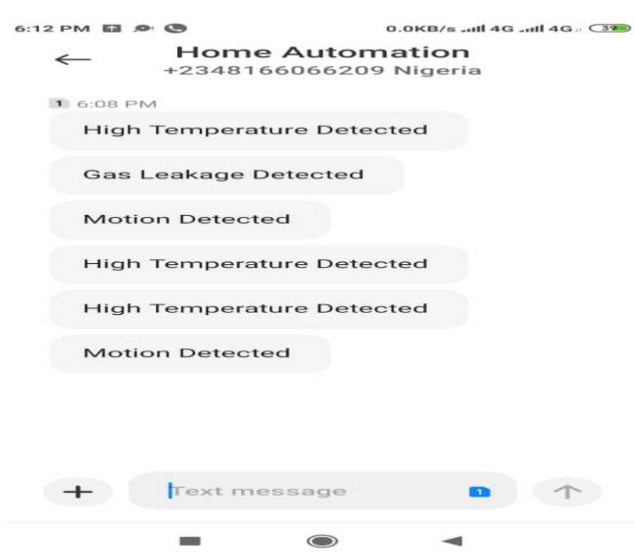


Fig. 8(a). Circuit indicating no Gas Leakages

Fig. 8(b). Mobile App indicating No Gas Leakages



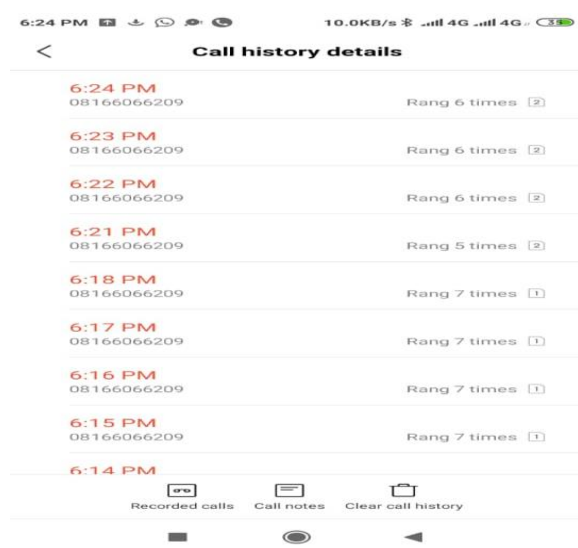


Fig. 9. Result showing SMS Messages to the user.

Fig. 10: Result Showing Call Logs to the User

4.1 Benefits

i. The system provides continuous monitoring of gas and smoke levels, reducing the risk of accidents and improving safety.
ii. Automatic SMS alerts and audible alarms ensure that users and authorities are promptly notified in case of an emergency.
iii. Users can monitor their premises from anywhere, providing peace of mind and allowing for quick action when needed.
iv. The system can log historical data, aiding in post-incident analysis and preventive maintenance.
v. The system can be easily scaled to accommodate multiple sensors and monitoring points.

5. Conclusion

This paper presents an IoT-based gas leakage detection system using an MQ-2 gas sensor. The sensor sends a signal to an ESP2866 NodeMCU microcontroller, which then sends an active signal to an externally connected device. The NodeMCU microcontroller is efficient, sending multiple messages per second, making it faster than other IoT platforms. The system is also cheaper and offers quick access and control. The IoT-Based Gas and Smoke Detection System addresses safety concerns, providing remote monitoring, quick response mechanisms through SMS alerts and audible alarms. Its scalability and data logging make it adaptable to various settings, from homes to industrial complexes. This paper contributes to the broader goal of leveraging technology for improved safety and security across different domains.

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