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Prototype of a Multisensor Fire Detection System Based on the Internet of Things (IoT)

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ABSTRACT

Fire is a disaster that cannot be predicted and often has a significant impact on human life, both materially and non-materially. Fires are usually detected only after they have grown large, resulting in unavoidable losses. Various factors, such as short circuits in electrical networks, LPG gas leaks, and human negligence, are the main causes of fires. In this situation, an early detection system that provides real-time information is needed to minimize the impact of the fire. This study aims to design a prototype of a Multisensor Fire Detection System Based on the Internet of Things (IoT) that integrates a flame sensor, MQ-2 gas sensor, and DHT22 temperature sensor with the Blynk application to provide real-time notifications. This system is also equipped with an LCD for warning display and a buzzer as an alarm. The prototype has been tested in a controlled environment that simulates fire conditions, including gas leaks and high temperatures, with several trials conducted to verify its reliability. The results showed that the system could detect fire at a maximum distance of 100 cm, hazardous gas concentrations starting from 600 ppm, and temperatures exceeding 35°C as the threshold for fire detection. However, its performance may be affected in environments with high humidity levels or areas with poor network connectivity. With effective integration of hardware and software, this prototype helps users detect potential fires at an early stage and minimize the risk of fire-related losses.

Keywords: fire detection, multisensor, internet of things, blynk

INTRODUCTION

Fire is one of the most unpredictable and often uncontrollable natural disasters. Fire incidents carry serious potential hazards and have an impact on people's lives and livelihoods. Therefore, fire is classified as a form of disaster[1]. Fire is a tragedy that occurs unexpectedly, and in addition to being undesirable for the community, it is often uncontrollable once the flames grow large. Fire incidents are extremely dangerous and disruptive to community life[2]. Fire is a frequently occurring incident, particularly in Indonesia, which can be caused by gas leaks, waste burning, electrical short circuits, sparks or cigarettes, and various other factors[3]. Natural factors such as drought, earthquakes, lightning, and others may also contribute[4]. Fires can occur anywhere, such as in houses, buildings, offices, and even commercial areas[5].

Fire is a highly undesirable phenomenon because it has the potential to cause harmful impacts on various parties. Fire incidents not only result in casualties but also trigger material losses amounting to billions of rupiahs. Fire cases are frequently found in community environments, especially in densely populated residential areas, industrial zones, and office complexes. The rapid increase in the construction of high-rise buildings in major cities in Indonesia further increases the risk of fire due to the complexity of infrastructure and the density of activities within them[6]. Fire incidents can occur in various locations, including public spaces and residential areas. In general, fires are only detected when the flames have grown large or black smoke begins to emerge from buildings, which often results in considerable losses. Every fire incident is always associated with energy changes and material transformation[7].

Fire incidents can occur in various locations, including public places and residential areas. Many factors can cause fires, such as electrical short circuits, LPG gas leaks, cigarette butts, and other causes. Usually, fires are only detected when the flames have started to grow or black smoke has already emerged from the building. Therefore, building safety, both for commercial buildings and residential areas, becomes very important because fire threats can arise without warning, thus requiring early preventive measures to avoid fires and minimize both material and non-material losses[8].

Fire is a phenomenon that is closely related to human activities. Its impacts are not limited to material losses such as building damage, but also include psychological effects and threats to human safety. Contributing factors include the lack of public awareness of fire risks, unpreparedness in facing emergencies, and the suboptimal integrated fire mitigation infrastructure supported by adequate protection measures[9]. Therefore, the implementation of a standardized active fire protection system in buildings becomes highly important to mitigate fire risks through comprehensive hazard identification[10]. Considering the potential danger of fire, a system is needed that can provide early warning to homeowners, company personnel, or relevant parties so that fires can be promptly detected and appropriately managed to minimize risks and losses[11].

Considering this condition, an integrated system is required in which the system can perform early detection, such as a multisensor fire detection prototype based on the Internet of Things (IoT). By implementing Internet of Things (IoT) technology, computer systems can be applied in various fields, including LPG gas leak detection and fire prevention, particularly in gas agencies and densely populated residential areas. To avoid disasters, fire protection systems are essential in every house or gas storage facility to minimize losses and damage. In addition, many houses or gas storage facilities are still not equipped with fire protection systems, resulting in the absence of early warnings. Internet of Things (IoT) technology enables users to utilize the internet for communication with connected devices, thereby facilitating various work activities[12].

