STM JOURNALS

Journal of
Refrigeration, Air Conditioning, Heating and Ventilation

ISSN: 2394-1952
Volume 11, Issue 1, 2024
January–April
DOI (Journal): 10.37591/JoRACHV

http://techjournals.stmjournals.in/index.php/JoRACHV/index

Review JoRACHV

# IOT Based Effortless Gas Leak Detection and Reservations

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***Abstract***

*The paper proposes an IOT Based Effortless Gas Leak Detection System for LPG and CO, utilizing gas sensors and a microcontroller. Positioned strategically, the sensors monitor air quality, triggering alarms if LPG or CO levels surpass safety thresholds.We plans to use this product for determination of gas leakage of LPG from household appliances and Carbon Monoxide produced from household appliances,vehicles and air conditioners with the help of MQ series gas sensors. This system not only detects gas leaks but also takes immediate action to mitigate potential hazards, making it an invaluable addition to residential settings. In order to protect users, the proposed approach is tested and the results are confirmed through providing an early warning signal in less severe circumstances, enabling a high-pitched alarm during a gas leak, and automatically shutting off the gas pipeline valve and the entire home electrical power during a gas leak.. An exhaust fan will ON automatically to pull out the leaked gases from room. An emergency message with location map will send to the rescue team and home owners phone number. The system consist of an android application placed near this system which will help to send message to owner. And this app will update the gas valve closing status to the server. So, user can access this server by using his/her android application and can check the status of valve and can control the valve from any remote location. The LPG Gas Quantity Assessment and Booking is also included in this paper which represents a modern solution that brings convenience, efficiency, and safety to the process of managing LPG gas cylinder orders, benefiting both users and distributors in the LPG industry.*

**Keywords:** IoT, Gas leak detection, safety, alarm system, remote control

## INTRODUCTION

Gas leaks in residential areas have emerged as a significant concern due to the potential for severe consequences such as explosions, fires, and health risks. Conventional methods for detecting gas leaks have shown limitations, highlighting the urgent necessity for advanced technologies to bolster safety measures. In response to this pressing issue, this paper presents an innovative Internet of Things (IoT)-based solution aimed at transforming gas leak detection and management within households.

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Received Date: May 20, 2024
Accepted Date: May 30, 2024
Published Date: June 07, 2024

**Citation:** Goutham Krishna T.M., Manya A., Sreerag C.V., Thaha H.S. IOT Based Effortless Gas Leak Detection and Reservations. Journal of Refrigeration, Air Conditioning, Heating and Ventilation. 2024; 11(1): 33–41p.

The primary objective of this work is to develop and implement an IoT-based gas leak detection and reservation system for residential settings. The system aims to detect gas leaks, particularly LPG and Carbon Monoxide, from household appliances using MQ series gas sensors. Additionally, it seeks to provide immediate actions to mitigate potential hazards, including activating alarms, shutting down

 

gas pipelines and power supplies, and activating exhaust fans to remove leaked gases from the room. Furthermore, the system includes a feature for users to assess LPG gas quantity and make reservations, enhancing convenience and safety in managing LPG gas cylinder orders. The scope of this work encompasses the design, development, testing, and implementation of the IoT-based gas leak detection and reservation system. It involves the integration of gas sensors, alarm systems, gas pipeline valves, power supply controls, exhaust fans, and communication modules to enable real-time detection, notification, and mitigation of gas leaks. The system also includes an Android application for users to monitor gas valve status, receive alerts, and make reservations for LPG gas cylinders. Additionally, the scope covers the transmission of emergency messages with location maps to rescue teams and homeowners in the event of a gas leak. The main advances includes Effortless Gas Leak Detection, Immediate Hazard Mitigation, Remote Monitoring and Control,LPG gas quantity Assessment and Booking, Integration of IoT Technology.

## LITERATURE REVIEW

V Praveen Sharma and Vijendar Reddy Gurram (2023) proposed the paper on "Gas Leakage Detection System Using IoT And Cloud Technology" which provides a comprehensive review of the current state of gas leakage detection systems utilizing Internet of Things (IoT) and Cloud technology [1]. The functions of the system include early detection of gas leaks, alerting users to potential dangers, and potentially saving lives by reducing damage caused by gas leaks. The system incorporates sensor-based and non-sensor based IoT systems, such as the use of MQ sensors and Arduino controllers, to detect gas leaks and communicate alerts to users via SMS messages or alarms. The study does, however, also point out multiple weaknesses with the gas leak spotting systems in use today.

