International Journal of Multidisciplinary Research and Growth Evaluation.

MQ-2 Sensor and Relay Applied to Gas Disaster Prevention Using Zigbee IoT Protocal

Yi-Jen Mon [1*], Hsin-Jung Tsai [2], Yu-Han Tu [3], Xin-Ya Huang [4]
[1-4] Department of Electronic Engineering, Ming Chuan University, Taiwan

* Corresponding Author: **Yi-Jen Mon**

Article Info

ISSN (online): 2582-7138
Impact Factor: 5.307 (SJIF)
Volume: 04
Issue: 05
September-October 2023
Received: 20-08-2023;
Accepted: 10-09-2023
Page No: 464-467

Abstract
This paper proposes an Internet of Things (IoT) system method that uses gas sensors to detect carbon monoxide gas and then issue a warning and initially eliminate toxic gases. When the gas sensor detects toxic gas, the LED on the sensor will stay on, and the LED on the CC2530 chip of the motherboard will also flash. Then a warning signal will be sent to the coordinator motherboard through the Zigbee protocol. At this time, the motherboard warning light will light up, and then the coordinator will send a command to end device, start the relay module to control the rotation of the fan to eliminate toxic gases. After actual verification, the design effect of this disaster prevention system is excellent and feasible.

Keywords: Zigbee, Relay, MQ-2 sensor, IoT, gas disaster prevention

1. Introduction

Zigbee is a low-power, short-range, low-speed, and low-cost wireless communication technology that is widely used in the Internet of Things (IoT). It is mainly used in disaster prevention systems, home automation, smart cities and other fields. Relays and MQ-2 gas sensors are one of the common applications of Zigbee and can be used in many scenarios of the Internet of Things. Zigbee, MQ-2 gas sensors and Relay have a variety of applications and technologies in IoT applications to disaster prevention systems. These combinations can increase the effectiveness of disaster warning, monitoring and response. Here are some possible applications and related technologies [1-4].

1. Gas sensing and monitoring

- The MQ-2 gas sensor can detect a variety of gases, including carbon monoxide (CO) and flammable gases (such as methane, propane, etc.). These sensors can be installed in areas with higher potential disaster risks, such as kitchens, basements or industrial sites.
- Through Zigbee connection, the sensor can regularly transmit gas data to the central control system.

2. Focus area monitoring

- Zigbee network allows multiple MQ-2 sensors to be connected to the same control center. This enables more comprehensive gas monitoring and ensures wider detection coverage.
- The system can alert users or initiate relevant countermeasures based on gas detection data.

3. Automatic remote power off

- Relay can be used to remotely control the power supply. When the MQ-2 sensor detects a flammable gas leak or excessive carbon monoxide, the system can use relays to cut off power to related equipment (such as furnaces, gas supplies, etc.) to reduce potential fire or gas leak risks.

4. Alerts and Notifications

- MQ-2 sensors connected via Zigbee can send alarm signals to the central control system. These alerts can notify users in a variety of ways, including app notifications, text messages, emails, and more.
- Users can also remotely access the system to view real-time sensor data and alarm status.

5. Data analysis and prediction

- IoT systems can analyze sensor data to understand trends in gas leaks or carbon monoxide crises.
- Based on historical data and models, the system can also predict potential disaster risks and help users develop better response strategies.

6. Remote control and automation

- IoT systems can automate responses, such as activating ventilation systems, calling emergency services or sending advice to users.
- The remote control function can also be used to remotely reset or restart the sensor to ensure proper operation.

2. Design process and result

The gas-sensitive material used in the MQ-2 gas sensor is tin dioxide (SnO2), which has low conductivity in clean air. When there is combustible gas in the environment where the sensor is located, the conductivity of the sensor increases as the concentration of combustible gas in the air increases. A simple circuit is used to convert changes in conductivity into an output signal corresponding to that gas concentration. The MQ-2 gas sensor has high sensitivity to liquefied gas, propane, and hydrogen, and is also ideal for detecting natural gas and other combustible vapors. This sensor can detect a wide range of combustible gases and is a low-cost sensor suitable for a variety of applications. The appearance of MQ-2 sensor is shown in Figure 1.

A relay is a common electronic component used to control circuits with high voltage or current. It is a programmable switch, usually consisting of an electromagnetic relay and corresponding control circuit. When conducting relay module experiments, if you find that the relay does not close or the phenomenon is wrong during the program, you can directly connect the 3.3V and GND on the development board and the relay with DuPont wires, and connect the IN signal input terminal of the relay to each other with wires. Test 3.3V and GND. At this time, the light of the relay should change and there is a closing sound, indicating that the relay is good, otherwise the relay may be broken. The appearance of relay is shown in Figure 2.