Previous studies have discussed various innovations in fire detection systems based on IoT, which have provided several innovative contributions in designing fire detection systems based on IoT. A previous study focused on the Design and Development of a Fire Detector System via Mobile Phone Based on a Microcontroller. This study aimed to design a device capable of detecting fire and to develop a microcontroller-based device that can detect fire through a mobile phone. The results of this study showed that when a room contains sparks and smoke, they are detected by the Uvtron R2868 Flame Sensor and the MQ2 Smoke Sensor. These sensors send signals to the microcontroller to activate the buzzer and the mobile phone. The mobile phone then sends an SMS stating "Fire Hazard"[13]. A previous study on the Design of a Smoke and Fire Detection System Based on Sensors, Microcontrollers, and IoT aimed to design and develop a smoke and fire detection system using sensors, microcontrollers, and IoT, which can be used to detect potential fire hazards in homes or specific buildings[14]. Another previous study on the Simulation of a Fire Alarm Using MQ-2 Sensor and Flame Sensor Based on Arduino Microcontroller aimed to develop an automatic fire detection device using an MQ-2 gas sensor and a flame sensor, equipped with an LM016L LCD, based on an Arduino microcontroller[15]. A previous study was also related to a Fire Detection Prototype Using a Flame Sensor, DHT11 Sensor, and NodeMCU ESP8266 Microcontroller Based on a Website. This study aimed to design a NodeMCU ESP8266-based prototype connected to a website, using a DHT11 sensor and a flame sensor to detect temperature and fire[16]. Another study focused on the Design and Development of an IoT (Internet of Things)-Based Fire Detection Device Using Smoke and Flame Sensors. This study aimed to develop an IoT-based fire detection device with two main types of sensors, namely the MQ-2 flame sensor and a smoke sensor, to provide early warning through network-based notifications[17]. A previous study on the Development of a Mobile Application and Sensor-Based Fire Detection Device for Electronic Security aimed to integrate a DHT22 temperature sensor, humidity sensor, and MQ-2 sensor into a mobile application to monitor environmental conditions in real-time. This system was designed to detect potential fire hazards by providing early warnings through the mobile application[18].

These studies reveal various approaches in utilizing IoT to enhance the effectiveness of fire detection systems. However, most of these studies have significant limitations: they typically use only one or two types of sensors, are limited to certain notification methods (either local alarms or single-platform notifications), and lack comprehensive real-time monitoring capabilities across multiple platforms. In addition, many systems focus on individual sensor responses rather than integrated multi-parameter detection, which could provide more accurate fire identification and reduce false alarms. The novelty of this study lies in the comprehensive integration of multiple detection parameters (flame sensor, MQ-2 gas sensor, and DHT22 temperature sensor) with a multi-platform notification system through the Blynk application for real-time remote monitoring, combined with a local warning system (LCD and buzzer alarm). This combination provides improved detection accuracy, reduces false alarms through multi-parameter verification, and ensures immediate response through both local and remote notification channels. This study aims to design a prototype of a multisensor fire detection system based on the Internet of Things (IoT) that integrates a flame sensor, an MQ-2 gas sensor, and a DHT22 temperature sensor. This system is equipped with the Blynk application to provide real-time notifications, an LCD as an information display, and a buzzer as an alarm. The prototype is designed to detect early signs of fire, such as the presence of flames, gas leaks, or rising temperatures, so that preventive actions can be taken immediately.

RESEARCH METHODS

1. Research Flow

This study used the waterfall model approach. The Waterfall method exemplifies a process that is planning-oriented. In principle, all activities in this process are planned and scheduled before the software development begins. This method presents software development as a sequence of distinct phases, as illustrated in Figure 1. Due to its sequential flow from one phase to the next, this methodology is known as the Waterfall

Method or software life cycle. These stages are divided into five phases: Requirements analysis and definition, System and software design, Implementation and unit testing, Integration and system testing, and Operation and maintenance[19], as illustrated in Figure 1.