These limitations include challenges in ensuring the reliability and accuracy of the systems, the need for more efficient and cost-effective solutions, and the scalability of IoT-based gas detection systems. It is indicated were future research should go to conquer these shortcomings and raise the average effectiveness of gas leak determining systems.

Gazi Zahirul Islam and Fernaz Narin Nur (2022) proposed the method of IoT-Based Automatic Gas Leakage Detection and Fire Protection System is designed to detect gas leaks, notify users, shut off gas supply, and deploy fire extinguishers automatically [2]. It also suggests enhancements such as utilizing Bluetooth or Wi-Fi for alert messages and introducing robots for gas detection. However, the system has limitations, including range constraints for alert notifications, reliance on sensor accuracy for effective operation, potential variations in response times based on sensor sensitivity and network connectivity, and scalability challenges for industrial applications. While the system offers valuable functions for gas leakage detection and fire protection, addressing these limitations is crucial to ensure optimal performance and practicality in real-world scenarios. Further development and improvements could enhance the system's efficiency and effectiveness in mitigating the risks associated with gas leaks and fire incidents.

An Internet of Things (IoT)-based smart gas leak detection and alarm system integrating the MQ6 gas sensor, Arduino, and ESP8266 WiFi module has been presented by Aakash Parashar and Chanchal Rai in 2021.

[3]. The system is designed to detect gas leaks in various settings such as homes and industries to prevent accidents. It functions by detecting gas leaks with the sensitive MQ6 gas sensor, promptly turning off the main gas supply, and sending alert SMS notifications to the owner. Additionally, the system employs components like Arduino, stepper motor, buzzer, and exhaust fan to take immediate actions in response to a gas leak, displaying gas leakage levels on an IoT-based display for user monitoring. However, limitations of the system include the MQ6 sensor's inability to provide exact gas concentrations, potential challenges in detecting certain gases or in high-interference environments, and

 

considerations regarding the system's cost, estimated to be around 7k to 8k, which may impact its accessibility to some users.

Bader Farhan Alshammari (2020) presents the paper on development of an IoT Gas Leakage Detector and Warning Generator system designed to detect gas leaks using sensors, microcontrollers, and network connectivity [4]. The system functions by capturing gas leakage information through sensors like the MQ-5 and transmitting it to a data cloud. Controlled by an Arduino Uno microcontroller, the system raises alarms through a buzzer and activates exhaust fans to prevent potential hazards. It also includes Wi-Fi connectivity for sending alerts to a dashboard, enabling real-time monitoring. While the system offers early detection of gas leaks and remote monitoring capabilities, it has limitations such as reliance on Wi-Fi connectivity, the need for sensor maintenance and calibration, limited scalability for monitoring multiple points, and vulnerability to power outages or network failures. Overall, the IoT Gas Leakage Detector and Warning Generator system provides essential safety benefits but faces challenges related to connectivity, maintenance, scalability, and reliability in adverse conditions.

S.M.Zinnuraain and Mahmudul Hasan (2019) introduces a cost-effective Smart Gas Leakage Detection and Safety System utilizing various components including sensors, microcontrollers, and a mobile application [5]. It functions in three main stages: detecting gas leaks, monitoring gas levels, and implementing safety measures in case of a leak. However, potential limitations may arise from sensor accuracy, false alarms, and reliance on uninterrupted power supply for continuous operation.

Suma V and Ramya R Shekar (2019) proposed the paper which outlines a Gas Leakage Detection system based on the Internet of Things (IoT) technology, aiming to address safety concerns related to gas leakages in households and similar environments [6]. It proposes an automated process for cylinder refills and utilizes sensors to detect gas leaks, triggering SMS alerts to users. However, potential limitations may include reliance on stable internet connectivity, sensor accuracy issues, and the need for regular maintenance to ensure consistent performance.

