Report

Smart LPG Leakage Detection Using IoT

A system that detects gas leaks and alerts consumers when one occurs.

Project in IoT with a
specialization in Computer Communication and Networking

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Abstract

Industries, residential buildings, and gas-powered vehicles all struggle with gas leaks. If the leak isn't discovered, it could explode, endanger lives, and harm the environment severely. On-site alarms serve as a warning mechanism in the traditional leakage detection system. In this report, we suggest a technique for leakage detection in which the user is additionally provided with wireless media access to the leakage information. As a result, preventive measures are always taken right away, even when no one is there. The NodeMCU ESP-12E and MQ-5 gas sensor are used by the detection system to identify the leak and automatically send an email and a notification through WiFi. The gas leakage detecting system prototype has been created and put to the test using LPG (Liquefied Petroleum Gas). According to the trial findings, the system can find the leak in less a minute.

Keywords: NodeMCU, ESP-12E, esp8266, MQ-5 sensor, notification, IoT, email alert

Contents

1. Introduction

Gas leakage is a severe issue that is seen in many locations today, including homes, workplaces, and vehicles like Compressed Natural Gas (CNG), buses, and cars. It has been noted that hazardous accidents frequently result from gas leaks. Because of its advantageous characteristics, which include a high calorific value, little smoke, little soot, and minimal environmental harm, liquefied petroleum gas (LPG), also known as propane, is a flammable mixture of hydrocarbon gases used as fuel in many applications, including homes, hostels, industries, automobiles, and vehicles. Since it is so extremely flammable, liquid petroleum gas (LPG) can burn even some distance away from the leak. These extremely combustible chemical molecules, propane and butane, make up the majority of this energy source. These gases are easily flammable. LPG is mostly used for cooking in residential settings. Gases that leak may ignite when an explosion occurs. Gas leaking causes a variety of incidents that cause property damage and human injuries. Home fires have been happening more regularly, posing an increasing hazard to both human lives and property in recent years. Based on their physical characteristics, such as toxicity, flammability, etc., the hazards of explosion, fire, and asphyxia exist. In recent years, there have been more fatalities brought on by gas cylinder explosions.

1.1 Project hypotheses

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This work proposes and discusses a low-cost sophisticated sensor-based gas leakage detector, alarm, and control system. The technology is highly effective, user-friendly, transportable, compact, and economical. It will only set you back 45 US dollars.

2. Background

Techniques for detecting gas leaks have been the subject of several research articles. A wireless LPG monitoring system was proposed for design by K. Padmapriya et al [2]. In this study, the power supply is cut off and the user is notified through SMS that there is a gas leak. The real-time gas monitoring and leakage detection system was proposed by Meenakshi Vidya et al [1]. An exhaust fan is used in this system to detect and manage the gas leak. Additionally, the level of LPG in the cylinder is regularly checked. Selvapriya et al [3]. suggested a system in which a gas sensor detects

a leakage and generates findings in both audible and visual formats. It offers a design methodology for both software and hardware [4].

3. Data

In this study, LPG gas is detected using semiconductor sensors. It makes use of an MQ-5 semiconductor sensor. The MQ-5 gas sensor's sensitive component is SnO2, which has reduced conductivity in clean air. The sensor conductivity rises alongside the rising gas concentration when the target flammable gas is present. The MQ-5 gas sensor responds to natural gas and has excellent sensitivity to propane, butane, and LPG. The sensor is versatile and inexpensive, and it can be used to detect a variety of flammable gases, particularly methane.

3.1 Data preparation

The MQ-5 is capable of detecting gas concentrations between 200 and 10,000 ppm. The output of the sensor is analog resistance. Therefore, the data generated here is analog.

4. Approach

The NodeMCU ESP-12E and MQ-5 gas sensor serve as the system's foundation. Analog output 1 is produced when the sensor detects gas in the atmosphere, while analog output 0 is produced when gas is not detected. Through the A0 pin, the esp8266 will receive the sensor output as an analog input. The block diagram for the gas leakage detection and alert system is shown in Figure 1.

