International Review of Practical Innovation, Technology and Green Energy (IRPITAGE) | ISSN (e): 2808-8611
Volumes 6 No. 1 (2026)

GASZACK: DESIGN AND CONSTRUCTION OF A GAS LEAK DETECTION DEVICE BASED ON SENSORS AND BUZZERS AS AN EARLY WARNING SYSTEM

Ahmad Daffa Athallah[1]*, Rafif Raihan Hafizh[2], Abdurrahman Yusuf Adya[3]
[123]MAN Insan Cendekia OKI / Indonesia
E-mail: daffaathallah.husien@gmail.com

Received : 05 February 2026	Accepted : 01 April 2026
Revised : 15 February 2026	Published : 30 May 2026

Abstract

LPG gas leakage is a serious hazard that frequently triggers explosions and fires in residential areas. GASZACK was developed as an appropriate technology-based early warning system utilizing an MQ-2 sensor and an Arduino Uno microcontroller. The device is designed to detect hazardous gas concentrations and instantly activate a buzzer alarm as a warning mechanism. The testing results demonstrated that the system achieved a response time of less than 5 seconds with sufficient accuracy for household-scale applications. This innovation offers an economical and easily replicable self-protection solution for communities to minimize the impact of accidents caused by gas leakage.

Keywords: Arduino Uno; buzzer; early warning system; LPG leakage; MQ-2 sensor.

INTRODUCTION

The use of Liquefied Petroleum Gas (LPG) as an energy source for households and small-scale businesses continues to increase because it is considered more practical, efficient, and economical compared to other conventional fuels. However, the use of LPG also carries a high level of risk in the event of gas leakage caused by damaged regulators, hoses, or improper cylinder installation. LPG, which consists primarily of propane and butane mixtures, is highly flammable and has a density heavier than air, causing leaked gas to accumulate in low-lying areas and potentially trigger explosions when exposed to sparks or open flames (Flores-Cortez et al., 2021). These conditions make LPG safety an important concern, particularly for households and micro-enterprises that still have limited access to or implementation of gas safety systems (Noviandra et al., 2022).

Cases of LPG leakage that are not promptly addressed often result in fires, property damage, and even loss of life. This problem is exacerbated by the limited ability of users to detect gas leaks at an early stage, particularly when gas concentrations are still low or when leaks occur at night while occupants are asleep. Therefore, an early warning system capable of providing rapid and automatic notifications in the event of gas leakage is highly needed. The development of sensor-based gas leakage detection devices has become one of the most widely adopted solutions due to their relatively high sensitivity and affordable implementation costs (Fauziyah et al., 2020). Several studies have been conducted to develop fire and gas leakage detection systems. Waworundeng (2020) developed a device capable of detecting fire and smoke with Telegram-based notifications. The results showed that the system was feasible to be integrated with other communication technologies in order to improve its efficiency.

Darnita et al. (2021) developed a fire and gas leakage detection system using an Arduino board. Similarly, Sasmoko and Mahendra (2017) designed an Arduino Uno-based fire detector system with SMS Gateway output, enabling users to receive remote notifications. Furthermore, Hidayat et al. (2024) integrated an MQ-2 sensor, temperature sensor, and ESP8266 module to develop a microcontroller-based gas and temperature detector system. In addition, Tanjung and Waluyo (2020) developed a temperature and smoke detection system for fabrication rooms using Arduino Uno, which proved capable of providing early warnings of potential fires. This indicates that the integration of multiple sensors can improve the accuracy and reliability of the system.

These studies demonstrate that the combination of the MQ-2 gas sensor and the Arduino Uno microcontroller is an efficient and economical solution for designing gas leakage detectors. However, most previous studies have primarily focused on fire detection systems, indicating that further development of more specific systems for gas leakage detection is still necessary. In this context, the innovation offered by the GASZACK device lies in the use of the MQ-2 gas sensor combined with a buzzer alarm system. The device is designed as a simple, practical, and economical solution to facilitate faster and easier detection of LPG leakage at an affordable cost, thereby minimizing the risk of fires and explosions. Furthermore, the development of GASZACK is expected to become a technological innovation that can be easily implemented in household and small-scale industrial environments to improve the safety aspects of LPG usage.