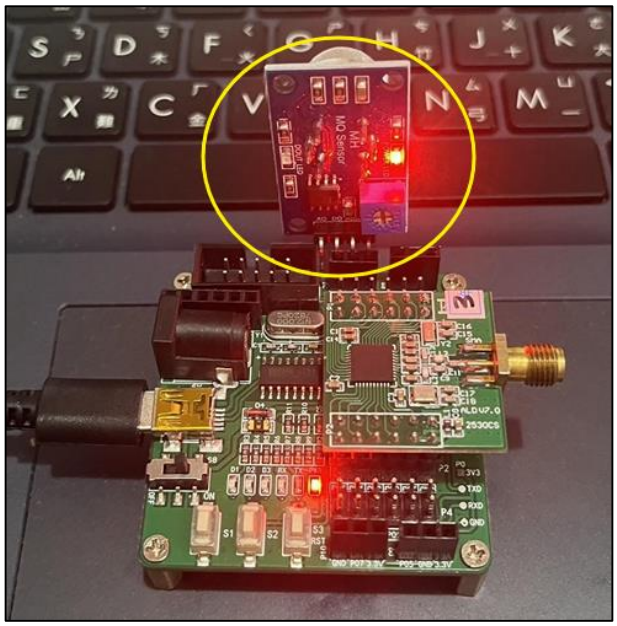

Fig 1: The appearance of MQ-2 sensor

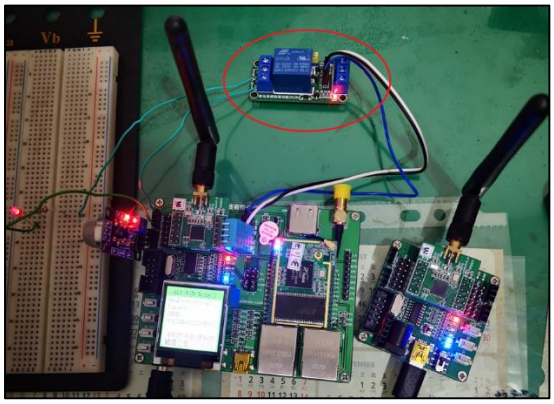

Fig 2: The appearance of relay

Zigbee mainly uses the physical layer and media access control layer defined in the IEEE 802.15.4 standard, using radio frequency signals to communicate in the 2.4GHz frequency band, which can meet the wireless communication needs in different scenarios. In addition, Zigbee also provides a complete set of communication protocols, including application layer, network layer and media access control layer, to realize a variety of different application scenarios. In general, Zigbee communication technology provides an efficient and reliable communication method for IoT applications. Zigbee supports a variety of network topologies, including star, tree, mesh structures, etc. Its architecture block diagram is shown in Figure 3 [5].

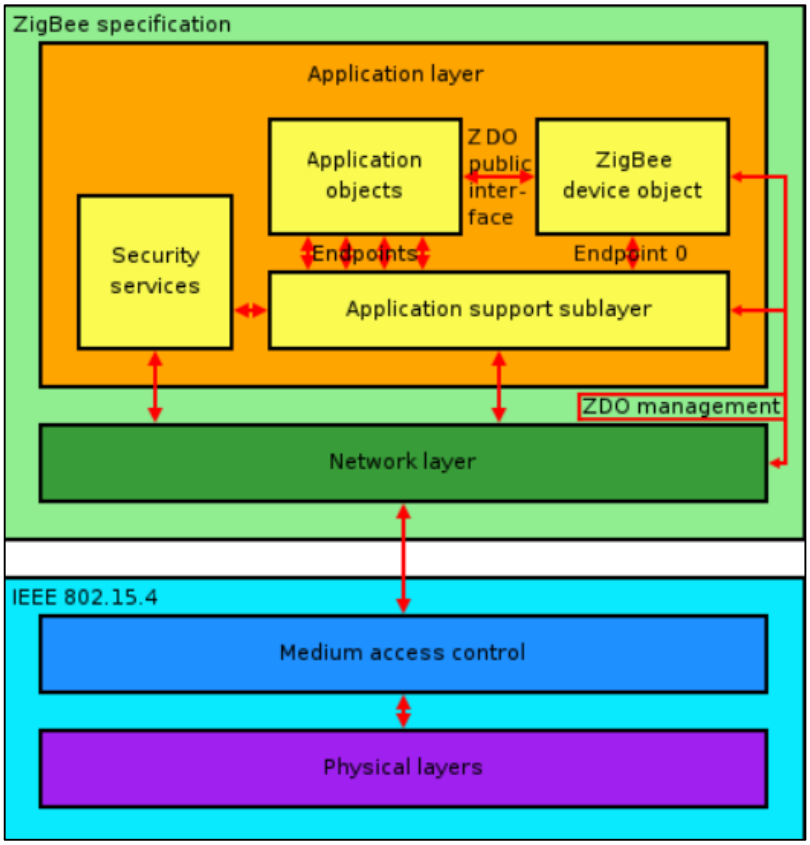

Fig 3: Zigbee architecture diagram [5]

Based on the above description, we can use Zigbee module for application design. This article first uses a simple single-point transmission at both ends to verify the correctness of the program code and the practicality of the theory. The chip motherboard produced by Tesas Instruments (TI) is used in conjunction with the backplane produced by Anderlan. One end forms the terminal and the other end forms the host [6, 7]. Since one of the two motherboards serves as a terminal and the other serves as a host, the host can control and receive data sent by the remote terminal sensor and perform necessary control and management. First, we use two motherboards to write programs, convert the programs into machine code, and then burn the terminal and coordinator program codes respectively. Then write a program to let the host collect the terminal's wireless transmission through Zigbee, convert the terminal's information sensor data, including gas sensors, into information displayed on the computer screen, and then return the control signal for the terminal's relay, complete Switching actions of various electromechanical equipment such as fans. At the same time, we can also install the written App on the mobile phone, and then we can use the mobile phone to connect to the coordinator through WiFi to achieve the purpose of mobile remote monitoring of the environment. The actual installation experiment is shown in Figure 4.

