IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, October 2026
Impact Factor: 8.2

A Literature Review of Microcontroller-Based LPG Gas Leak Detection and Alert Systems Using Gas Sensors, GSM and Local Alarms

Aliraja Naim Ansari, Ali Ahmed Shaikh, Raja Kumar
Soomod Chetan Chavan, Mrs. T. S. Sonawane
Department of Computer Engineering
Guru Gobind Singh Polytechnic, Nashik, Maharashtra, India

Abstract: *Liquefied petroleum gas (LPG) is the most common household and commercial cooking fuel, but leaks can cause fire, explosion and suffocation, and many people cannot reliably smell small leaks. Electronic detectors that sense gas and raise an alarm are a widely used preventive measure. This review analyzes microcontroller-based gas leak detection research relevant to our proposed LPG gas leak detection and alert system, which combines a semiconductor gas sensor, a microcontroller, a local buzzer and display, and a GSM module for SMS alerts. We synthesize eight research publications and four manufacturer datasheets covering GSM-based detectors, FPGA and wireless-sensor-network systems, smart-home gas safety, automatic stove shutoff, and detection-method surveys. Through thematic and comparative analysis we identify four research gaps: most systems alert but do not act; fixed thresholds and uncalibrated sensors risk false or missed alarms; alert delivery depends on a single channel with little alarm management; and quantitative evaluation is limited. We then outline how the proposed system addresses these gaps and list directions for future work.*

Keywords: LPG leakage, gas sensor, MQ-2, MQ-6, GSM, SMS alert, microcontroller, safety system, embedded systems

I. INTRODUCTION

A. Background

LPG is a flammable mixture mainly of propane and butane, used for cooking, heating and as vehicle fuel. It is naturally odorless, so an odorant (ethyl mercaptan) is added to make leaks noticeable [1]. However, some people have a poor sense of smell, and small leaks may go unnoticed. Leaks arise from damaged pipes, loosely fitted hoses and faulty valves or regulators [1]. Reported incidents of gas leakage have caused loss of life and property worldwide [1]. Electronic gas leak detectors therefore provide an active safety layer in homes, industries and vehicles.

Leak detection technology is commonly grouped into hardware-based methods (optical, acoustic, cable sensor, soil, vapor sampling), software-based methods (flow, pressure, volume and statistical analysis), and non-technical methods such as patrols [1], [8]. For domestic LPG, low-cost hardware sensing with a microcontroller is the practical route.

B. Problem Context

Detecting a leak is only the first step. The safety value of a detector depends on whether the right person is told in time and whether the hazard is actually reduced. Three needs follow: (i) reliable sensing of LPG concentration with a sensible alarm threshold; (ii) immediate local alerting for people in the premises and remote alerting for an owner who is away; and (iii) mitigation, such as ventilation or cutting off the gas supply, so that an alarm does not leave the leak running. Most published systems address the first two and leave the third to the user.

C. Existing Situation

Existing work falls into four strands. First, microcontroller and GSM detectors combine a gas sensor, buzzer and SMS or call alert [1], [2], [3]. Second, networked systems use RF or wireless sensor nodes to cover several locations and to

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, October 2026
Impact Factor: 8.2

locate leaks [4], [5]. Third, smart-home and appliance-level systems add cutoff valves, fire modules or stove automation [6], [7]. Fourth, surveys classify detection techniques [8]. Manufacturer datasheets describe the behavior of the sensing and communication parts [9]–[12].

D. Limitations of Existing Approaches

A critical reading of the literature reveals four limitations:

- **Alert without action.** Several detectors only sound an alarm or send a message [1], [2], [3]. An exhaust fan, where used, only dilutes the gas rather than stopping the supply [5].
- **Fixed thresholds and cross-sensitivity.** The prototype reviewed in [1] compares the analog sensor reading with a single fixed value. MQ-series sensors need a warm-up period and respond to more than one gas, and the MQ-2 also responds to smoke [9], so a fixed, uncalibrated threshold can cause false alarms or missed leaks.
- **Single channel and weak alarm management.** GSM avoids dependence on internet or Wi-Fi [1], but a single SMS channel can fail with poor signal. In the code reported in [1], the SMS routine sends the message twice in each detection cycle with no latch or cooldown, which can flood the user with repeated messages.
- **Limited quantitative evaluation.** The studies mostly demonstrate that an alert is received [1]. Response time, false-alarm rate, sensor drift and testing with real LPG are not reported in detail.

