International Journal of Engineering and Computer Science Applications (IJECSA)
Vol. 1, No. 1, March 2022, pp. 19∼26
ISSN: 2828-5611
DOI: 10.30812/IJECSA.v1i1.1698

Plume Detection System Based on Internet of Things

I Nyoman Susila Astraning Utama, Sirojul Hadi, I Putu Hariyadi
Universitas Bumigora, Mataram, Indonesia

Article Info

Article history:

Received January 17, 2022
Revised January 26, 2022
Accepted February 01, 2022

Keywords:

Plume Detection
Gas Leak
Internet of Things
LPG Gas
Alcohol Evaporated Gas

ABSTRACT

Security is one of the important aspects in a system or environment. Residential, office, tourist and industrial areas are places that are prone to fires because they contain flammable objects. Slow handling when a gas leak occurs can trigger a fire. The solution that can be used to minimize the occurrence of fires is to build tools that work to monitor the condition of the room or environment that is prone to leakage of gas or other flammable liquids. The design and manufacture of a system to detect LPG and alcohol gas leaks can be useful for providing information in the event of a gas or alcohol leak so that it can be handled quickly and minimize fire damage. This system combines an plume detection system with an internet of things system so that it can provide information when a gas or flammable liquid leak occurs. The gas leak information is sent as a notification to the telegram from the operator. The design and manufacture of this system uses the Waterfall methodology with the following stages: analyzing (covering the need for system creation), system design (including designing electronic circuits and web monitoring interfaces), implementing system design and testing the system as a whole. The result of this research is that an electronic detection system has been successfully built that can distinguish gases and can provide information via telegram and web if gas is detected in the sensor environment. In the LPG gas leak test, the results show that the characteristics of LPG gas, namely the sensor output voltage, have an average of 4.17 volts with an average Part Per Million (PPM) of 8340 and the characteristics of alcohol gas, namely the sensor output voltage, have an average of 0, 13 volts with an average Part Per Million (PPM) of 254.

Corresponding Author:

Sirojul Hadi,
Universitas Bumigora, Mataram, Indonesia.
Email: sirojulhadi@universitasbumigora.ac.id

How to Cite: I. N. S. A. Utama, S. Hadi, and I. P. Hariyadi, ”Plume Detection System Based on Internet of Things,” *International Journal of Engineering and Computer Science Applications (IJECSA)*, vol. 1, no. 1, pp. 19-26, Mar. 2022. doi: 10.30812/ijecsa.v1i1.1698.

1. INTRODUCTION

Security is one of the important aspects in a system or environment, whether residential, office, tourist attractions, shopping centers or places prone to fire. Fires often occur due to human negligence caused by several factors, such as small or large leakage of Liquid Petroleum Gas (LPG) gas cylinders, due to carelessly discarded cigarette butts, short circuits of electric current that cause fires and spread to other parts. Fires certainly harm many parties both morally and materially, and not a few also cause death [1, 2]. One of the mechanisms that can be used to reduce the occurrence of these fires is to create a tool that functions to monitor or monitor the condition of leaks of gas or other flammable liquids. The monitoring system is a system that carries out a continuous monitoring process [3]. A monitoring system is needed in the process of monitoring the state of an object being observed in order to obtain timely information. Odors generated by gases detected by smell that produce odors that can be recognized by gas sensors [4–6].

Various studies have been carried out by researchers on gas leak monitoring systems. Rimbawati and team [7] have succeeded in making a gas leak detector using the MQ-6 sensor to overcome fire hazards. This tool can provide warnings in the form of alarms and LEDs that light up when the output voltage on the sensor exceeds 13 milli Volts. Meanwhile, Hidayat and team [8] have succeeded in making a gas leak detection system using an MQ-6 sensor based on a wireless sensor network. When the MQ-6 sensor detects LPG gas, the sensor will send a notification message to the user's cellphone. In addition, Kridalaksana and team [9] have succeeded in designing an LPG gas leak detector with an MQ-6 sensor via Android as an information medium. The design of the tool made can transmit gas analog data information to an android smartphone via the Internet.