Chaitali Bagwe and Vidhya Ghadi (2018) introduces an IOT Based Gas Leakage Detection System with functions including constant gas concentration monitoring using sensors like MQ5 and DHT22, alerting users and authorities through various devices, sending SMS and Email notifications, storing data for analysis and prediction, and providing a user interface for data visualization [7]. However, the system may face limitations such as reliance on stable internet connectivity, sensor accuracy, challenges in accurate prediction of gas leaks, and the need for sensor maintenance and calibration. Despite these limitations, the system offers advanced features for gas leak detection and response, emphasizing the importance of considering these factors during implementation and operation.

Kumar Keshamoni and Sabbani Hemanth (2017) introduced the paper that discusses a comprehensive IoT-based solution titled "Smart Gas Level Monitoring, Booking & Gas Leakage Detector" to tackle the issue of gas shortages [8]. It encompasses features like continuous weight measurement, gas ordering via IoT, and sensors for gas leakage and temperature changes detection. Despite its potential advantages in enhancing safety and convenience, limitations might include the need for robust connectivity, calibration challenges for weight measurement, and potential false alarms from sensors due to environmental factors.

Fabien Chraim and Kris Pister (2016) describes a wireless gas leak detection and localization system designed for industrial plants [9]. It employs wireless sensor nodes to detect gas leaks and send data to a central server for analysis and localization. Despite achieving a detection rate of 91% and an accuracy of 5 meters in localization, the system may face limitations in terms of scalability, environmental interference, and real-time response in dynamic industrial environments.

 

Rasika S Ransing and Manita Rajput (2015) highlighted the paper which outlines the creation of a smart home system tailored for elderly care using a Wireless Sensor Network [10]. It addresses safety concerns by employing ZigBee technology to monitor temperature levels, crucial for preventing hazards in compact living spaces like homes. However, potential limitations may include the need for additional sensor functionalities to address broader aspects of elderly care beyond temperature monitoring, as well as concerns regarding privacy and data security in such interconnected systems.

## METHODOLOGY

The methodology for the IoT-based effortless gas leak detection and reservation project involves a systematic approach to ensure effective implementation and reliable functionality. The project encompasses three main phases: sensing, communication, and reservation. In the sensing phase, gas sensors are strategically placed in target areas to detect leaks promptly. These sensors are connected to microcontroller, which process and transmit the data. The communication phase involves the integration of IoT devices and a central server using wireless protocols. This allows real-time transmission of gas sensor data to the central server, enhancing the responsiveness of the system. The server employs cloud-based storage and analytics to process the incoming data, enabling quick identification and localization of gas leaks. Additionally, the system incorporates a reservation mechanism where users can reserve time slots for gas-related activities, ensuring safe and controlled usage. User interfaces, such as mobile applications or web platforms, facilitate interaction with the system, allowing users to monitor gas levels, receive alerts, and make reservations seamlessly. The implementation of appropriate security measures to safeguard confidential information and ensuring system dependability is essential to the project's effectiveness.

Overall, the methodology combines sensor technology, IoT communication, cloud computing, and user-friendly interfaces to create an efficient and user-centric solution for effortless gas leak detection and reservation management (Figure 1).