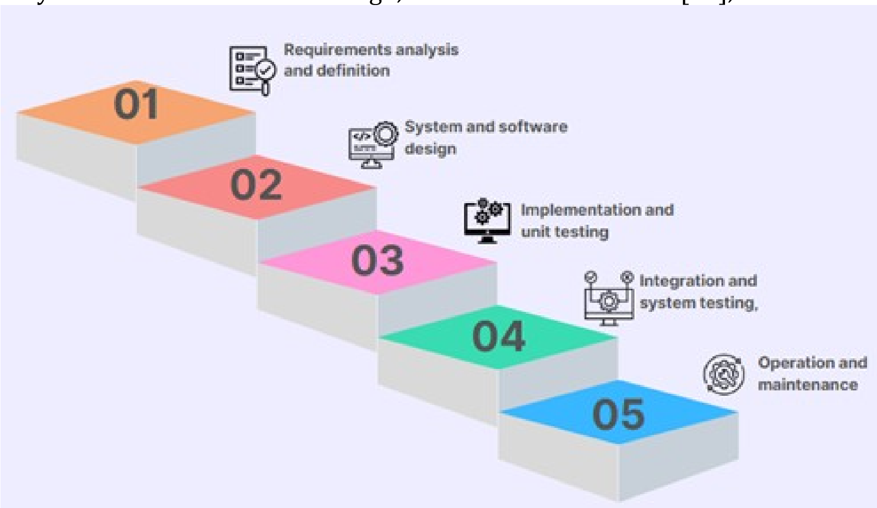

Figure 1. Research Flow of the Waterfall Model

The waterfall model is divided into five stages, namely: (a) Requirements analysis and definition: In this stage, an analysis is conducted regarding the required hardware and software. Data collection is carried out through relevant literature studies aimed at ensuring that the components align with the needs and objectives of the study. (b) System and software design: In this stage, a comprehensive system design is developed based on the requirements that have been previously analyzed. This process includes the design of hardware and software to be used in the multisensor fire detection based on an IoT prototype. (c) Implementation and unit testing: This stage involves the implementation of the system design into a physical form, including both hardware and software. (d) Integration and system testing: In this stage, all hardware and software components that have been individually tested are combined into an integrated system. (e) Operation and maintenance: In this stage, the operation and maintenance of the developed system are essential to ensure optimal performance.

2. **Hardware Design**

The design of the hardware system consists of several components that support the assembly of the Multisensor Fire Detection System Based on the Internet of Things (IoT), both in terms of the system block diagram and the wiring diagram.

a. System Block Diagram Design

The complete block diagram of the Multisensor Fire Detection System Based on the Internet of Things (IoT) prototype is shown in Figure 2. In the input section, there is a flame sensor module to detect fire, an MQ-2 sensor module to detect gas leaks, and a DHT22 temperature sensor to monitor room temperature. In the processing section, there is a NodeMCU ESP32; in the diagram, the NodeMCU ESP32 functions as the brain or the main processing unit of the Multisensor Fire Detection System Based on the Internet of Things (IoT) prototype. The NodeMCU ESP32 receives data from sensors such as the flame sensor, MQ-2 sensor, and DHT22 temperature sensor. The received data is processed to determine whether there is a fire, a gas leak, or a high room temperature. Based on the processed data, the NodeMCU ESP32 makes decisions to activate the alarm (buzzer), display a warning on the LCD screen, and send a notification to the Blynk application if a fire, gas leak, or high room temperature is detected. In the output section, there are the Blynk application, LCD, and buzzer. The Blynk application functions as an output that displays real-time information regarding early signs of fire. Users can view notifications and system status through this application. Meanwhile, the LCD functions as an output that displays warnings or information related to gas leaks, high room temperature, or fire. This allows users to directly observe the system status without having to check through the Blynk application. The buzzer functions as an alarm that activates in the event of a gas leak, high room temperature, or fire. This alarm helps the system owner to immediately respond to emergency situations detected by the sensors.