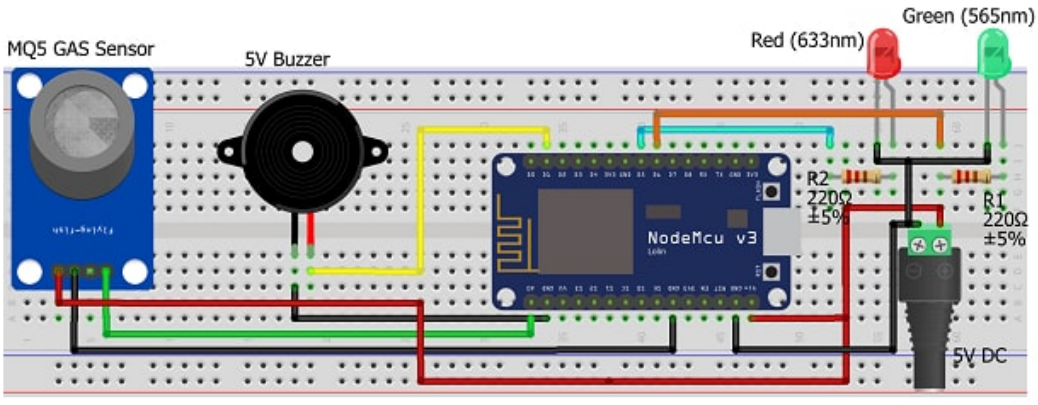

Figure 1: Circuit Diagram

If the sensor output is high, the buzzer will begin to tune, a pop-up message will appear on the user's phone, and an alert email will be sent. The buzzer won't tune if the sensor output is low. The buzzer typically consists of a number of switches or sensors that are connected to a control unit that can identify which button was pressed

or whether a predetermined amount of time has passed. The buzzer also typically illuminates a light on the appreciate button or control panel and emits a warning sound in the form of a continuous or sporadic buzzing or beeping sound.

The following hardware parts are needed for the creation of a sensor-based gas leakage detector and alarm system. The quantity and list of necessary hardware opponents are shown in the following list.

- NodeMCU esp8266 x1
- MQ-5 gas sensor x1
- AM1117 voltage regulator x1
- 5V Buzzer x1
- Led Red x1
- Led Green x1
- Resistor 220 ohm x2
- Jumper Wires
- Breadboard
- Battery (9V)

4.1 Device Details

- **NodeMCU ESP8266**

  The focal point of this project is NodeMCU. It receives data from the MQ5 sensor and transmits it to the Blynk app. Additionally, it will code-controlled buzzers and LEDs.