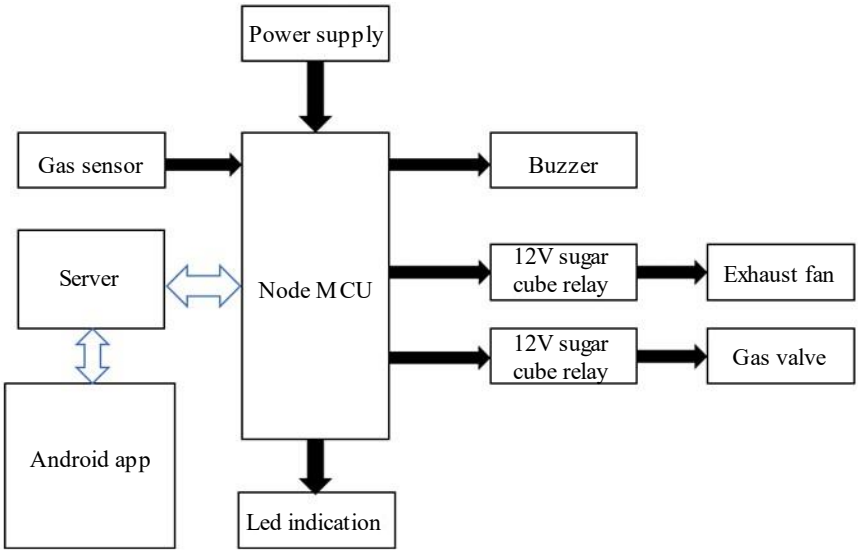


**Figure 1.** Block Diagram of sensor technology.

## COMPONENTS

*Node MCU – ESP8266:* NodeMCU is a versatile open-source firmware and prototyping board for microcontroller units, featuring switches for reset and flash, an LED indicator, and a CP2102 USB to UART module for data conversion. With four power pins, three ground supply pins, and 17 GPIO pins, the ESP8266 board offers extensive functionality including secure digital I/O interface and four PWM channels. It operates using three control pins: enable, reset, and wake, functioning at full capacity when the enable pin is high and in a low-power state when it's low.

 

*MQ-7 GAS Sensor:* The MQ-7 CO Carbon Monoxide Coal Gas Sensor Module is a dependable device designed to detect carbon monoxide and natural gas concentrations in the air. It operates within a 5V to 12V DC supply range, featuring analog outputs from the A0 pin, digital output signals from the D0 pin, and a common reference point from Ground (GND). Additionally, the module includes an internal heating element powered with a recommended preheat time, offering a comprehensive pinout configuration and voltage specification for accurate gas concentration measurements**.**

*MQ-6 GAS Sensor:*The MQ-6 gas sensor is vital for detecting potentially harmful gases, particularly LPG, leveraging a semiconductor core with tin dioxide for broad gas detection capabilities. With its three-pin configuration ensuring optimal operating conditions and output signals, it's deployed across diverse environments for enhanced safety. Its rapid response time and wide sensitivity spectrum make it effective in detecting various poisonous gases, though regular calibration is crucial for maintaining accuracy. Overall, the MQ-6 gas sensor stands as a dependable solution for safeguarding human health and the environment in various applications.

*Voltage Regulator:* It controls the input given to it, as the name suggests.An electrical regulator with a tendency to automatically maintain a steady voltage level is called a voltage regulator.The power supplies of 5V and 12V are needed for this project. The voltage regulators 7805 and 7812 must be used for attaining these voltage levels.

*HX711:* The HX711 is a pivotal component in precision weighing applications, functioning as a specialized analog-to-digital converter (ADC) designed for use with load cells or strain gauges.The primary purpose of the HX711 is to convert minute analog signals produced by load cells into precise digital data, facilitating accurate weight measurements.

*Load Cell:* An electro-mechanical sensor nicknamed a load cell is used to gauge weight or force. Its basic yet efficient design depends on the widely acknowledged link between the flow of electricity, material deformation, and applied force.

*BC547:* An NPN bipolar junction transistor is BC547.It is largely used for switching and amplification reasons.Like the other transistors, the BC547 is also utilized for raising current.

*Buzzer:* An auditory signaling device, such as a buzzer or beeper, can be piezoelectric, electromechanical, or electromechanical.Buzzers and beepers are commonly used in alarm systems, timers, and to validate user input, such as mouse clicks and typing.

*Relay:* A relay, a fundamental component in electrical engineering, functions as a pivotal electrical switch that facilitates the controlled flow of electricity within a circuit. Its significance lies in its ability to enable the remote manipulation of high-voltage circuits through the utilization of low-voltage signals.

## CIRCUIT DIAGRAM

The regulated power source offers the circuit's input. The transformer steps down the AC input, or 230V from the mains supply to 12V, which is then sent to a rectifier. A pulsing DC voltage is what the rectifier produces as its output. Therefore, the rectifier's output energy is sent through a filter to eliminate any stray AC components in order to obtain a clean DC voltage. This voltage is now applied to a voltage regulator in order to produce a clean, sustained DC voltage (Figure 2).

