Pakistan Journal of Engineering Technology and Science (PJETS)
Volume 13. Issue.1, PP. 69-77, JUNE 2025
https://doi.org/10.22555/10.22555/pjets.v13i1.1278
E-ISSN 2224-2333
P-ISSN 2222-9930

Development of Automated Fire Control System: An Integrated Solution for Gas, Fire, and Smoke Detection

Shujaat Ali[1], Syed Saad Ali[2], Sajjad Ali[3], Asad A. Zaidi[4], Ahsan Zafar[5], Saqib Munawwar[6], Muhammad Shafique[7]

[1]Scholar, Tianjin University, School of Electrical and Information Engineering, Tianjin-China
[2] Lecturer, Nazeer Hussain University, Department of Electrical Engineering, Pakistan
[3]Scholar, Nazeer Hussain University, Department of Electrical Engineering, Pakistan
[4]Associate Professor, Islamic University of Madinah, Department of Mechanical Engineering, Saudi Arabia
[5]Scholar, Tianjin University, School of Electrical and Information Engineering, Tianjin-China
[6]Assistant Professor, Nazeer Hussain University, Department of Electrical Engineering, Pakistan
[7]Lecturer, Nazeer Hussain University, Department of Computer Science, Karachi-Pakistan
[*]Corresponding Author: Syed Saad Ali, saad.ali@nhu.edu.pk

Abstract:

The major shortcomings of gas, fire, and smoke detection must be addressed to prevent accidents. Gas leaks, fires, and smoke-related incidents pose a significant threat to the country. The main objective of this prototype is to develop a system that detects, manages, and issues immediate alerts for gas leaks, fires, and smoke, thus enabling swift responses to mitigate potential harm. This prototype highlights the importance of household safety by developing an integrated system to detect, control, and manage gas, fire, and smoke incidents. Conventional systems often lack the necessary automation and speed required for effective emergency responses. This project addresses the critical need to automate the detection and control of such dangers. Gas leaks and fires can lead to rapid and severe damage, highlighting the importance of rapid detection and response. This project utilizes an advanced methodology that integrates gas sensors, flame sensors, smoke sensors, and automated control mechanisms. The system automatically secures a leak of gas utilized in cylinders or pipes. For fires, it deploys water sprinklers to suppress flames, whereas fans automatically clear smoke. The implementation of an Arduino-based system automatically controls the system. Flame, gas, and smoke sensors were integrated with the Arduino to control and manage the system. Sensors and Arduino mathematical calculations were also monitored. This prototype is designed to monitor detection over a 100 cm span. Inspired by the latest technologies, this prototype addresses the critical need for household safety by automating the detection, control, and management of gas, fire, and smoke incidents.

Keywords: *Real-time fire smoke detection, technology, microcontroller, prototype, development, monitoring, and controlling.*

I. INTRODUCTION

The global challenge of gas leakage is a major cause of fires. In this study, a robotic gas and fire detection scheme was designed for flame extinguishers. In this study, the MQ2 sensor was used for smoke, gas, and fire detection. An ultrasonic sensor was installed in the robotic system to detect barriers for efficient operation. The microcontroller is integrated with the system to operate the actions of the water sprayer to stop the fire [1]. Innovation in technology and electronics contributes to improving fire detection systems. This study investigates technological innovation in sensor design and fire data control, and demonstrates the fire parameters to be extinguished. This study addressed several issues encountered during fire detection [2]. The fire, smoke, and gas avoidance system construction is considered to proficiently sense gas leaks and fires using gas and flame sensors. The gas leaks sense and switches off the gas supply and opens the exhaust to suck the gas and send messages to users via the global system for mobile communication technology. This technology was inspired by the Internet of Things-based technologies to provide real-time parameters [3]. Smoke sensors are a major global issue of increasing accuracy, sensitivity, and efficiency. Innovation in the mechanism of smoke detection is considered in this study. This experimental study examined the efficiency of smoke atoms fluctuating from 0 to 10% at concentrations of 2–5 parts per million [4]. This study demonstrates the design of a