LITERATURE REVIEW

Characteristics of LPG Gas and Safety Risks

Liquefied Petroleum Gas (LPG) is a mixture of hydrocarbon gases, predominantly propane and butane, stored in liquid form under pressure. Physically, LPG has a relative density approximately 1.5 to 2.0 times heavier than air. This characteristic is highly important in the context of community education, as the public needs to understand that gas detectors should be installed in low positions (close to the floor) to ensure maximum detection effectiveness. The primary hazard arises when the gas concentration reaches the Lower Explosive Limit (LEL), which for LPG is around 2% of air volume or equivalent to 20,000 ppm (Widartiningsih, 2017).

MQ-2 Semiconductor Gas Sensor Technology

The MQ-2 sensor was selected due to its broad capability in detecting flammable gases such as LPG, methane, propane, and smoke. This sensor operates based on changes in the resistance of Tin Dioxide (SnO_2) material when exposed to gas molecules. The MQ-2 has a detection range of 200 to 10,000 ppm, making it highly suitable for providing early warnings long before gas concentrations reach the Lower Explosive Limit (LEL). Although the MQ-6 sensor is known to be more specifically sensitive to LPG, the use of the MQ-2 sensor in community-based applications offers an additional advantage in the form of smoke detection capability, which is beneficial for general fire protection systems (Hadi, 2022).

Arduino Uno Microcontroller as an Appropriate Technology

The Arduino Uno functions as the central control unit due to its ability to process analog signals from sensors into digital data in real time. In community service-based research, the use of Arduino is emphasized because of its ease of programming through an open-source platform, the availability of components in local markets, and its relatively low cost compared to industrial alarm systems. These advantages enable communities and local users to independently maintain and operate the device (Sohibun et al., 2021).

Early Warning Standards and Response Time

The effectiveness of an early warning system is measured by its response speed. Based on the international standard EN 50194-1, household gas detectors must be capable of providing warnings within less than 30 seconds. Recent studies have shown that Arduino-based systems with proper calibration can achieve accuracy levels of up to 97.97% and response times of under 5 seconds. This rapid response is highly crucial in gas leakage scenarios occurring in confined kitchen spaces, where gas accumulation can happen very quickly (Ramadhani, 2022).

METHOD

The development of the GASZACK device applied the Borg and Gall Research and Development (R&D) model, which was simplified into five stages: (1) preliminary research and information gathering related to LPG hazards; (2) system design planning; (3) prototype development; (4) functionality and response time testing; and (5) final revision of the device. The primary focus of this methodology was to develop a device that is not only technically functional but also practical and safe for community use. The components utilized in the development of the GASZACK device consisted of an MQ-2 sensor, Arduino Uno microcontroller, buzzer alarm, wiring materials, PCB board, and a 9V battery. In this system, the MQ-2 sensor functions as the input component. Based on the literature review, the MQ-2 gas sensor is capable of responding quickly and is relatively affordable in terms of cost for detecting gas concentrations in the surrounding area. Furthermore, the Arduino Uno microcontroller processes the input data, while the buzzer serves as the warning system when gas leakage exceeds the predetermined threshold value. The detailed stages of the GASZACK device development are presented in Table 1.

Table 1. Details of GASZACK device development activities

Aspect	Method	Experimental Details
Research Type	Research and Development (R&D)	Applied the Borg and Gall model
Research Stages	Five main stages	1. Research (preliminary study) 2. Planning 3. Prototype Development 4. Testing 5. Revision
Research Object	Gas leakage detection system	Focused on household and industrial environments
Main Components	Hardware	MQ-2 sensor (LPG, propane, methane detection), Arduino Uno, buzzer
System Working Principle	Automatic detection and response	The MQ-2 sensor detects gas concentration, Arduino processes the data, and the buzzer is activated when the threshold value is exceeded
Prototype Design	Electronic circuit	Designed using a PCB board
Power Supply	Power source	9V battery compatible with Arduino
Programming	Software	Used Arduino IDE for signal processing and system control
Testing Environment	Direct testing	Conducted in an environment containing gas to simulate leakage
Testing Parameters	Response time and reliability	Measured buzzer activation speed and detection consistency
Testing Results	System performance	Successfully detected leakage and activated the alarm in less than 5 seconds
Calibration	Sensor adjustment	The system was calibrated to improve gas detection accuracy
System Evaluation	Final performance	The system was considered responsive, accurate, and economical
System Output	Early warning	Buzzer alarm activated when hazardous gas was detected