Based on previous research, an plume detection system was built that can distinguish types of gas and can provide notifications to users when a gas leak occurs via telegram. users can also monitor the sensor environment through the website as a medium of information. This system is designed using the IoT NodeMCU ESP-8266 Module which allows the device to be connected to the Internet network. The sensor used is the MQ-2 gas sensor which functions to detect gas leaks, including hydrogen gas, LPG, methane, and alcohol. Notification of gas leaks can be used as a preventive measure so as to minimize the occurrence of gas leaks.

2. RESEARCH METHOD

The research methodology used in this study is the waterfall method. The waterfall method is a method commonly used in system design. The waterfall method is a method that has steps in making the system sequentially or linearly [10]. The stages contained in the waterfall method can be shown in Figure 1.

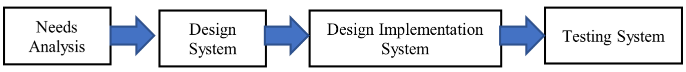

Figure 1. Waterfall method

2.1. Network Design System

Network design serves to determine the path of data transmission from the plume detection system to web monitoring and telegram. Plume detection system will be assigned an IP address as an identifier of the system to connect to the internet and connect to the interface of the system.

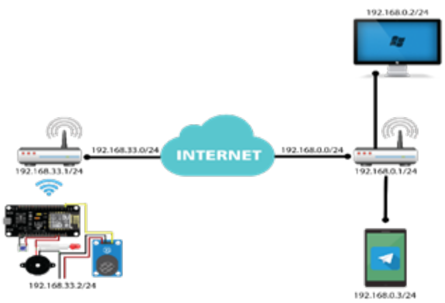

Figure 2. Network design

2.2. IP Address System

In the IP addressing design of the plume detection system, there are two class C network addresses used, namely 192.168.1.0/24 and 192.168.43.0/24. Details of IP allocation per network device are shown in Table 1.

Table 1. TCP/IP Addressing Design

No	Device Name	IP Address	Subnetmask
1	Router 1	192.168.1.1	255.255.255.0
2	Router 2	192.168.43.1	255.255.255.0
3	Electronics Circuit	192.168.43.10	255.255.255.0
4	Personal PC/Laptop	192.168.1.9	255.255.255.0
5	Smartphone	192.168.1.4	255.255.255.0

2.3. Hardware Design

The hardware design of the plume detection system consists of several components consisting of a power supply, sensors, and microcontroller. The hardware circuit can be shown in Figure 3.

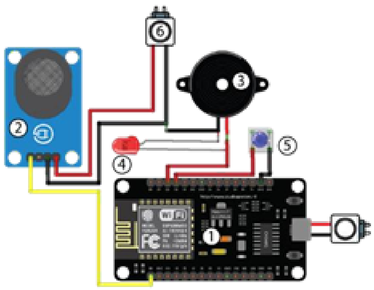

Figure 3. The hardware circuit design

Based on Figure 3, the components used in hardware design are as follows:

1. Microcontroller NodeMCU ESP8266
2. Gas Sensors MQ-2
3. Buzzer
4. LEDs 5mm
5. Push button
6. Power supply

2.4. Software Design

In the plume detection system using software. This system uses a database running on the hosting as well as the PHP programming language to create websites and the C programming language to program NodeMCU. The designs carried out are:

1. Database design

The database used in the development of this plume detection system based IoT uses MySQL. In the database design, 1 master table will be used to build a plume detection system.

2. Gas attribute table

The Gas Table is used to hold all the data from the MQ-2 sensor which is sent through the NodeMCU. In the gas table there are attributes such as no, Ldr, Time and Telegram.

Table 2. Gas Attribute

No.	Attribute name	Type	Size	Description
1	no(*)	Integer	10	Identitas data
2	Ldr	Integer	10	ADC data sensor
3	Time	Timestamp	-	Time of data entered
4	Telegram	Integer	1	Telegram Notification

3. Web Monitoring Design

The web interface is required to view the parameters that have been reported by the MQ-2 sensor via the NodeMCU to the database.