model-based project for flame detection to secure the lives of humans. This system demonstrated fire parameters without any delay. By implementing innovative methodologies, the protection of human beings has increased in the face of disasters. The application of this modern prototype promotes life security for domestic and industrial implementations [5]. This study focuses on an Internet of Things (IoT)-based smoke detection system to ensure fire security and facilitate real-time parameters for sensing smoke. The sensors were employed with a wireless communication network to communicate with cloud-based servers, and instant notice and alert generation were considered during the design of the prototype. The objective of this study was to determine fire safety algorithms and enhance the efficiency of domestic and commercial applications [6]. An appropriate fire detection system is often a major global problem. This study addresses a solution for fire detection using a programmable logic controller. The controller robotically managed the operation. Two smoke sensors and one heat sensor were integrated with a controller to detect and communicate [7]. Indonesia has the third highest number of smokers worldwide. This study aimed to design an automatic cigarette smoke detection system to control air cleanliness. The microcontroller UNO was integrated with an MQ-135 sensor for smoke and a TA12-100 sensor to calculate the energy consumption and exhaust fan automatic switches to remove smoke [8]. This study provides an innovative IoT-based solution for anti-theft and fire detection in houses. The motive of this system is to detect fires and theft in a single system. The smart system is integrated with a wireless communication system to transmit data [9]. The major problem worldwide is the rapid detection of fire. The use of innovative IoT-based technologies using ESP32 Arduino Mega, along with sensors and IoT technologies for data monitoring and control via the cloud. The sensor includes an MQ for gas and smoke data collection and transmits fire data to the cloud [10]. The latest smoke detection system accuracy and efficient operation were considered in this study to detect particles ranging from 0 to 10%. This system detects dust particles of different sizes for measurement [11]. Fire damages and breaks people's lives and things. Conventional fire alarms produce noise without indication. The smart Arduino demonstrates real-time parameters and location detection through an alert system. The development of an effective fire detection system is considered in this study [12]. The major concerns of the industry are security and robotics. This study considered industrial robotics and security systems for industrial applications. The prototype considers IoT technologies integrated with Node MCU and sensors, and data transmitted via IoT technologies using a Wi-Fi module to switch the water sprinkler and alarm to alert [13]. Fast detection and notification save lives. Internet-based technologies are deployed for information collected from sensors via an Arduino. Different sensors sense flame and gas particles. The main objective of this study was to construct a sprinkler-based system for spraying water after smoke detection [14]. This study aims to design a smoke detection system installed on distribution panels and provide an optimal solution. The samples were taken from four smoke detectors, demonstrating that the carbon concentration increased when installed on the left or right side of the exhaust system [15]. This study provides an economical solution for automatic fire detection and quenching schemes utilizing a programmable logic controller. The heat and smoke detection control temperature and smoke increased during fire events. The signals are transmitted to the controller, which energizes the solenoid valve to release the rising pressure of carbon dioxide to quench the fire [16]. Failure of safety equipment is a key problem worldwide for human life and property security. This study demonstrates the latest innovations related to the safety of fire events. Thus, there is a need to implement an emerging response scheme to prevent and monitor fires [17]. This study focuses on the response and operation of photoelectric smoke detectors compared with conventional systems. Simulation-based studies compared the measured real smoke parameters at six sites. The outcome shows that the conventional smoke detectors need 7.42 min while analogue detectors need 11.57 min [18]. Internet of Things (IoT)-based systems are rapidly being integrated with sensors and web applications. The remote control of industrial applications is one of the biggest challenges in detecting gas leakage. In this study, the industrial application of the MQ-2 sensor integrated with an Arduino WSP32 module was considered. IoT-based gas detection and smart notifications use sensing data to diminish possible hazards. The prototype is capable of robotically optimizing the system [19]. Internet of Things (IoT) technology is rapidly growing worldwide. IoT methods forecast future device malfunctions. The main goal of this study is to design a system inspired by robotic technology. Remote access plays a vital role in the smart management of devices. This study focuses on an IoT-based intelligent home automated scheme using different modules and sensors for the domestic control of fire and smoke. Immediate identification and solutions are considered in this study to notify the user via the smart mobile application Blynk [20]. The utilization of Internet of Things-based fire detection and alarms has increased quickly because of remote access and control. Thus, reliable and efficient alarm detection systems must be deployed. This study investigated fire incidents and alarms over five years. Fuzzy logic system for identifying fire signal arrangement.