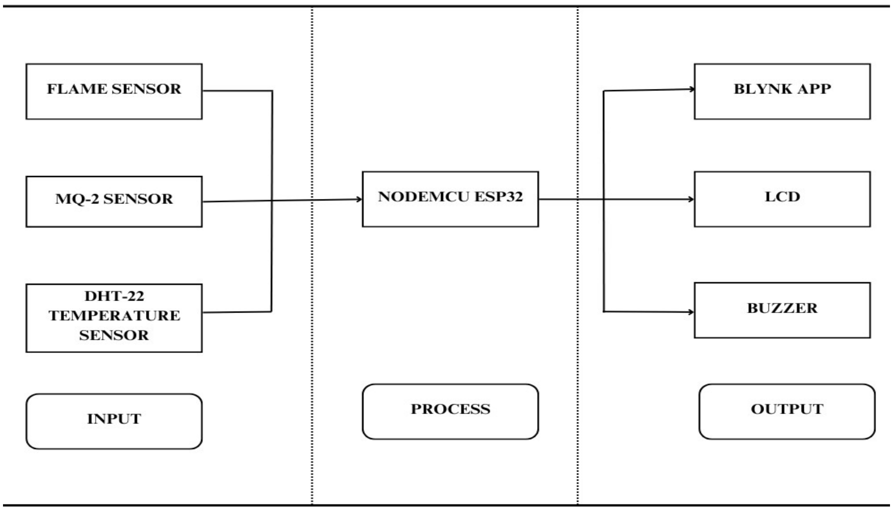

Figure 2. System Block Diagram Design

b. Wiring Diagram Design

In the process of designing a device, a wiring diagram is required as a guide. The wiring diagram functions as an initial design that facilitates the device development process. This diagram contains information regarding the components used and the wiring paths. The wiring diagram of the Multisensor Fire Detection System Based on the Internet of Things (IoT) prototype can be seen in Figure 3.

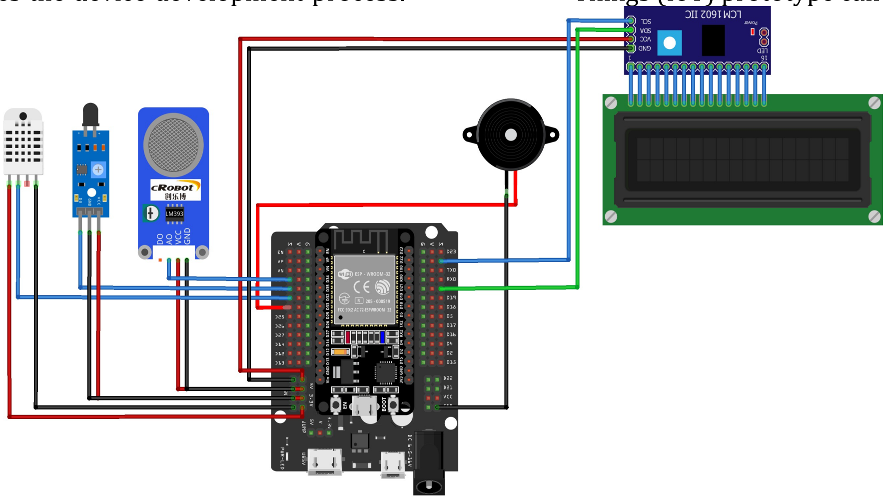

Figure 3. Wiring Diagram Design

The hardware installation begins with the preparation of essential components, including the NodeMCU ESP32 microcontroller, flame sensor, DHT22 temperature sensor, MQ-2 gas sensor, buzzer, and 16×2 I2C LCD. The assembly process starts by connecting the NodeMCU ESP32 to the ESP32 shield, followed by the installation of both components along with the I2C LCD into the protective casing. Subsequently, the sensors are connected to specific pins on the ESP32: the flame sensor is connected to GPIO35, the MQ-2 gas sensor to GPIO34, and the DHT22 temperature sensor to GPIO32, with the Vcc and GND pins each connected to the appropriate power source. The buzzer is connected to GPIO33, while the 16x2 I2C LCD is connected via the SCL pin to GPIO22 and the SDA pin to GPIO21, with Vcc and GND connected to the 5V power supply and ground on the ESP32 shield.