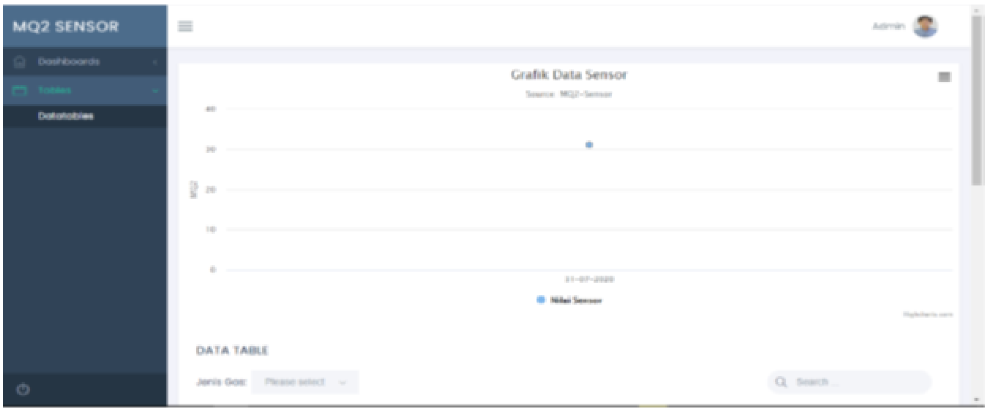

Figure 4. Web monitoring design

3. RESULT AND ANALYSIS

Based on system design. The results of the implementation of hardware that functions as a plume detection system can be shown in Figure 5.

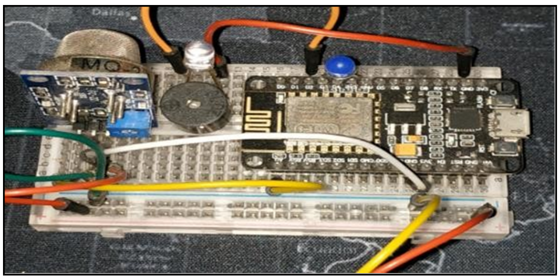

Figure 5. Hardware plume detection system

The circuit is a hardware prototype that was built. The main controller in the circuit is the IoT module nodeMCUESP8266. The gas sensor used to detect plume gas is the MQ-2 sensor which is sensitive to LPG, methane, smoke, alcohol and other gases.

3.1. Web Interface Result

The web interface functions so that users can monitor places that are prone to gas leaks and can distinguish types of gas. Plume gas detection can be used as a reference for taking preventive decisions or actions to prevent further damage due to gas leaks.