The study outcome found an approximately 80% increase in the implementation of the system over five years [21]. This study focuses on Rwanda, and East Africa considers that unexpected fires cause human damage. The real Internet of Thing-based modern technologies were implemented in the ESP-8266 module integrated with flame, gas, and temperature sensors to automatically locate the fire site. The Blynk application provides cloud server monitoring and control to protect selected areas from flame and gas [22]. Conventional fire-detection systems require human interaction to handle fire accidents after alarm situations. To address these boundaries, an automation-based system was considered in this study, and a design system utilizing Raspberry Pi-based technologies integrated with various sensors, including a DHT 11 temperature sensor, an IR flame sensor, and an MQ-2 smoke sensor. These sensors were controlled by a Python programming-based controller to provide immediate, real-time detection and alerts. The system IoT framework uses the Blynk application to allow the control of parameters using cloud services. This system can be implemented in domestic and industrial utilization [23]. Fire is a natural process that may occur wherever and at any moment owing to an incident. This study aims to develop a quick fire-detection scheme for house monitoring using sensors. Some sensors were integrated with an Arduino microcontroller with a Node MCU ESP8266 [24]. Gas leakage is a global concern for emerging countries, especially Bangladesh. Many people have lost their lives due to fire incidents. Gas leakages and explosions damage the climate. This work provides a prototype solution to detect gas leakage and fire using Internet of Things-based technologies. The main aim is to minimize the gas leak, close the solenoid valve, and initiate the fan to remove smoke. The flame sensor detects the fire, the and sucker drops the fire extinguisher material into the fire. The Global System for Mobile Communications network module notifies the user. The buzzer energizes, and the LCD demonstrates the parameters. This study provides an economical solution for detecting gas leaks and fire [25]. Global fuel demand is increasing daily. Natural gas and liquefied petroleum gas are mostly utilized as fuels in kitchens. Gas cylinder blast is sometimes due to gas leakage, and to avoid this case, this study provides Internet of Things-based technologies to detect gas and provide alerts for emergency control. This system automatically detects gas leakage to protect the cylinders from the blast [26]. A delay in fire incidents can increase the life of materials. The motive for this study was to design a project that quickly notifies users. The house fire detection system determines room and gas levels. The sensors were tested at various locations to analyze the temperature and room gas leakage. [27]. Gas cylinders and explosions caused by leakage are major problems worldwide. The traditional leakage detection system uses alarms for warning, while this study focuses on the Global System for Mobile Communications network technology to inform users via a short message service. This system is equipped with a gas and flame sensor to identify fires and explosions. An exhaust fan was installed at the site to remove the leaked gas, and the solenoid valve opened the water. The project was designed using liquefied petroleum gas [28]. Current innovations and technical advancements improve safety and security. Daily cooking fuel gas leakage occurs, and incidents become uncontrollable if rapid action is not taken. This study aimed to demonstrate a detection system for domestic applications. The MQ2 gas sensor was integrated with a controller to notify users via an SMS [29]. This intelligent system motivates the design of a gas, smoke, fire, and motion detector with an SMS alarm. The system uses a smoke sensor for fire detection and motion sensors for security purposes on domestic premises [30].