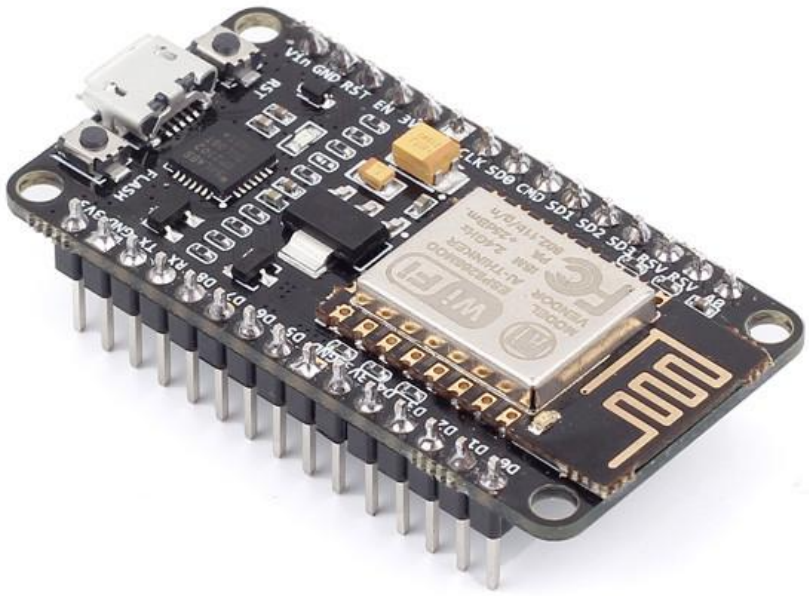

Figure 2: NodeMCU ESP8266 Board

The NodeMCU board essentially functions as a breakout/development board for the AI-thinker ESP12E module. The ESP-12E itself, like the earlier modules, was challenging to work with because it wasn't breadboard-friendly and needed header pins that weren't widely available. At the time, the only solution to these issues was an adapter combined with an FTDI breakout board and a few other connections to make it breadboard-friendly and simple to program. Arduino-like (software-defined) GPIO either the Arduino IDE or the Explorer IDE can be used to program it. With the onboard USB-TTL converter, programming is simple. There are 10 onboard digital I/O pins, one for analog input, and pins for SPI, IIC, and 1-Wire. extensive WiFi capabilities (can join an existing access point or establish a new one). It can function as a tiny webserver for straightforward pages and is used to connect gadgets to the internet so they can download and upload data. an internal PCB antenna, logic level of 3.3V

- **MQ-5 gas sensor**

  The MQ5 is a gas leakage sensor used in both consumer and industrial applications. It can detect LPG, natural gas, and coal gas and refrain from consuming alcohol, cooking, and smoking. The potentiometer allows for sensitivity adjustment. A buzzer is used by the MQ-5 Methane LPG Liquid Propane Gas Sensor Module particle sensor to detect any material that is even present in the air.

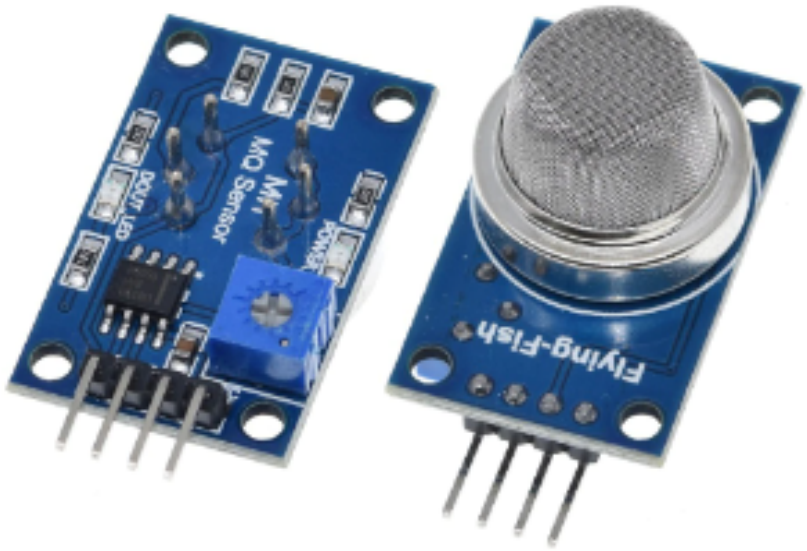

Figure 3: MQ-5 sensor

Analog out (A0) and digital out are two outputs that this module can give (D0). You may measure gas leakage and gas volume, which is expressed in PPM, using analog output. Either High or Low values are provided by the digital output. This is used to find gas leaks and send out a warning. It is better suited for gas leak detection.

4.2 Network Model

We used a NodeMCU that is based on the Blynk esp8266 in our project. A blynk notification will be delivered to your smartphone when the gas concentration rises. This describes the operation of the gas leak detection system. The network architecture is shown below:

Figure 4: Network Architecture with Blynk

A comprehensive software package called Blynk is needed to prototype, deploy, and remotely manage linked electrical devices of any size, from small-scale personal IoT initiatives to vast quantities of commercially connected items. Anyone can use Blynk to connect their gear to the cloud, create no-code iOS, Android, and web applications, analyze current and past data from devices, and remotely manage them from any location in the globe.