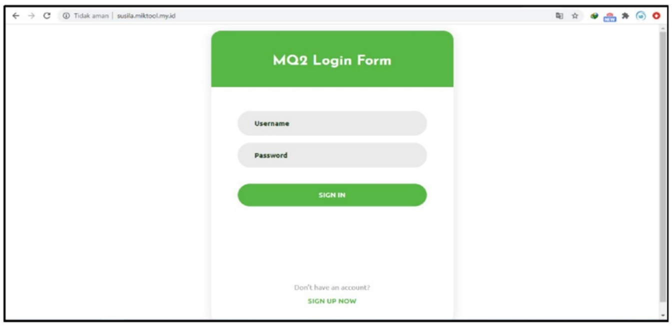

Figure 6. Login form

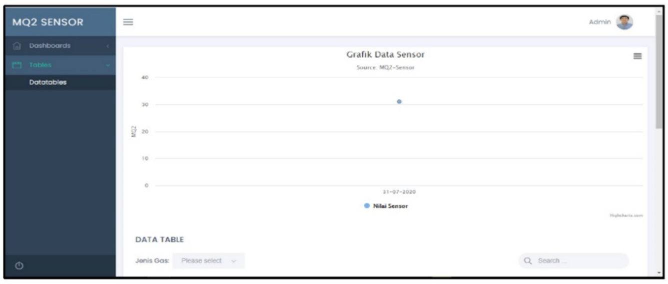

Figure 7. Main menu

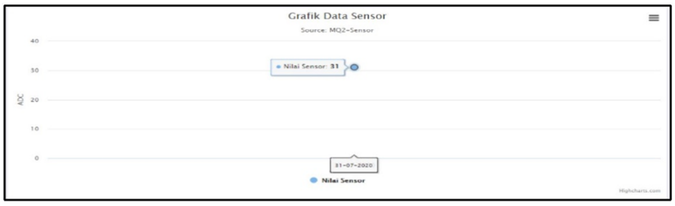

Figure 8. Sensor graphics

Figure 9. Data table

The Web interface consists of several menus, namely the login menu as shown in Figure 6 which functions as security which can only be accessed by the admin. The main menu display is as shown in Figure 7. On the web there is also a graphical menu and table data as shown in Figure 8 and Figure 9 which functions to monitor gas leak data.

3.2. Testing Result

System testing was carried out on two types of gas, namely LPG gas and gas that was evaporated from alcohol. The test was carried out 6 times and the distance between the plume detection system and the gas source was 20 cm. Plume detection result data will be sent to web monitoring and telegram. In order to be able to send data through the internet network, the plume detection system must first be connected to the WiFi router. The system can be connected to the internet can be shown in Figure 10.

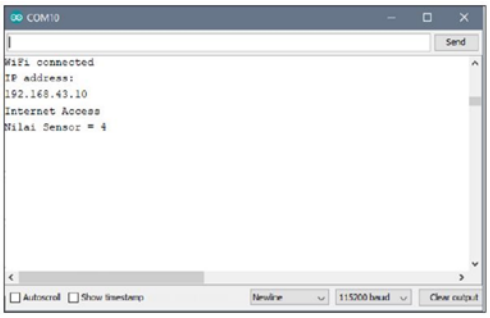

Figure 10. The results of the plume detection system are connected to the internet

1. LPG Testing Result

The experimental scenario carried out is that data is taken every 30 seconds by the plume detection system and then the data is sent to web monitoring and telegram as notification of gas leaks. The experimental scenario can be shown in Figure 10. The test results of the plume detection system for LPG gas can be shown in Table 3.

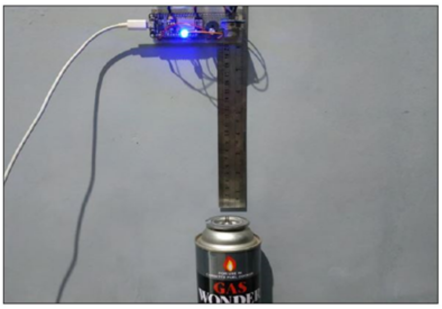

Figure 11. Experimental scenario on LPG gas

Table 3. LPG gas test results

Testing	ADC value	Output voltage sensor (volt)	PPM
1	800	3,91	7813
2	1024	5,00	10000
3	750	3,66	7324
4	950	4,64	9277
5	680	3,32	6641
6	920	4,49	8984
Average	854	4,17	8340