II. MATERIALS AND METHODS

A. Components

The components used in the prototype are as follows:

Microcontroller: Arduino UNO Atmega328 represents a microcontroller board rooted in an open-source electronic design. The primary component of the prototype is the Arduino, which controls the operation of the entire system as shown in Figure 1 and Table 1.

Figure 1: Arduino UNO

Table 1: Arduino UNO specifications

S.No	Description	Specification
1.	Operating Voltage	5 volts
2.	Input Voltage Range	7 - 12 volts
3.	Flash Memory	32 KB
4.	Clock Speed	16 MHz

Flame Sensor: The hardware setup used a flame sensor, which is a critical component designed to detect and respond to potential fire hazards. Therefore, as shown in Figure 2 and Table 2, it is imperative to position the sensor at an optimal distance.

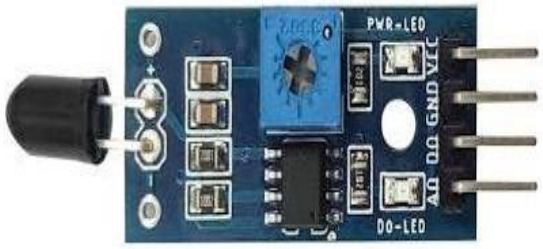

Figure 2: Flame sensor

Table 2: Flame Sensor Specifications

S.No	Pin Name	Specifications
1.	Vcc	Power supply (+5V)
2.	GND	Connected to the ground of the DC supply
3.	D0	0~5V Digital output to microcontroller
4.	A0	0~5V Analog output to microcontroller

MQ-2 Sensor: The implementation of the MQ-2 sensor (as shown in Table 3 and Figure 3) is a pivotal element in the hardware configuration of this project. This sensor operates under specific technical specifications and offers multi-faceted functionality, making it suitable for detecting various gases and smoke.

Table 3: MQ-2 Sensors Specifications

S.No	Pin Name	Specifications
5.	Vcc	Power supply (+5V)
6.	Ground	Connected to ground of DC supply
7.	Digital out	0~5V Digital output to micro-controller
8.	Analog	0~5V Analog output to micro-controller

Figure 3: MQ-2 sensor

Solenoid Valve: A Solenoid Valve is an electromechanical device designed for the precise control and regulation of fluid or gas flow within a system. It operates based on the principle of using an electromagnetic coil to actuate a plunger or piston, which in turn opens or closes a valve orifice, thereby governing the flow of the medium through the valve.

B. Methodology

This system is a model for comprehensive gas leakage, fire, and smoke detection and management. The system integrates development, comprising sensors and detectors, microcontroller technology, and a control system, to enhance the detection and management of gas, fire, and smoke. The main control mechanisms of the prototype depend on the controller. The controller was integrated with fire, gas, and smoke sensors to manage the system operation. The LCD demonstrates the parameters, and the buzzer energizes when detecting the incident. Upon gas leakage, the solenoid valve operates and shuts down the gas, and the fire water sprinkler detects the temperature rise. It automatically provides a sufficient amount of water for fire suppression linked to Analog Pin A2 of the Arduino module, and upon the detection of smoke, the exhaust fan starts and removes the smoke from the sensing area. The solenoid valve, which is essential for controlling the gas flow and preventing leakage, is precisely connected to Digital Pin 3 on the Arduino module. The water sprinkler deployed for fire suppression was intricately connected to Digital Pin 5 on the Arduino module. The buzzer was linked to Digital Pin 6 on the Arduino module. Figure 4 shows the hardware flow of the designed experimental setup and is further elaborated in Figures 5,6 and7.