Meanwhile, the systematic workflow of the GASZACK device development activities is described as follows:

Stage 1: Research and Information Gathering

a) Identification of LPG gas leakage problems in residential environments.
b) Literature review regarding safe gas threshold limits and the characteristics of the MQ-2 sensor.

Stage 2: Design Planning

a) Development of the electronic circuit schematic (Arduino, Sensor, and Buzzer).
b) Design of component layout on the PCB board to ensure stability and compactness.

Stage 3: Prototype Development

a) Hardware assembly and programming using Arduino IDE.
b) Configuration of the alarm threshold value at 800 ppm.

Stage 4: System Testing

a) Functional testing using LPG gas exposure.
b) Evaluation: Is the response time less than 5 seconds?
   - If NO: Return to Stage 3 for recalibration.
   - If YES: Proceed to Stage 5.

Stage 5: Finalization and Revision

a) Improvement of the physical design and sensor stability.
b) Preparation of the final report.

RESULTS AND DISCUSSION

During the development stage of the GASZACK device, all components were assembled according to the initial design plan. All elements were connected using cables and mounted on a PCB board to improve circuit stability. The Arduino Uno was programmed using the Arduino IDE software based on a series of programmed instructions (Figure 1).

Figure 1: Assembly process of the GASZACK device

However, testing was necessary to verify whether the device operated properly and fulfilled its intended functions. This process involved creating conditions in which flammable gas was released near the sensor and measuring the time interval between gas detection and alarm activation. Through several testing trials, the average response time interval was determined. As a result, the system successfully operated and continuously detected gas concentration levels. When the gas concentration exceeded the predetermined threshold, the system automatically activated the alarm (Figure 2).

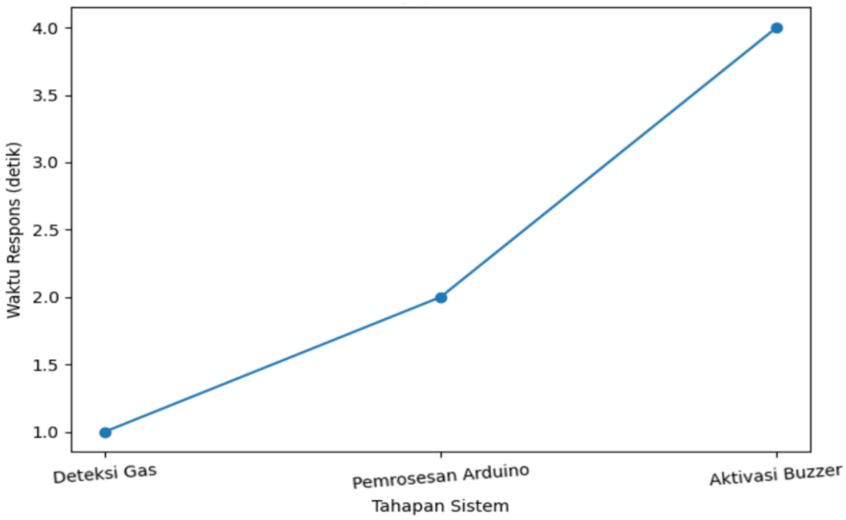

Figure 2: Graph of GASZACK device testing results

Figure 2 illustrates the graph of the GASZACK system testing results, showing that the device was able to operate sequentially, starting from the gas detection process to the activation of the buzzer alarm with a relatively fast response time. During the gas detection stage, the sensor required approximately 1 second to recognize the presence of gas in the surrounding environment. This indicates that the MQ-2 sensor has a sufficiently high sensitivity in detecting gas leakage at an early stage.