3. Software Design

In the software design stage, the Arduino IDE software is used to program the NodeMCU ESP32 and other hardware components so that they operate according to the designed system workflow. The flowchart of the system workflow design for the Multisensor Fire Detection System Based on the Internet of Things (IoT) prototype can be seen in Figure 4.

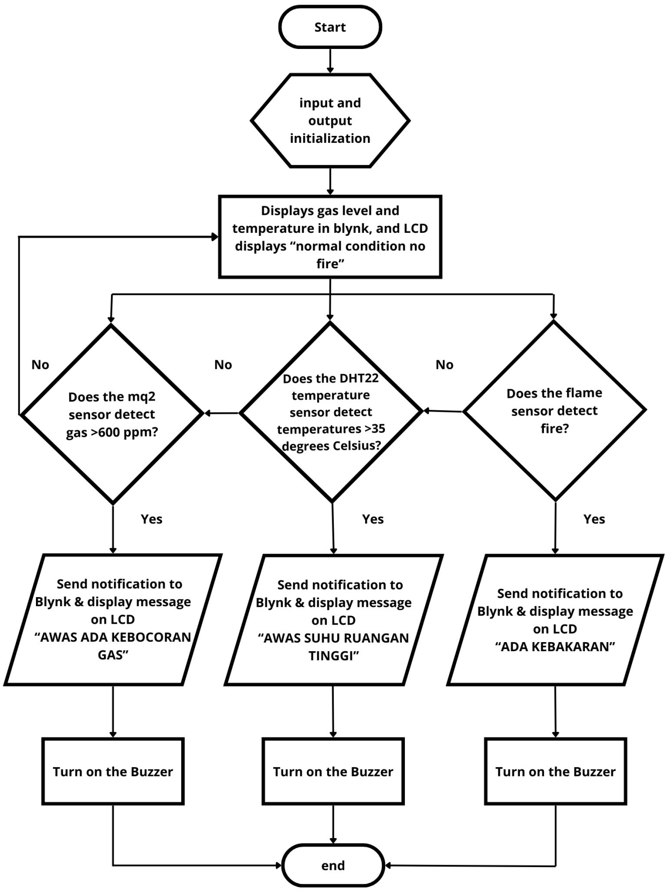

Figure 4. System Workflow Flowchart

4. House Model Design

This house model design is used as a model or representation of the environment or situation to be simulated. In the context of this study, the house model is used as a medium to test and implement the Multisensor Fire Detection System Based on the Internet of Things (IoT) prototype. By using the house model, the researcher can simulate fire conditions and test the developed alarm system more realistically before it is implemented on a larger scale or in an actual environment. The design of the house model can be seen in Figure 5, which is created using SketchUp software.

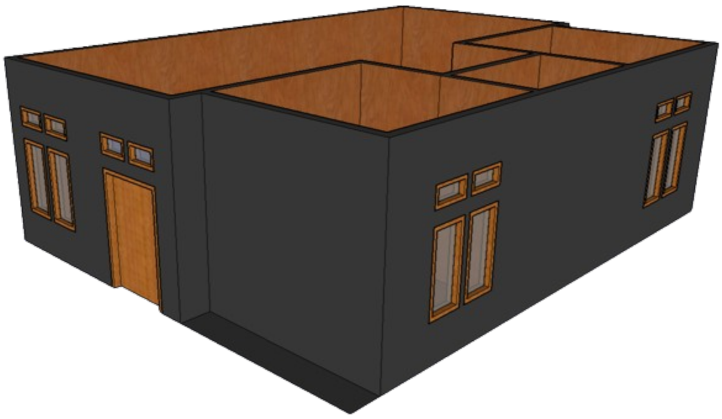

Figure 5. House Model Design

RESULTS AND DISCUSSION

The results obtained from the prototype of the Multisensor Fire Detection System Based on the Internet of Things (IoT) include the hardware design results, the software design results, the fire detection test results using the flame sensor, the gas detection test results using the MQ-2 sensor, and the temperature detection test results using the DHT22 sensor.