In this integrated system, a NodeMCU microcontroller receives a 5V power supply, distributing it to various components such as sensors, load cells, and indicating LEDs. GPIO pins on the NodeMCU facilitate digital connections, employing transistors as switches for efficient control. Additionally, a

 

separate 12V power source powers critical elements like buzzers, relays, gas valves, and exhaust fans. Relays are utilized to manage the activation of exhaust fans and the shutdown of the gas valve, ensuring safety and control. The load cell measures the weight of the cylinder, providing data for automated booking processes. Information gathered by sensors and load cells is relayed to a server for analysis and monitoring. This system demonstrates an interconnected approach, leveraging digital technology and automation to enhance efficiency, safety, and data-driven decision-making in managing gas usage and cylinder inventory.

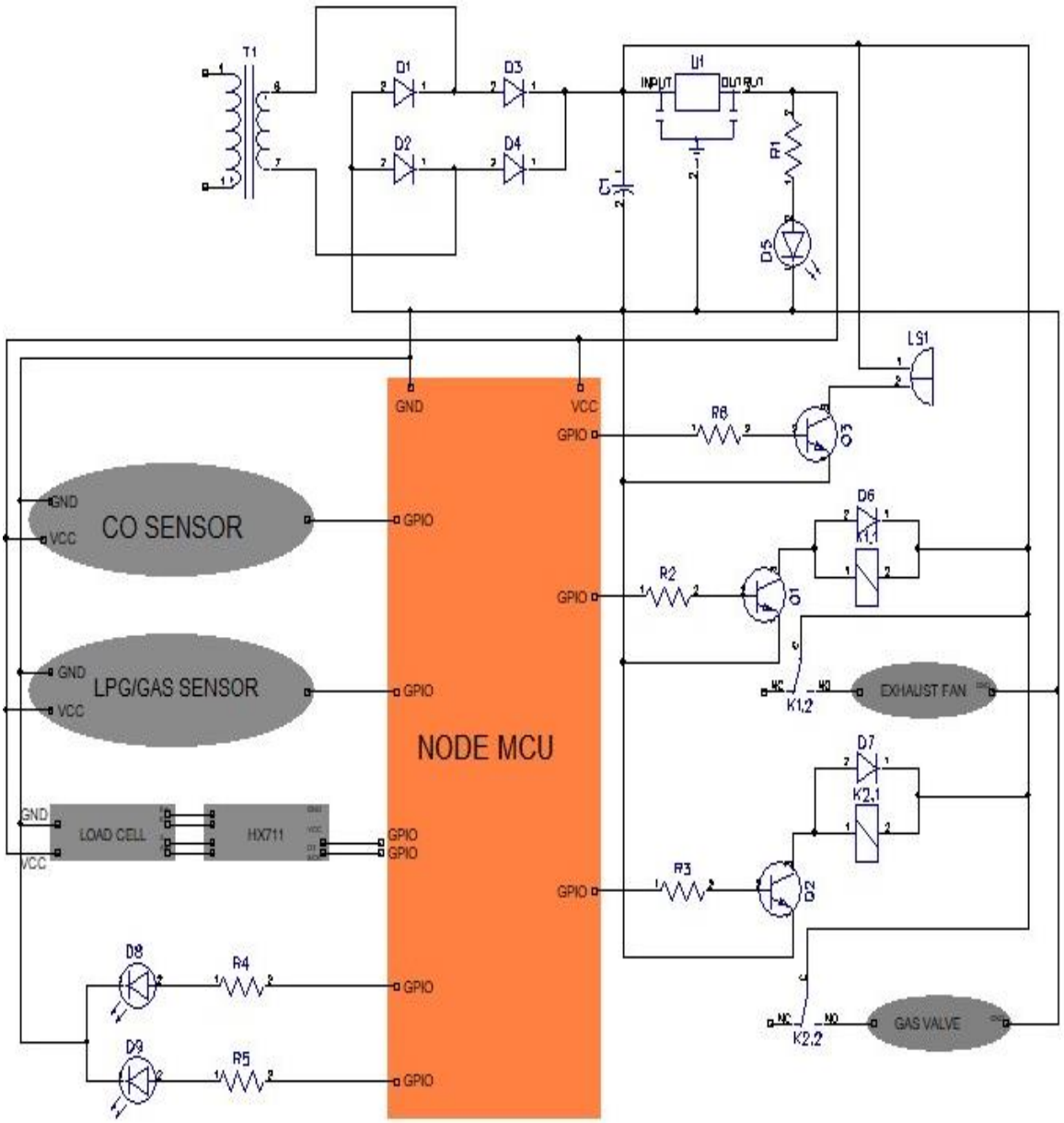


**Figure 2.** Circuit Diagram for IOT based effortless gas leak detection and reservation system.

In this project circuit designing and PCB designing process is done using Dip Trace. A simple-to-use PCB design package called DipTrace is used to create schematics and drawings.

It offers intuitive tools for circuit design, component placement, and routing traces. With features like 3D modeling and extensive libraries, DipTrace suits both hobbyists and professionals, facilitating the entire process from concept to manufacturing (Figures 3,4,5).

 