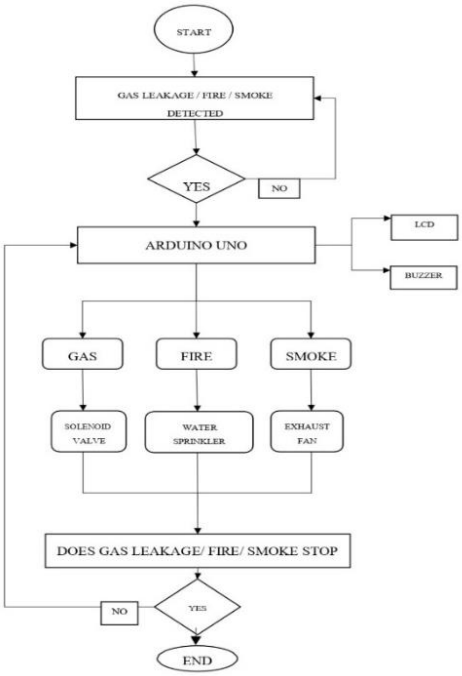

Figure 4: Hardware flow of the Automated gas, fire, and smoke detection control and protection system

Figure 5: Experimental Setup

Figure 6: Fire Detection

Figure 7: Gas Detection

***Software Setup*:** The following method was used for the software implementation of gas, fire, smoke detection, control, and management systems using Arduino UNO:

Main Program Logic:

The crux of the gas, fire, and smoke detection system's functionality resides within the `loop()` function. The code structure is described as follows:

void setup() {
// Initialization of sensors, components, and communication }
void loop() {
// Read data from sensors
// Process sensor data for detection and analysis
// Control actuators based on sensor data and system logic
// Display information on output devices (e.g., LCD)
// Implement alarms, notifications, and safety protocols
}

To acquire data from gas sensors, fire detectors, smoke detectors, and other pertinent sensors, pertinent sensor libraries and functions are utilized.

***Mathematical calculation*:**

Current calculation of the exhaust fan

P = V x I -------- (i)
P is the output in watts.
V is the voltage.
I currently go through the fan.
Voltage = 12 V
P= 4.8 watt
Now, solve for I

$$I = \frac{4.8\ W}{12V}$$

I = 0.4 A -------- (ii)

III. RESULTS AND DISCUSSION

In the result phase, the microcontroller, fire, smoke, and gas sensors operate experientially. The prototype works proficiently and efficiently to manage the flow and experimental setup. This prototype is an economical and efficient solution tailored to household applications. This stands out as a cost-effective endeavor, featuring an intuitive user interface designed to meet the needs of individuals. This innovative system contributes to user control over the presence of gas leaks, fires, and smoke within the premises. This system holds promise for scalability and commercialization, with the potential to evolve into a comprehensive Home Automation System. The main goal of this system is to develop a system that can quickly and accurately detect and manage potentially hazardous situations involving gas leakages, fires, and smoke. This system achieves this strategy by employing hardware components, making the system accessible to a wide range of users. A key advantage of this system is its ability to provide real-time feedback through visual indicators. The activation of red LEDs and audible alarms promptly alerts users to the presence of gas leakages, fires, or smoke. In addition, an LCD screen displays the concentration levels of these hazards, thereby enhancing situational awareness. Moreover, this system goes beyond detection by enabling control mechanisms including solenoid valve operation, water sprinklers, and exhaust fan control. This holistic approach enhances safety measures in home and industrial settings.