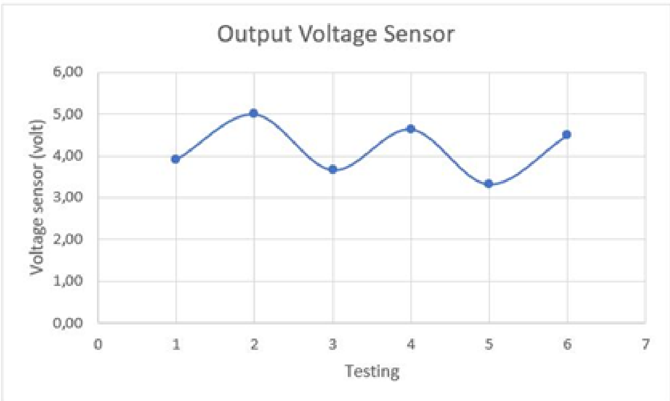

Figure 12. Sensor output voltage for LPG gas

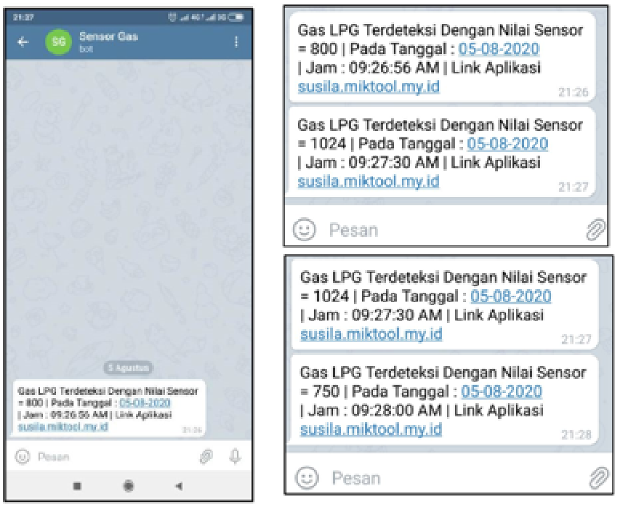

Figure 13. Telegram notification for LPG gas

Based on the results of the tests that have been carried out, it is found that LPG gas can be recognized and detected by the plume detection system. Characteristics of LPG gas captured by the gas sensor, namely the sensor output voltage has an average of 4.17 volts with an average Part Per Million (PPM) of 8340. Test result data can also be sent to the web and telegram.

2. Alcohol Testing Result

The experimental scenario carried out is that alcohol data is taken every 30 seconds by the plume detection system and then the data is sent to web monitoring and telegram as notification of gas leaks. The experimental scenario can be shown in Figure 14. The test results of the plume detection system for the alcohol evaporated gas can be shown in Table 4.

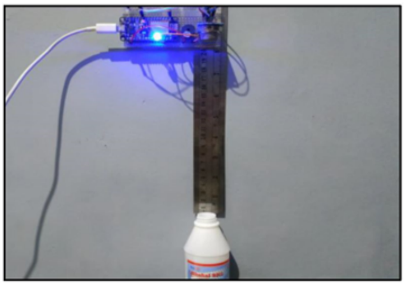

Figure 14. Experimental scenario on evaporation of alcohol gas

Table 4. Test results for the gas from the evaporation of alcohol

Testing	ADC value	Output voltage sensor (volt)	PPM
1	23	0,11	225
2	26	0,13	254
3	26	0,13	254
4	27	0,13	264
5	27	0,13	264
6	27	0,13	264
Average	26	0,13	254

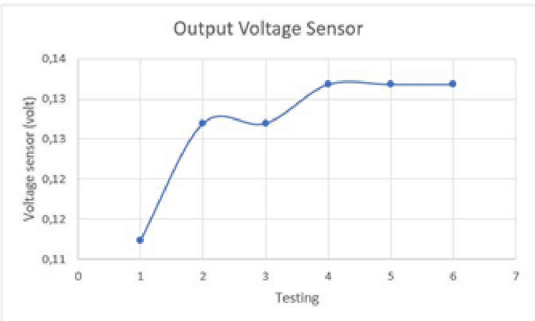

Figure 15. Sensor output voltage for alcohol gas

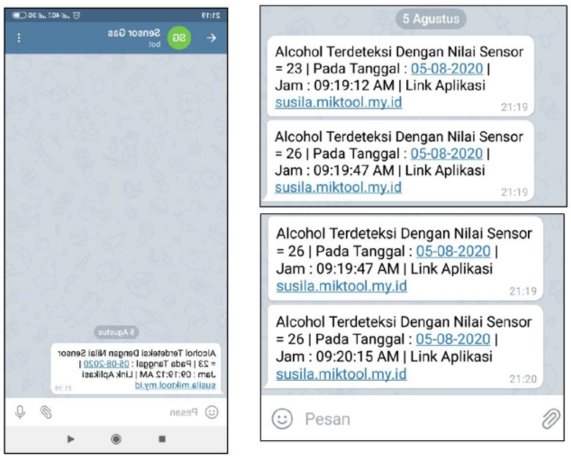

Figure 16. Telegram notification for alcohol gas

Based on the results of the tests that have been carried out, it is found that alcohol gas can be recognized and detected by the plume detection system. The characteristic of alcohol gas captured by the gas sensor is that the sensor output voltage has an average of 0.13 volts with an average Part Per Million (PPM) of 254. The test result data can also be sent to the web and telegram.