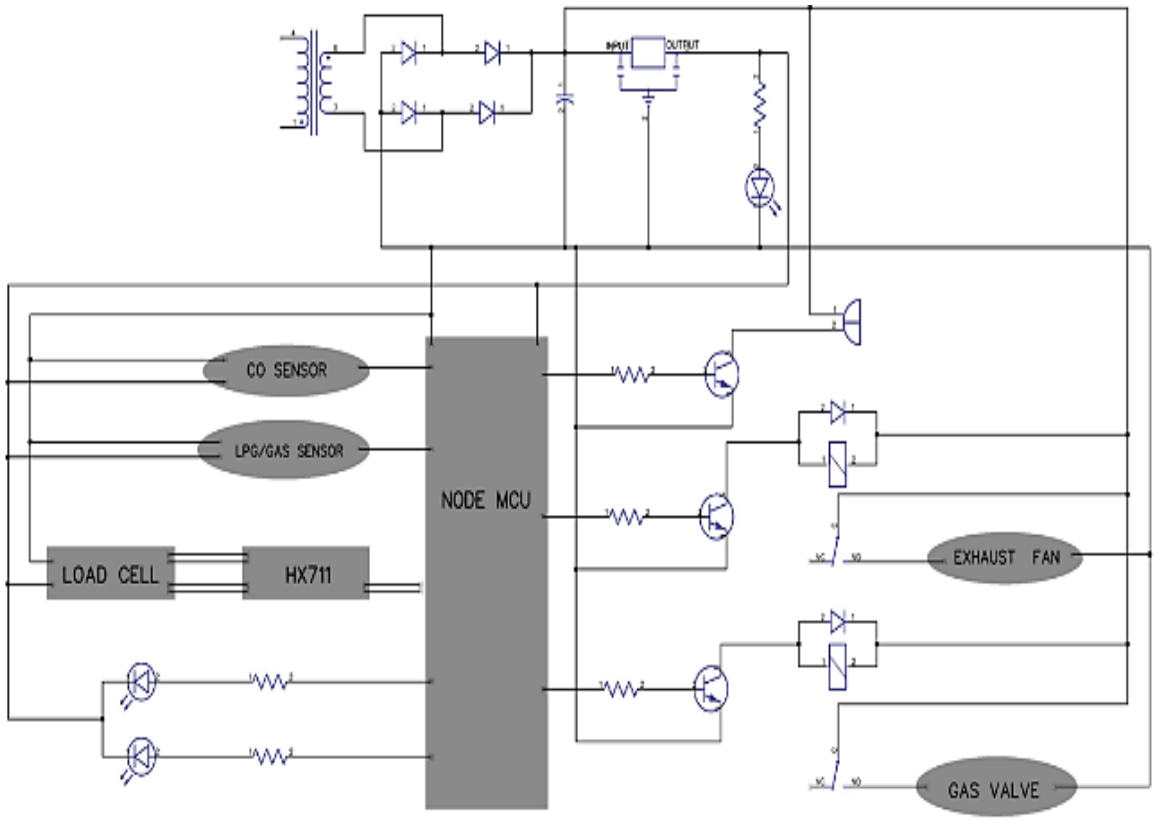


**Figure 3.** Circuit designing using DIP TRACE.