Furthermore, during the Arduino processing stage, the response time increased to approximately 2 seconds. This stage indicates that the sensor data underwent processing before the system made a decision to activate the alarm. The processing time is still considered relatively fast and demonstrates that the microcontroller was capable of performing the system control functions effectively.

The final stage, namely buzzer activation, required approximately 4 seconds from the moment the gas was initially detected. The increase in response time at this stage indicates that the system required a certain delay before the alarm was fully activated. Nevertheless, a 4-second response time is still considered effective in providing an early warning to users, allowing them to take immediate preventive actions against the potential risk of fire or explosion caused by gas leakage. Overall, the graph demonstrates a progressive increase in response time at each stage of the GASZACK system. This indicates that the device operated sequentially and stably, starting from gas detection, data processing, and finally to the activation of the warning alarm. With a relatively short total response time, GASZACK can be considered an effective early warning system for gas leakage and is feasible for implementation in household as well as small-scale industrial environments.

For optimal effectiveness, the device should be installed at a height of 10–30 cm above the floor, in accordance with the physical properties of LPG gas, which is heavier than air. The placement should be within a radius of 1–3 meters from potential leakage sources (gas cylinders or stoves) while avoiding areas with excessively strong airflow to ensure that gas concentrations can be accurately detected by the sensor. The development and testing of the GASZACK device produced positive results, demonstrating that the device can function effectively as a gas leakage detection system. The integration of the MQ-2 gas sensor, Arduino Uno, and alarm system operated according to the planned design and showed positive product performance. This was indicated by the sensor's ability to detect flammable gases such as LPG, propane, and methane.

Once the threshold value was exceeded, the Arduino Uno microcontroller activated the alarm system, producing an audio warning within less than five seconds. The GASZACK prototype was tested repeatedly in a controlled environment using simulated gas exposure, and the results showed that the MQ-2 sensor was capable of effectively detecting gas leakage. The alarm system operated successfully and provided adequate audio warnings throughout the testing process. Therefore, the developed solution was able to warn users of gas leakage before it escalated into a fire or explosion. In addition to being responsive, the GASZACK prototype also demonstrated stable operation. The Arduino Uno microcontroller efficiently processed the information provided by the sensor without delays or interruptions. The use of a PCB in the development of this solution contributed to improved system efficiency. Furthermore, the developed prototype was compact, lightweight, and easy to operate. The use of a 9V battery also demonstrated that the system could operate autonomously without requiring a complex electrical connection. Thus, it can be concluded that the developed system is capable of operating effectively in household environments, kitchens, laboratories, and industrial settings.

The development of this device is consistent with other studies dedicated to Arduino-based gas detectors. Various studies have shown that MQ-series sensors can be utilized to detect LPG gas concentrations in the air and integrated with buzzer-based alarm systems and microcontrollers. Research conducted by Hadi (2022) demonstrated that the use of an MQ-2 sensor combined with Arduino Uno was capable of effectively detecting gas leakage in enclosed spaces. In addition, Lowongan et al. (2015) and Nurnaningsih (2018) explained that sensor-and buzzer-based gas detection systems can improve user responsiveness to the potential hazards of LPG leakage. This technology has become increasingly relevant for implementation among communities and micro-enterprises because it can enhance knowledge, skills, and awareness regarding the importance of LPG safety in household and business environments.

However, the GASZACK prototype developed in this study is more user-friendly compared to most solutions currently available on the market. Its low production cost and simple construction make it more accessible to the general public. Therefore, it is evident that the GASZACK prototype has strong potential for widespread practical adoption. Nevertheless, several issues related to the performance of the GASZACK prototype still need to be addressed. First, the efficiency of the MQ-2 sensor may depend on environmental conditions such as temperature, humidity, and airflow. Second, the current prototype only provides local audio warnings, indicating that further improvements are necessary to enhance the overall efficiency of the system.