A. Compile results: Figure 8 shows the compilation results for the software setup.

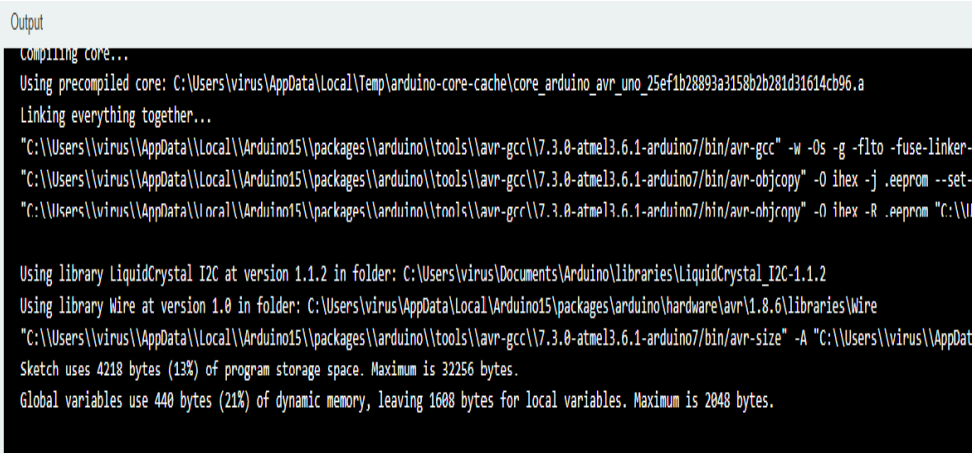

Figure 8: Compile Results

B. **Schematic diagram:** To design a circuit, a simulation-based fire, smoke, and gas-based model was designed using Proteus Software. An organizational mechanism that combines an automatic sensor, power, fire control, and protection was implemented. Figure 9 shows the schematic design of this system using the Proteus Software (Figure 9)

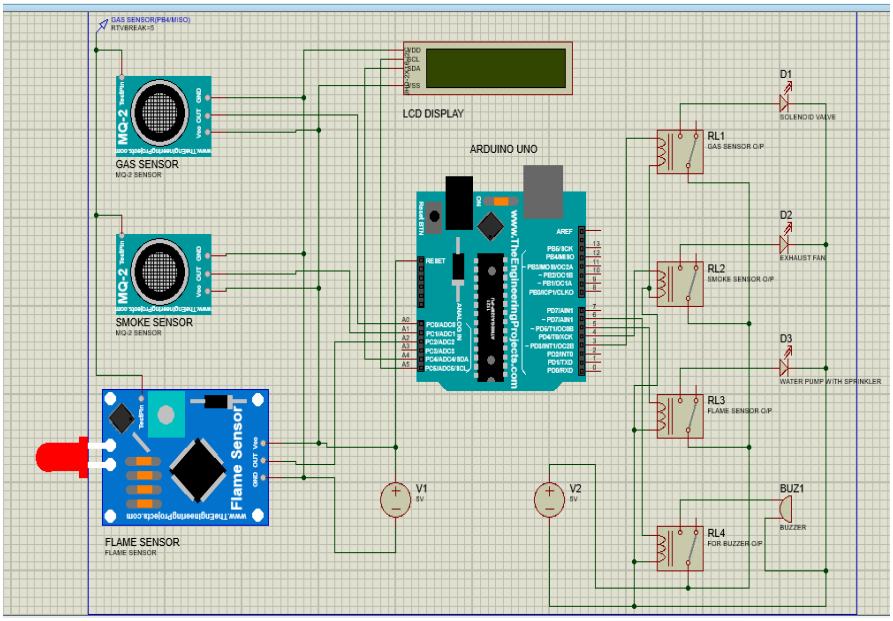

Figure 9: Schematic diagram

IV. CONCLUSION

The primary objective of this system is to offer a reliable, safe, and cost-effective solution for the detection and control of gas leakages, fires, and smoke. This serves as a key tool for enhancing safety measures in both residential and commercial settings. The components utilized in this project are readily accessible and budget-friendly. The most notable advantage of this system is its ability to provide swift responses and accurate detection and control, thereby facilitating the effective management of hazardous situations. The system employs visual indicators in the form of LEDs, signalling the absence of gas leakage, fires, or smoke. Furthermore, it can transmit signals when dangerous conditions are detected. In the event of gas leakage, fire, or smoke detection, the system promptly activates red LEDs and sounds an alarm. Additionally, an LCD screen was integrated to display the concentration levels of gas leakages, fires, and smoke. The system is equipped with a solenoid valve for water control, sprinkler systems, and exhaust fans for comprehensive hazard management. This innovative technique enables controlled operation of home appliances, mitigates potential safety risks, and promotes a secure environment. The cumulative results show that the design and application of the automated gas, fire, and smoke detection control and protection system worked properly, and the experimental setup was tested for fire, smoke, and gas detection. The simulation verification of Proteus software was utilized to design a schematic model for the prototype. Compared with conventional systems, this system can detect fire, smoke, and gas in a single system.