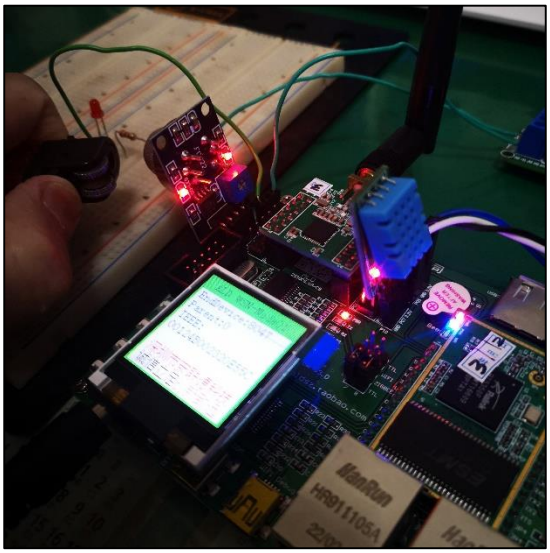

Fig 4: Experimental result of MQ-2 gas sensor

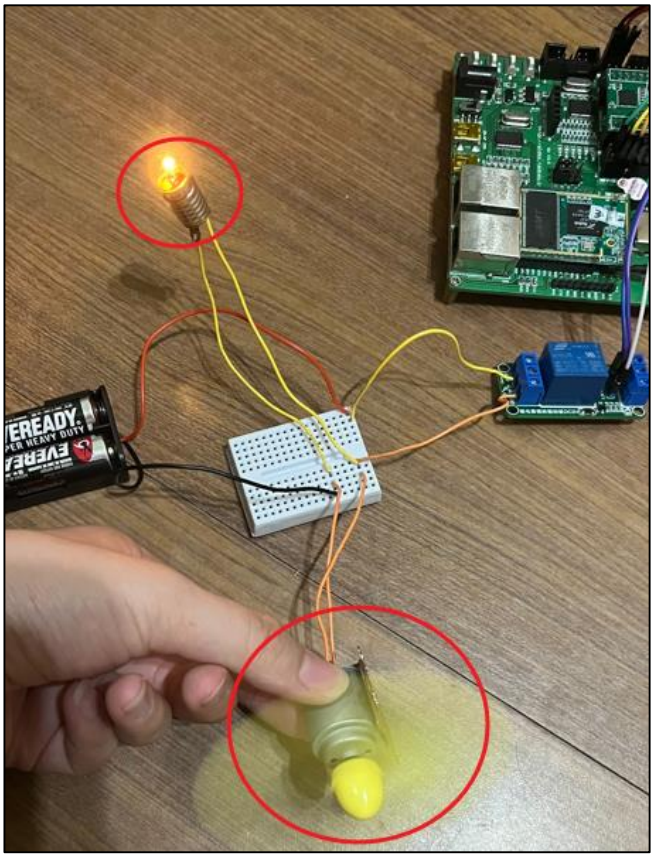

Fig 5: Experimental diagram of using relay to control fan and light

3. Conclusion

The methods and experiments proposed in this article prove that using Zigbee combined with relay, MQ-2 sensor and other technologies can realize various applications of gas disaster prevention, such as environmental monitoring, gas monitoring, etc., improving the efficiency and safety of disaster management. Through these technologies, in the event of a disaster, early warning and preliminary crisis elimination can be provided, remote monitoring and automatic control can be achieved, and property losses and casualties caused by disasters can be reduced. Experimental results show that such a design concept can be realized and has good results.

4. References

[1]. Smith JR, Johnson AB. Zigbee Wireless Sensor Networks. IEEE Communications Magazine. 2007; 45(4):71-77.

[2]. Brown ML, Davis CR. Applications of MQ-2 Gas Sensors in Environmental Monitoring. IEEE Sensors Journal. 2015; 15(3):1424-1432.

[3]. Chen X, Li L, Zhang Q. Relay-Assisted Communication for Internet of Things. IEEE Internet of Things Journal. 2018; 5(2):405-413.

[4]. Liu Y, Zhang J, Zhang Y. Internet of Things-Based Early Warning System for Disaster Prevention and Mitigation. IEEE Transactions on Industrial Informatics. 2019; 15(4):2439-2446.

[5]. https://commons.wikimedia.org/wiki/File:ZigBee_protocol_stack.png

[6]. 2.4GHz IEEE 802.15.4 and ZigBee® applications CC253X System-on-Chip Solutions User Manual, Texas Instruments, U.S.A. SWRU191, April 2009.

[7]. ZigBee Management System Manual-V2, Anlander Technology Co., Ltd., China, 2019.