This study develops hardware in the form of a prototype of the Multisensor Fire Detection System Based on the Internet of Things (IoT), which can be monitored remotely using a smartphone. The overall structure of the hardware prototype of the Multisensor Fire Detection System Based on the Internet of Things (IoT) consists of several main components, namely the ESP32, flame sensor, DHT22 temperature sensor, MQ-2 gas sensor, buzzer, and 16x2 I2C LCD. These components are carefully assembled and connected to one another according to the previously designed wiring diagram. This process is carried out to ensure that each part of the hardware functions optimally and supports the system in performing fire detection tasks based on the Internet of Things (IoT).

The implementation of this hardware aligns with the approach used in studies[20], [21], which also employed multisensors for fire detection. However, the use of the ESP32 as the main microcontroller provides advantages in terms of processing capabilities and more stable WiFi connectivity compared to conventional microcontrollers used in previous studies. This comprehensive component integration reflects the evolution of fire detection technology from simple systems to integrated systems based on IoT.

The prototype of the Multisensor Fire Detection System Based on the Internet of Things (IoT) is built using the Blynk application software as the user interface, which is designed to facilitate users in monitoring sensor data in real time, allowing users to quickly identify the conditions monitored by the prototype of the Multisensor Fire Detection System Based on the Internet of Things (IoT). In addition, this device is capable of sending notifications through the Blynk application on a smartphone, providing early warnings related to potential fires, thereby helping to minimize the risk of losses caused by fire. The design or visual layout of the Blynk application user interface on the smartphone can be seen in Figure 6.

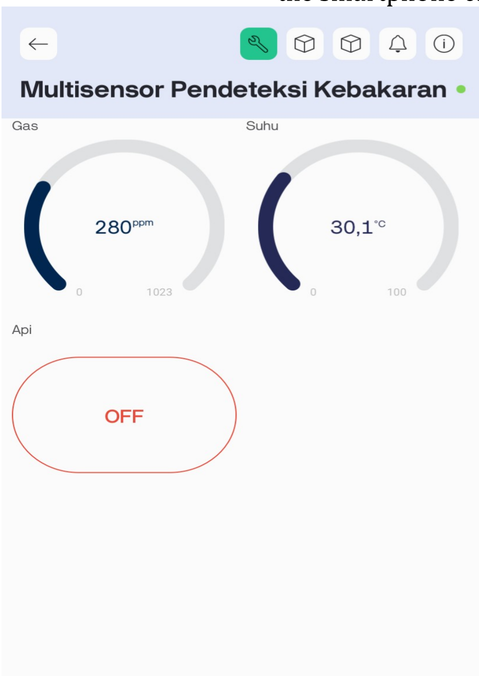

Figure 6. User Interface Display of the Blynk Application on a Smartphone

The selection of the Blynk application as the monitoring platform shows significant progress compared to the SMS notification system used in the study[22]. The IoT platform through the Blynk application provides a more user-friendly and responsive interface, enabling more effective and intuitive real-time monitoring for users.

1. Fire Detection Testing Using a Flame Sensor

The objective of the fire detection test is to evaluate the ability of the flame sensor to detect fire. The flame sensor operates by detecting specific wavelengths of light emitted by flames. The simulation is conducted using three candles as the fire source to ensure that the Multisensor Fire Detection System Based on the Internet of Things (IoT) prototype can respond to the form of alerts through the LCD, the Blynk application, and the buzzer.

Based on the test results, the system successfully provides an appropriate response when detecting fire. When the sensor detects a fire, the system automatically activates three warning mechanisms, namely displaying the text "Fire Detected" on the LCD screen, sending a "Fire Detected" notification through the Blynk application on the user's smartphone, and generating an alarm sound from the buzzer. The use of these three different types of warnings aims to ensure that users receive information through multiple channels, thereby minimizing the possibility of missing a fire alert.