E. Motivation

The individual technologies (gas sensing, microcontrollers, GSM and local alarms) are mature and inexpensive, but are rarely combined with calibration, alarm management and a mitigation step in one affordable unit. A low-cost detector that senses LPG, warns people nearby, notifies the owner by SMS, and can trigger ventilation or gas cutoff would close the loop from detection to safety.

F. Proposed Research Direction

Our proposed LPG gas leak detection and alert system uses an LPG-sensitive MQ-series sensor, a microcontroller, a buzzer and LED for local alarm, a display for gas level, and a GSM module for SMS alerts to stored numbers. The MQ-6 is specified for LPG [10], and the MQ-2 for LPG, propane, hydrogen and smoke [9]. The SIM800 module supports text-mode SMS through AT commands [11], and the ESP32 integrates Wi-Fi and Bluetooth if an internet alert path is added [12]. The prototype is under development, so this paper establishes a literature foundation and does not report experimental results.

G. Objectives

The objectives of this review are: (1) to analyze LPG leak detection methods and prior surveys; (2) to evaluate sensor, microcontroller and GSM-based designs; (3) to examine networked, smart-home and mitigation-oriented systems; (4) to compare the reviewed studies and identify research gaps; and (5) to position the proposed system relative to those gaps.

H. Scope and Search Strategy

This review covers eight publications dated 2011–2019 on gas leak detection, together with four manufacturer datasheets. The publications were drawn mainly from the literature reviewed in the base paper on gas leakage detection and monitoring [1] and its cited works. Keywords included “LPG leakage,” “gas leak detector,” “MQ2,” “GSM,” “microcontroller” and “smart-home gas safety.” The selection is therefore limited, and coverage of recent IoT-based studies should be extended in future work.

I. Organization of the Paper

Section II presents a thematic literature review, a comparative table and the research gaps. Section III concludes with key insights and future directions. The reference list follows.

II. LITERATURE REVIEW

The review is organized into four themes: (A) detection methods and surveys; (B) microcontroller and GSM-based detectors; (C) networked and smart-home systems; and (D) mitigation and sensor behavior.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, October 2026
Impact Factor: 8.2

A. Detection Methods and Surveys

Murvay and Silea [8] surveyed gas leak detection and localization techniques. The base paper [1] groups methods into hardware-based, software-based and non-technical methods, and classifies detection as automated, manual or semi-automated. Automated detection runs without an operator once installed, manual methods such as handheld or thermal imaging devices need a person, and semi-automated methods need some input. For domestic LPG use, automated hardware sensing is the relevant category. A practical consequence is that large-scale pipeline techniques such as aerial imaging or statistical analysis are not suited to a household cylinder, which is why low-cost point sensors are the common choice.

B. Microcontroller and GSM-Based Detectors

Asafe et al. [1] built a detector from an Arduino microcontroller, an MQ-2 gas sensor, a SIM800 GSM module, a buzzer and an LCD. The sensor output is read on an analog pin and compared with a fixed value; above it, the buzzer sounds, the display shows a warning and an SMS is sent to a stored number. The authors choose GSM over IoT because it does not need internet or Wi-Fi and so is less exposed to network failure. The design was tested with a gas-based flame source and SMS messages were received. Weaknesses visible in the paper are the fixed threshold, the repeated SMS in code, no gas shutoff, and some inconsistencies between the text, block diagram and photographs (for example, sensor and board labels). The message also refers to "smoke/gas," which reflects the MQ-2 sensitivity to smoke [9].