4. CONCLUSION

Based on the results of the design and testing that has been done, it is found that the plume detection system has been successfully built. The system has succeeded in distinguishing two types of gas, namely LPG gas and gas from the evaporation of alcohol. In order to make it easier for users to monitor gas leaks, the web interface and Telegram notification bot have been successfully built. In the LPG gas leak test, the results show that the characteristics of LPG gas, namely the sensor output voltage, have an average of 4.17 volts with an average Part Per Million (PPM) of 8340 and the characteristics of alcohol gas, namely the sensor output voltage, have an average of 0, 13 volts with an average Part Per Million (PPM) of 254. Suggestions for further development are to increase the gas sensor used so that it can distinguish other types of gas and build an android-based interface.

5. ACKNOWLEDGEMENTS

We would like to thank those who have supported this research.

6. DECLARATIONS

AUTHOR CONTIBUTION

All authors contributed to the writing of this article.

FUNDING STATEMENT

-

COMPETING INTEREST

The authors declare no conflict of interest in this article.

REFERENCES

[1] D. D. Hutagalung, "Rancang Bangun Alat Pendeteksi Kebocoran Gas dan Api dengan Menggunakan Sensor MQ-2 dan Flame Detector," *Jurnal Rekayasa Informasi*, vol. 7, no. 2, p. 127, 2018.

[2] S. Hadi and A. Adil, "Rancang Bangun Pendeteksi Gas Berbasis Sensor MQ-2," *Seminar Nasional Sistem Informasi dan Teknik Informatika (SENSITIF 2019)*, pp. 327–334, 2020.

[3] Mudjahidin and N. D. P. Putra, "Rancang Bangun Sistem Informasi Monitoring Perkembangan Proyek Berbasis Web," *Jurnal Teknik Industri*, vol. 11, no. 1, p. 75, 2012.

[4] M. Rivai, D. Purwanto, H. Juwono, and H. A. Sujono, "Electronic nose using gas chromatography column and quartz crystal microbalance," *Telkomnika*, vol. 9, no. 2, pp. 319–326, 2011.

[5] H. Widyantara, M. Rivai, and D. Purwanto, "Implementation Analog Neural Network for Electronic Nose using Field Programable Analog Arrays (FPAA)," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 2, no. 6, 2012.

[6] S. T. Radi, S. Ciptohadijoyo, W. S. Litananda, M. Rivai, and M. H. Purnomo, "Electronic nose based on partition column integrated with gas sensor for fruit identification and classification," *Computers and Electronics in Agriculture*, vol. 121, pp. 429–435, 2016.

[7] Rimbawati, H. Setiadi, R. Ananda, and M. Ardiansyah, "Perancangan Alat Pendeteksi Kebocoran Tabung Gas LPG Dengan Menggunakan Sensor MQ-6 Untuk Mengatasi Bahaya Kebakaran," *Journal of Electrical Technology*, vol. 4, no. 2, pp. 53–58, 2019.

[8] I. Hidayat, "Sistem Pendeteksi Kebocoran Gas Menggunakan Sensor MQ-6 Berbasis Jaringan Sensor Wireless," *Techno.Com*, vol. 17, no. 4, pp. 355–364, 2018.

[9] M. F. Putra, A. H. Kridalaksana, and Z. Arifin, "Rancang Bangun Alat Pendeteksi Kebocoran Gas LPG Dengan Sensor Mq-6 Berbasis Mikrokontroler Melalui Smartphone Android Sebagai Media Informasi," *Informatika Mulawarman : Jurnal Ilmiah Ilmu Komputer*, vol. 12, no. 1, p. 1, 2017.

[10] D. Sudrajat, M. Achdisty, N. Kurniasih, Roslina, Parwito, S. Mulyati, A. Purnomo, and S. Sallu, "The Implementation of Innovation in Educational Technology to Improve the Quality of Website Learning in Industrial Revolution Era 4.0 Using Waterfall Method," *Journal of Physics: Conference Series*, vol. 1364, no. 1, pp. 0–6, 2019.