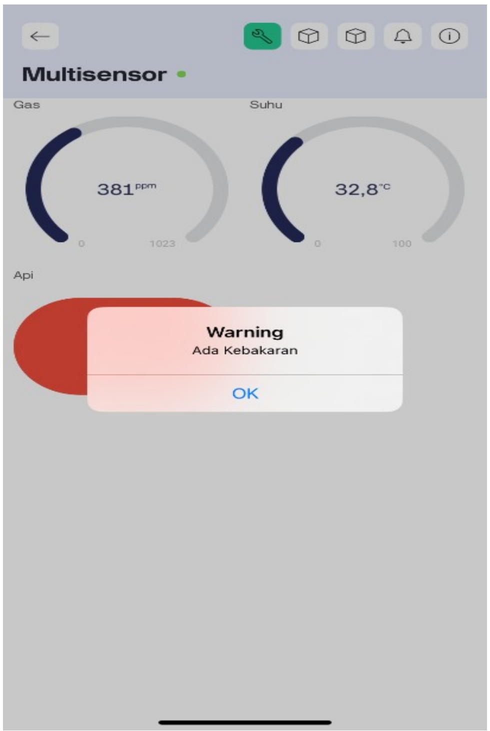

Figure 7. Flame Sensor Notification Display on the Blynk Application

Figure 7 shows the notification on the Blynk application when the flame sensor detects the presence of fire. The sensor status changes from Off to On, indicating the presence of fire near the sensor. The system automatically sends a "Fire Detected" warning notification to the user via smartphone.

Based on the test results shown in Table 1, the flame sensor is capable of detecting fire at a maximum distance of 100 cm. At a distance of 110 cm, the sensor no longer detects the presence of fire, and the system remains in a normal state without providing any warning. The system can detect the presence of fire from the nearest distance of 10 cm to a maximum distance of 100 cm with a very high level of consistency. At each test distance within this range, all output components of the system provide simultaneous and reliable responses. This is indicated by the simultaneous activation of the sensor indicator, Blynk status, LCD, and buzzer.

Table 1. Flame Sensor Test Results

Distance	Sensor Indicator	Blynk Status	LCD Status	Buzzer
10 cm	On	*Ada Kebakaran*	*Ada Kebakaran*	On
20 cm	On	*Ada Kebakaran*	*Ada Kebakaran*	On
30 cm	On	*Ada Kebakaran*	*Ada Kebakaran*	On
40 cm	On	*Ada Kebakaran*	*Ada Kebakaran*	On
50 cm	On	*Ada Kebakaran*	*Ada Kebakaran*	On
60 cm	On	*Ada Kebakaran*	*Ada Kebakaran*	On
70 cm	On	*Ada Kebakaran*	*Ada Kebakaran*	On
80 cm	On	*Ada Kebakaran*	*Ada Kebakaran*	On
90 cm	On	*Ada Kebakaran*	*Ada Kebakaran*	On
100 cm	On	*Ada Kebakaran*	*Ada Kebakaran*	On
110 cm	Off	Off	Normal condition no Fire	Off

Note: *Ada Kebakaran* = Fire Detected

Based on the test results, it can be concluded that the system has a maximum detection distance limit of 110 cm. The warning system with three outputs implemented in this prototype provides beneficial layered security. The combination of visual warnings (LCD and Blynk notification) and audible warnings (buzzer) increases the probability that users will be aware of the potential fire hazard.

The test results of the flame sensor show a significant improvement through a physical implementation, providing concrete validation of the accurately measured 100 cm detection range. The consistent response at all tested distances indicates reliable sensor calibration. However, real-world implementation may face challenges from ambient light interference and dust accumulation, which were not simulated under controlled testing conditions. The multilayered warning system addresses the limitations of single notification methods that may potentially result in missed alerts.

2. Gas Detection Testing Using the MQ-2 Sensor

The gas detection test aims to evaluate the capability of the MQ-2 sensor in detecting the presence of hazardous gases that become early indicators of fire occurrence. The MQ-2 sensor functions to detect the concentration of specific gases such as methane, butane, LPG, and smoke. Unlike the flame sensor, which has high sensitivity and a fast response in transmitting data, this sensor has a slightly slower response time and requires a relatively close distance to detect the presence of gas effectively. This test is conducted by bringing a lighter close to the sensor to simulate a gas leak condition.

The test results show that the MQ-2 sensor is capable of detecting the presence of gas following the system workflow flowchart. When the gas level reaches 600 ppm or more, the system issues a warning through the LCD screen displaying the warning text "Awas Ada Kebocoran Gas" (Warning Gas Leak Detected), emits an alarm sound through the buzzer, and sends a warning notification "Awas Ada Kebocoran Gas" (Warning Gas Leak Detected) to the smartphone device via the Blynk application, as shown in Figure 8.