REFERENCES

[1] Datok, SJK T. Pusat Telok. "A Development of Gas Leak Detector and Fire Detection System." APS 1, 2024.

[2] M. I. El-Afifi, S. S. A. F. R. Team, and M. M. Elkelany, "Development of fire detection technologies," Nile Journal of Communication and Computer Science, vol. 7, no. 1, pp. 58–66, 2024.

[3] M. Nabatte and R. B. Basoma, "A design and implementation of an automated fire and gas accident avoider system," Journal of Innovative Technologies and Business for Sustainable Development, vol. 5, 2024.

[4] B. Wang, X. Zhao, Y. Zhang, Z. Song, and Z. Wang, "A capacitive particle-analyzing smoke detector for very early fire detection," Sensors, vol. 24, no. 5, p. 1692, 2024.

[5] C. V. N. Raja, B. Kusumanjali, G. Lavanya, Y. Priyanka, P. S. Krishna, and T. S. Rayapureddi, "Fire detection and protection system," Juni Khyat Journal, vol. 14, no. 3, no. 04, 2024.

[6] P. Pathak and S. Ali, "Smoke detection using IoT," International Journal of Progressive Research in Engineering Management and Science (IJPREMS), vol. 4, no. 6, pp. 128–132, Jun. 2024.

[7] B. W. Dionova, A. D. Setiawan, D. J. Vresdian, L. P. Pratama, M. I. Abdullah, and M. N. Mohammed, "Automatic fire extinguishing system using smoke detector and heat detector based on programmable logic controller," Eksergi: Jurnal Teknik Energi, vol. 20, no. 1, pp. 4–8, 2024.

[8] Y. A. Janitra, A. Aditya, H. N. Hadi, and S. Widodo, "The development of automatic cigarette smoke detection system using TA12-100 and MQ-135 sensors," Jurnal Techno Nusa Mandiri, vol. 21, no. 1, pp. 29–36, 2024.

[9] M. Ju, "Design of anti-theft alarm and fire detection system based on IoT cloud platform," Journal of Computing and Electronic Information Management, vol. 13, no. 1, pp. 71–73, 2024.

[10] S. M. Al-Chalabi, A. M. Al-Chalabi, and R. A. Al-Khafaji, "Innovative pre-fire alert smart detection system-based embedded system," AIP Advances, vol. 14, no. 5, 2024.

[11] B. Wang, X. Zhao, Y. Zhang, Z. Song, and Z. Wang, "Research on a capacitive particle analysis smoke detector," Scientific Reports, vol. 14, no. 1, p. 11319, 2024.

[12] H. An, "Development of voice-instructed smart fire alarm using Arduino and IoT functionality," Journal of Basic and Applied Research International, vol. 30, no. 2, pp. 13–25, 2024.

[13] V. Sailaja, M. Nandini, K. S. N. Lakshmi, V. M. Raju, M. U. Farukh, and S. V. Lakshmi, "Automatic fire detection, monitoring and controlling in industries using IoT," International Journal of Marketing Management, vol. 12, no. 1, pp. 64–70, 2024.

[14] N. V. Tri and H. D. Trung, "Design and implementation of an IoT system for indoor measurement and monitoring fire and gas warning," Buletin Ilmiah Sarjana Teknik Elektro, vol. 6, no. 2, pp. 190–202, 2024.

[15] I.-M. Gu, Y.-M. Yeon, D.-S. Ryu, and S.-H. Kim, "Optimization of smoke-detector installation location based on effect of fan equipment inside distribution panel on fire detection performance," Fire, vol. 6, no. 2, p. 49, 2023.