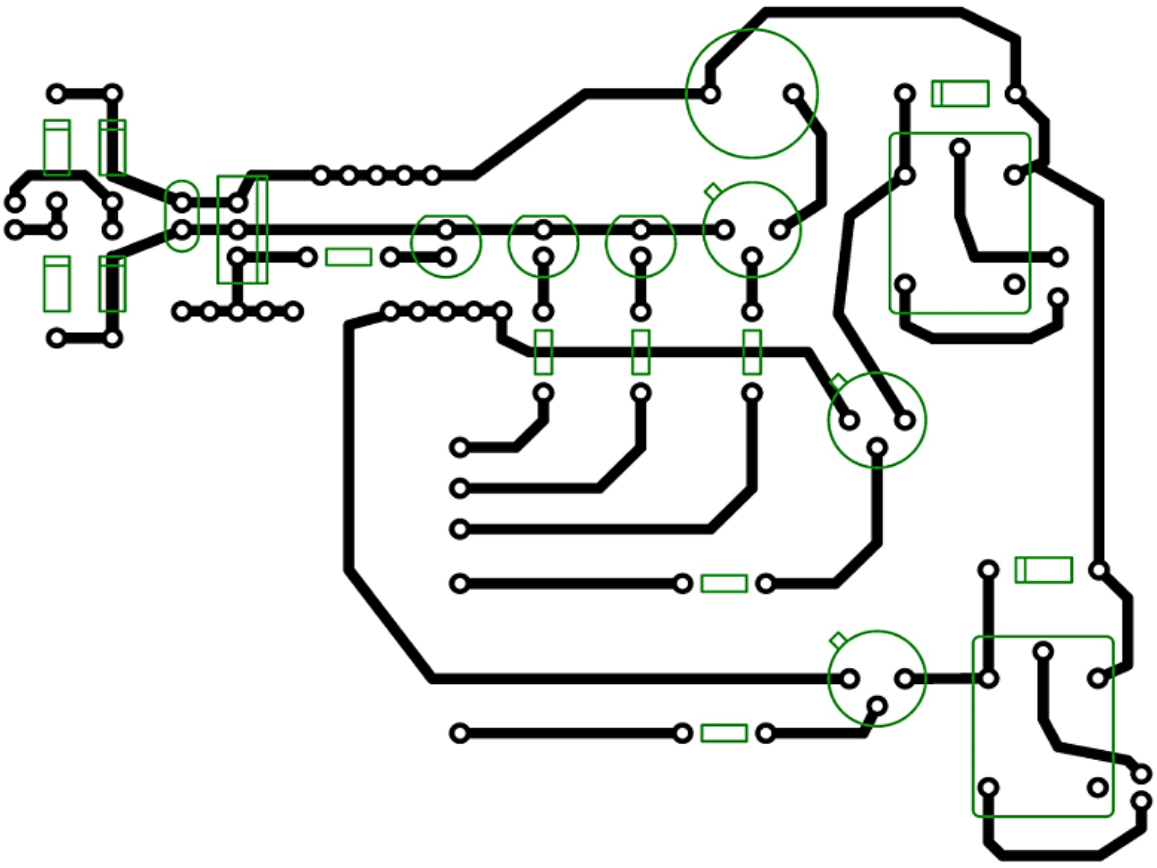

**Figure 4.** PCB designing using DIP TRACE.

 