Arpitha et al. [2] used an FPGA with an MQ-6 sensor and GSM so that an automatic warning call reaches the first response team without delay; it has no remote monitoring or supply shutoff. Sonkar et al. [3] reported a microcontroller-based LPG leakage detector with a GSM module for alerts, a design pattern similar to [1].

C. Networked and Smart-Home Systems

Kareem [5] proposed an embedded real-time system for domestic kitchens, in which sensor nodes in several households communicate with a central node, and the responsible person is identified through the RF module address and alerted by text message. The exhaust fan used in such systems reduces risk by expelling gas but does not shut off the supply. Chengjun et al. [4] developed a wireless-sensor-network system for the petrochemical industry that collects data from RF sensors to locate leaks, stressing inter-node communication, though without remote monitoring or automatic shutoff. Park et al. [6] described a smart-home gas safety system based on intelligent meters with a built-in microcontroller and cutoff valve, linked to smoke and CO sensors and fire-extinguishing modules; its dependence on a special meter limits independent use.

D. Mitigation and Sensor Behavior

Yalmar et al. [7] built an automatic safety gas stove in which IR sensors detect utensils and motors turn off the knob when none is present. It assumes the leak is confined to the burner and has no gas sensing, so pipe leaks are not covered. The base paper [1] also reviews an LPG system with a weight sensor for cylinder level, an MQ sensor, SMS alert and automatic booking, along with an exhaust fan and a solenoid valve that closes on a leak. This shows that mitigation hardware is feasible in low-cost designs.

Sensor datasheets matter to design. The MQ-2 senses LPG, propane, hydrogen and smoke [9], while the MQ-6 is specified for LPG and butane-propane mixtures [10]. Semiconductor MQ sensors use a heated element and need a warm-up period before readings are stable, so thresholds should be set after calibration in clean air [9], [10]. The SIM800 accepts AT commands for text-mode SMS [11].

The comparison of these studies is summarized in Table I.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, October 2026
Impact Factor: 8.2

TABLE I
COMPARATIVE ANALYSIS OF REVIEWED GAS LEAK DETECTION STUDIES

Ref.	Year	Approach / Technology	Main Contribution	Key Finding	Limitation
[1]	n.d.	Arduino + MQ-2 + SIM800 GSM + LCD + buzzer	Low-cost LPG leak detector with SMS and local alarm	Works without internet; SMS alert to stored number	Fixed threshold; no shutoff; SMS repeated per cycle
[2]	2016	FPGA + MQ-6 + GSM	Automatic warning call to first-response team	Fast call-based alert	No remote monitoring; no gas shutoff
[3]	2015	Microcontroller + LPG sensor + GSM	LPG leakage detector with SMS	Simple, low-cost GSM alerting	Alert only; no mitigation
[4]	2011	Wireless sensor network, RF sensors	Gas leak detection and location (petrochemical)	Centralized location of leak via inter-node data	No remote monitoring or auto shutoff
[5]	2019	Embedded real-time system, RF sensor nodes	Domestic leak detection for kitchens	Node-ID based SMS alerts; alarm	Exhaust fan only dilutes gas; supply not cut
[6]	2013	Smart-home gas safety management	Gas meter with cutoff valve, CO/smoke, fire modules	Integrated cutoff and fire response	Needs special intelligent meter
[7]	2015	IR sensors + motors on gas stove	Auto stove-knob turn-off	Prevents unattended burning	No gas sensing; ignores pipe leaks
[8]	2012	Survey of leak detection methods	Classification of detection techniques	Hardware, software and non-technical groups	Survey only; no system

E. Identified Research Gaps

Existing studies have shown that low-cost gas sensors, microcontrollers and GSM can detect LPG and notify a user [1]–[3]; networked and smart-home systems extend coverage and add cutoff [4]–[6]. Four gaps remain.