CONCLUSION

Based on the results of the design, construction, and testing of the GASZACK device, it can be concluded that the MQ-2 sensor- and buzzer-based gas leakage detector was successfully developed as an early warning system for LPG leakage. The device was capable of detecting the presence of flammable gases with a relatively fast response through the stages of sensor detection, data processing by the Arduino microcontroller, and buzzer alarm activation. The testing results showed that the MQ-2 sensor was capable of effectively detecting gas leakage, which was then processed by the microcontroller to activate the buzzer as a warning medium for users. The system operated sequentially and stably, thereby helping to minimize the risk of delayed response to gas leakage that could potentially lead to fires or explosions. With its simple, economical, and user-friendly characteristics, GASZACK has strong potential to be implemented in household environments as well as small-scale businesses as an effort to improve LPG usage safety. Furthermore, this device can also serve as an alternative early warning technology that is practical and can be further developed using Internet of Things (IoT)-based systems or remote notification technologies.

REFERENCES

Darnita, Y., Discrise, A., & Toyib, R. (2021). Prototype Alat Pendeksi Kebakaran menggunakan Arduino. Jurnal Informatika UPGRIS, 7(1), pp. 31-35.

Fauziyah, I. N., Harliana, H., & Gigih, M. B. (2020). Rancang Bangun Alat Pendeteksi Kebocoran Gas LPG menggunakan Sensor MQ-6 berbasis Arduino. Jurnal Ilmiah Intech: Information Technology Journal of UMUS, 2(1), pp. 41-50.

Flores-Cortez, O., Cortez, R., & González, B. (2021). Design and Implementation of an IoT based LPG and CO Gases Monitoring System. https://arxiv.org/abs/2107.07406. Accessed April 30, 2026.

Hadi, T. K. (2022). Analisis Perancangan Alat Pendeteksi Kebocoran Gas LPG Berbasis Sensor MQ-2 dan Arduino Uno. Jurnal Minfo Polgan, 11(2), pp. 105–108.

Hidayat, J. J., Werdana, A. P., & Setyowati, C. (2024). Perancangan Sistem Deteksi Gas dan Suhu berbasis Mikrokontroler IoT menggunakan Metode Prototyping. Jurnal Fasilkom, 15(2), pp. 398-407.

Lowongan, T. R., Rahardjo, P., & Divayana, Y. (2015). Detektor LPG menggunakan Sensor MQ-2 berbasis Mikrokontroler ATMega 328. Jurnal Spektrum, 2(4), pp. 53–57.

Noviandra, M. E., Karim, S., & Suswanto. (2022). Sistem Deteksi Kebocoran Gas LPG menggunakan Wemos D1 R1 dengan Sensor MQ-2. Antivirus: Jurnal Ilmiah Teknik Informatika, 16(2), pp. 190-199.

Nurnaningsih, D. (2018). Pendeteksi Kebocoran Tabung LPG melalui SMS Gateway menggunakan Sensor MQ-2 berbasis Arduino Uno. Jurnal Teknik Informatika, 11(2), pp. 121-126.

Ramadhani, A. (2022). Sistem Monitoring Keamanan Tabung Gas LPG menggunakan Jaringan Saraf Tiruan dengan Metode Back Propagation berbasis Internet of Things (IoT). Skripsi. Universitas Lampung.

Sasmoko, D., & Mahendra, A. (2017). Rancang Bangun Sistem Pendeteksi Kebakaran berbasis IoT dan SMS Gateway menggunakan Arduino. Jurnal Simetris, 8(2), pp. 469-476.

Sohibun, Daruwati, I., Hatika, R. G., & Mardiansyah, D. (2021). MQ-2 Gas Sensor using Micro Controller Arduino Uno for LPG Leakage with Short Message Service as a Media Information. Journal of Physics Conference Series, 2049(1):012068, pp. 1-8.

Tanjung, T., & Waluyo, S. (2020). Sistem Pendeteksi Suhu dan Asap untuk Pencegahan Kebakaran berbasis Arduino Uno pada Ruangan Fabrikasi CV. Ready Technic. Skanika, 3(4), pp. 41-46.

Waworundeng, J. (2020). Desain Sistem Deteksi Asap dan Api berbasis Sensor, Mikrokontroler, dan IoT. Cogito Smart Journal, 6(1), pp. 117-127.

Widartiningsih, P. M. (2017). Sistem Pendeteksi Kebocoran Gas LPG berbasis Mikrokontroler. Prosiding SNIPS 2017, pp. 28-34.