[16] W. O. Adedeji, A. O. Adekoya, O. Olukayode, K. A. Oyewole, and T. S. Amosun, "Design and simulation of programmable logic controller based multi-channel fire detection and alarm system," Adeleke University Journal of Engineering and Technology, vol. 6, no. 1, pp. 22–32, 2023.

[17] H.-G. Lee, U.-N. Son, S.-M. Je, J.-H. Huh, and J.-H. Lee, "Overview of fire prevention technologies by cause of fire: Selection of causes based on fire statistics in the Republic of Korea," Processes, vol. 11, no. 1, p. 244, 2023.

[18] E. Hwang, H.-b. Choi, and D.-m. Choi, "Response characteristics of smoke detection for reduction of unwanted fire alarms in studio-type apartments," Fire, vol. 6, no. 9, p. 362, 2023.
[19] N. Ibrahim, "Gas leakage and fire detector based on Internet of Thing (IoT) network," American Journal of Engineering, Mechanics and Architecture, vol. 1, no. 9, pp. 2993–2637, 2023.
[20] T. Hasan, M. A. Abrar, M. Z. R. Saimon, M. Sayeduzzaman, and M. S. Islam, "Constructing an integrated IoT-based smart home with an automated fire and smoke security alert system," Malaysian Journal of Science and Advanced Technology, pp. 1–10, 2023.
[21] S. H. Park, D. H. Kim, and S. C. Kim, "Recognition of IoT-based fire-detection system fire-signal patterns applying fuzzy logic," Heliyon, vol. 9, no. 2, 2023.
[22] B. Venuste, G. Geoffrey, and N. J. P. Nyakuri, "Smart approach for fire detection systems in Kigali," Journal of Appropriate Technology, vol. 9, no. 3, pp. 152–161, 2023.
[23] D. Queloz and J. Dubochet, "Designing a Raspberry Pi-based hardware module for multi-sensor fire and flame detection system," International Journal of Research Publication and Reviews, vol. 4, no. 5, pp. 1445–1448, 2023.
[24] H. Hery, C. A. Haryani, A. R. Mitra, and A. E. Widjaja, "The design of microcontroller based early warning fire detection system for home monitoring," IJNMT (International Journal of New Media Technology), vol. 9, no. 1, pp. 6–12, 2022.
[25] G. Z. Islam, M. Hossain, M. Faruk, F. N. Nur, N. Hasan, K. M. Khan, and Z. N. Tumpa, "IoT-based automatic gas leakage detection and fire protection system," International Journal of Interactive Mobile Technologies, vol. 16, no. 21, 2022.
[26] S. More, S. Shelar, V. Randhave, and A. Bagde, "IoT based smart kitchen system," International Journal of Scientific Research in Science, Engineering and Technology, pp. 479–485, 2021.
[27] Suwarjono, I. H. Wayangkau, T. Istanto, R. Rachmat, M. Marsujitullah, H. Hariyanto, W. Caesarendra, S. Legutko, and A. Glowacz, "Design of a home fire detection system using Arduino and SMS gateway," Knowledge, vol. 1, no. 1, pp. 61–74, 2021.
[28] P. Ghosh and P. K. Dhar, "GSM based low-cost gas leakage, explosion and fire alert system with advanced security," in Proc. 2019 Int. Conf. Electrical, Computer and Communication Engineering (ECCE), pp. 1–5, 2019.
[29] A. Singh, M. Verma, and L. Sahu, "Detection of liquefied petroleum gas using sensor through Arduino Uno microcontroller," International Research Journal of Engineering and Technology (IRJET), vol. 5, no. 4, pp. 2101–2104, 2018.
[30] F. O. P. Kpae, M. Macmammah, N. D. Ezekiel, C. T. Woji, A. Abubakar, and O. N. Kpaa Friday, "Design and implementation of a smart home (smoke, fire, gas and motion detector)," International Research Journal of Engineering and Technology (IRJET), vol. 5, no. 8, 2018.