5. Results

The MQ5 sensor will require up to 3 minutes to warm up once the power is turned on. The gas level will remain constant after the sensor is ready. There will be no gas leak detected, hence the green light will be ON. Additionally, the buzzer will be turned off. Red light will turn ON in the event that any gas is detected and the level rises above 600 ppm, signaling a gas leak. Additionally, a Blynk app alert will be sent to the user.

The alarm, which includes a buzzer, will sound if the system detects a gas concentration in the air that is higher than the safety limit, alerting the users at home to the anomalous situation and enabling them to take any necessary action. The smell of gas in the house is the most obvious indicator of a leak. However, there are specific bodily symptoms that you might experience if there is a carbon monoxide leak. The output of this study is that the leakage will be discovered and stopped two hours after it begins. The degree of gas leakage can even be detected by this technology. This is a powerful technique for automatically locating and stopping the gas leak. Moreover, turning off the power supply also helps to avoid fire incidents. The concept of gas detection and control can be applied broadly across a range of industries. This system can be put in any room, including a restaurant in a hostel. This may help to lessen

mishaps brought on by gas leaks in residential settings as well as in similar commercial settings.

6. Discussion

A small amount of LPG has been introduced close to a gas sensor module to design and test the systems' hardware and software components. The authors of this research are actively developing this device to have multiple functions. The addition of a subsystem that allows for the monitoring of gas usage and waste is one of this system's major future functionalities. The system is adaptable since it may be expanded to include more sensors and relays in accordance with the overall LPG supply setup at those premises. With this approach, the author is including more clever software-based features. This system automatically detects, regulates, and alerts to gas emissions.

This system's user app will get a lot of clever features added. The system will be more user-safe thanks to its overall features. The system will be prepared for usage in a variety of settings, including the home, workplaces, and automobiles. After creating the final prototype with intelligent multipurpose characteristics, the system will be implemented as a pilot project in actual-life situations.

6.1 Limitations and Challenges

The costs and warm-up time are further drawbacks. After being turned on, a portable gas detector with an NDIR combustible gas sensor needs up to five minutes of warm-up time before the sensor readings are reliable. Furthermore, NDIR sensors cost 3–4 times as much as catalytic bead sensors.

7. Conclusion

This work proposes and discusses the design of a sensor-based automatic gas leakage detector with an alert and control system. This gadget for detecting gas is low-cost, low-power, lightweight, portable, safe, approachable, effective, multi-featured, and easy to use. Gas leakage detection will benefit us in the health sector, but it will also help to boost our economy since when gas leaks, they not only poison the air, but they also waste gases, which is bad for business.

The suggested method will just cost USD 45, making it fairly affordable for even those in poverty. It is apparent from the accessible literatures that not enough has been done to develop a smart gas detection system. Future upgrades to this system will incorporate more sophisticated features that will increase user comfort and safety. The development of smart gas sensors has greatly increased the range of applications for them as a result of the widespread use of handheld devices. In the upcoming years, the market is anticipated to be primarily driven by the requirement to ensure worker safety.

Bibliography

[1] Hussain Attia and H.Y. Ali. Electronic design of liquefied petroleum gas leakage monitoring, alarm, and protection system based on discrete components. 11:9721–9726, 01 2016.

[2] A. Mahalingam, R. Naayagi, and Nikos Mastorakis. Design and implementation of an economic gas leakage detector. pages 20–24, 03 2012.

[3] Apeh Simon. Design and development of kitchen gas leakage detection and automatic gas shut off system. Vol.5:222–228, 05 2022.

[4] T. Soundarya, Anchitaalagammai J V, G. Priya, and S.S. kumar. C-leakage: Cylinder lpg gas leakage detection for home safety. *IOSR Journal of Electronics and Communication Engineering*, 9:53–58, 01 2014. doi: 10.9790/2834-09165358.