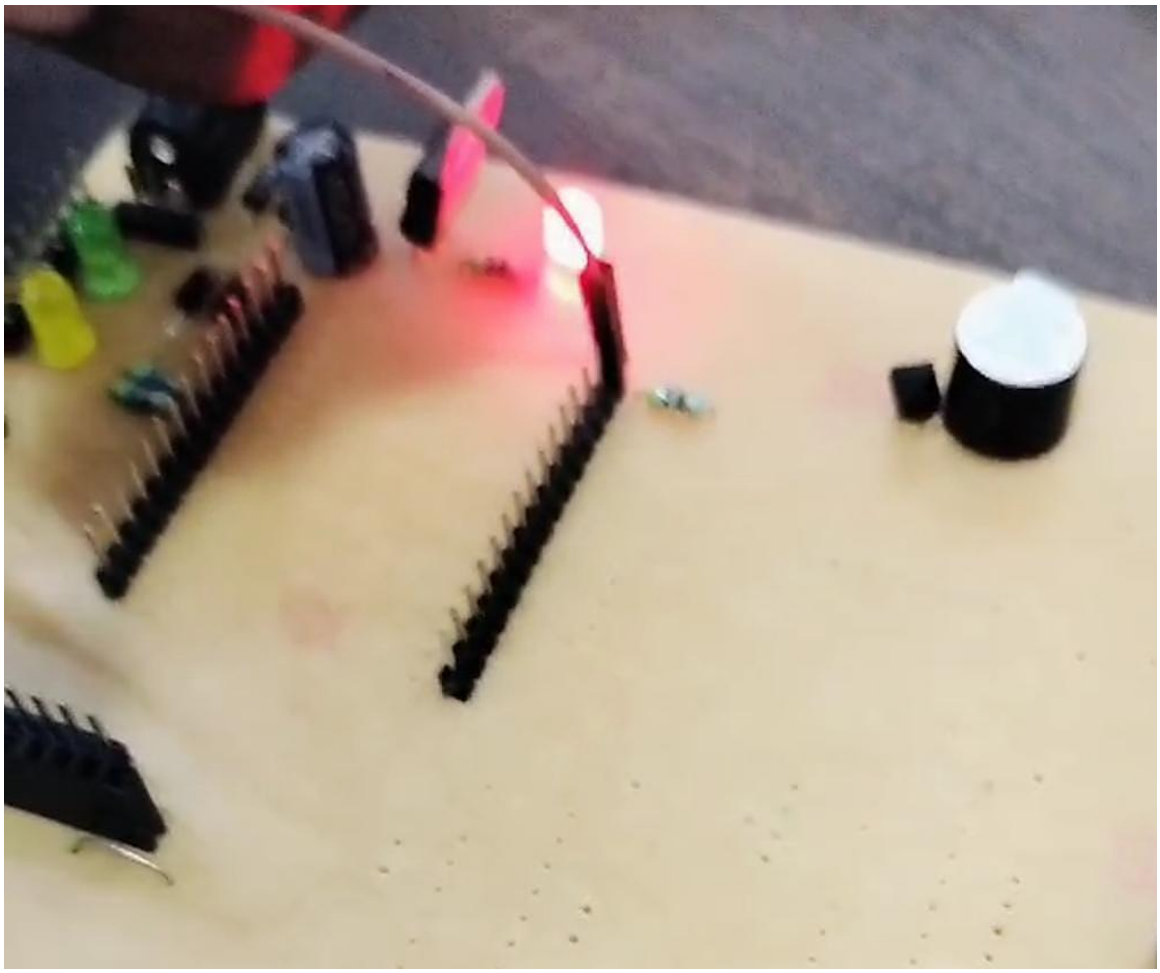

**Figure 5.** Image in proper functioning of gas sensors.

## CONCLUSION

In conclusion, our IoT-based gas leak detection and mitigation system emerges as an innovative solution for bolstering gas safety within residential domains. Extensive testing has corroborated its ability to swiftly identify gas leaks and enact proactive measures to mitigate potential hazards, including the shutdown of gas pipelines, activation of alarms, and timely notifications to emergency services and homeowners. Additionally, our system offers supplementary features such as automatic exhaust fan activation and remote monitoring and control via a dedicated Android application, enhancing user convenience and accessibility. Looking forward, our focus is on enhancing the system's capabilities by potentially integrating additional sensors to ensure comprehensive gas detection. Furthermore, we aim to explore collaborative opportunities with gas distributors to streamline LPG cylinder management processes, thereby fostering efficiency and convenience for consumers and industry stakeholders alike. Through ongoing refinement and technological advancements, our endeavor is to elevate gas safety standards within residential environments while optimizing gas management practices. In essence, our project not only addresses critical safety concerns but also prioritizes user-friendly functionality, positioning it as a pivotal contributor to improved gas safety and management practices within residential settings.

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