- **Gap 1 (Alert Without Mitigation).** Detection systems have addressed alerting [1]–[3]; however, limited attention has been given to low-cost units that also trigger ventilation or gas cutoff [5], [7].
- **Gap 2 (Calibration and False Alarms).** Prototypes use a single fixed value [1]; limited attention has been given to warm-up handling, clean-air calibration, adjustable thresholds and sensor cross-sensitivity [9], [10].
- **Gap 3 (Alert Reliability and Management).** GSM avoids internet dependence [1]; limited attention has been given to alarm latching, cooldown to avoid repeated SMS, multiple recipients, and a second alert path.
- **Gap 4 (Quantitative Evaluation).** Studies mostly confirm that an alert is received; limited attention has been given to response time, false-alarm rate and testing under controlled LPG concentration.

Why these matter. An alarm that does not stop the leak leaves the hazard in place. Uncalibrated thresholds cause nuisance alarms that users learn to ignore, or missed leaks. Repeated or lost messages weaken trust, and without measured response times the safety value is unproven.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 2, October 2026 Impact Factor: 8.2

How the proposed system addresses these gaps. The proposed system is designed to (a) trigger local alarm plus SMS and, as planned extensions, a relay for an exhaust fan or valve, addressing Gap 1; (b) use a warm-up delay, clean-air calibration and a configurable threshold, addressing Gap 2; (c) latch the alarm, send one SMS per event with a cooldown, and support more than one recipient, addressing Gap 3; and (d) log sensor values and measure response time and false alarms during testing, addressing Gap 4. These strategies must be validated experimentally.

III. CONCLUSION

This review analyzed eight publications and four datasheets on LPG and gas leak detection. Microcontroller and GSM detectors are low-cost and effective at alerting, networked systems extend coverage, and smart-home systems add cutoff. However, these strands remain separate: most systems alert without acting, thresholds are fixed, alert handling is basic, and evaluation is limited. The proposed LPG gas leak detection and alert system responds by combining a gas sensor, local alarm, SMS alert with alarm management and an optional mitigation output. Because the prototype is under development, the claims here concern the literature and design rationale.

Future work should focus on: (1) automatic gas shutoff using a solenoid valve and exhaust fan control; (2) IoT or app-based monitoring with a GSM fallback; (3) multi-sensor fusion with temperature and flame sensing to reduce false alarms; and (4) controlled testing with measured response time and false-alarm rate.

REFERENCES

[1] Y. N. Asafe, A. J. Oyeranmi, O. A. Olamide, and A. O. Abigael, “Gas leakage detector and monitoring system,” Yaba College of Technology, Lagos, Nigeria.
[2] T. K. Arpitha et al., “FPGA-GSM based gas leakage detection system,” in Proc. IEEE Annu. India Conf. (INDICON), Bangalore, 2016, pp. 1–4.
[3] B. S. Sonkar et al., “Microcontroller-based LPG leakage detector using GSM module,” Int. J. Electr. Electron. Res., 2015, pp. 264–269.
[4] D. Chengjun et al., “Development of gas leak detection and location system based on wireless sensor networks,” in Proc. 3rd Int. Conf. Measuring Technol. Mechatronics Autom., Shanghai, 2011, pp. 1067–1070.
[5] H. Kareem, “Embedded real-time system for detecting leakage of the gas used in Iraqi kitchens,” Indones. J. Elect. Eng. Comput. Sci., vol. 14, pp. 1171–1176, 2019.
[6] G. Park et al., “Development of gas safety management system for smart-home services,” Int. J. Distrib. Sens. Netw., 2013.
[7] A. P. Yalmar et al., “Implementation of automatic safety gas stove,” in Proc. IEEE Annu. India Conf. (INDICON), New Delhi, 2015, pp. 1–6.
[8] P. Murvay and I. Silea, “A survey on gas leak detection and localization techniques,” J. Loss Prev. Process Ind., vol. 25, no. 6, pp. 966–973, 2012.
[9] Hanwei Electronics, “MQ-2 semiconductor sensor for combustible gas, technical data sheet.”
[10] Hanwei Electronics, “MQ-6 semiconductor sensor for LPG, technical data sheet.”
[11] SIMCom, “SIM800 series hardware design and AT command manual.”
[12] Espressif Systems, “ESP32 series datasheet,” Shanghai, China.