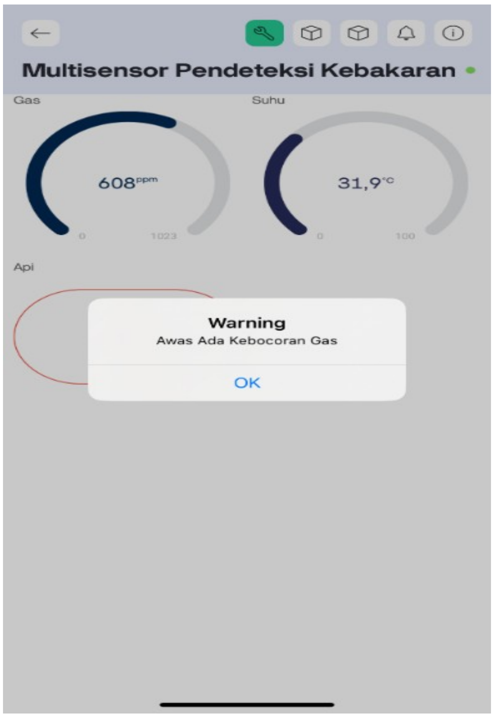

Figure 8. MQ-2 Gas Sensor Notification Display on the Blynk Application

Figure 8 displays the notification on the Blynk application when the gas level reaches the minimum threshold of 600 ppm. The notification “Awas Ada Kebocoran Gas” (Gas Leak Detected) is automatically sent to the user's smartphone, ensuring that the system functions properly following the system workflow flowchart.

Based on the test results, as shown in Table 2, the system is capable of distinguishing between safe and hazardous conditions based on the detected gas levels. Within the range of 300–550 ppm, the system remains in a normal state without issuing any warnings. This indicates that the system has a good capability to differentiate between normal and hazardous conditions. When the gas level reaches or exceeds 600 ppm, all warning components, such as the warning notification via Blynk, LCD, and buzzer, are activated simultaneously, showing good integration between the sensor and the warning system.

Table 2. MQ-2 Gas Sensor Test Results

Gas Level	Sensor Indicator	Blynk Status	LCD Status	Buzzer
300 ppm	Off	Off	Normal condition no fire	Off
380 ppm	Off	Off	Normal condition no fire	Off
400 ppm	Off	Off	Normal condition no fire	Off
450 ppm	Off	Off	Normal condition no fire	Off
500 ppm	Off	Off	Normal condition no fire	Off
550 ppm	Off	Off	Normal condition no fire	Off
600 ppm	On	Awas Ada Kebocoran Gas	Awas Ada Kebocoran Gas	On
700 ppm	On	Awas Ada Kebocoran Gas	Awas Ada Kebocoran Gas	On
900 ppm	On	Awas Ada Kebocoran Gas	Awas Ada Kebocoran Gas	On
1000 ppm	On	Awas Ada Kebocoran Gas	Awas Ada Kebocoran Gas	On

Note: *Awas Ada Kebocoran Gas* = Warning Gas Leak Detected

The selection of a 600 ppm threshold represents a more conservative approach compared to common LPG leak detection standards, which often trigger warnings at levels of 300–400 ppm for industrial applications. This higher threshold reduces false positive alerts but may delay detection in certain scenarios. However, the effectiveness of the sensor may be affected in environments with high humidity or in areas with cross-sensitivity to other volatile compounds, a limitation that is not addressed in the current testing protocol.

The test results of the MQ-2 sensor are consistent with studies[23], [24], which also utilized the MQ-2 sensor for smoke and gas detection. However, this study contributes by establishing a 600 ppm threshold validated through systematic testing, providing a reliable baseline for the implementation of similar systems. The system's ability to distinguish between normal and hazardous conditions indicates proper calibration, addressing the issue of false alarms that often pose challenges in conventional gas detection systems.

3. Temperature Detection Testing Using the DHT22 Sensor

This test aims to determine the ability of the DHT22 sensor to detect significant temperature changes that may indicate a potential fire. The sensor is configured to provide warnings through the Blynk application, LCD screen, and buzzer sound when the temperature reaches or exceeds the threshold of 35°C. The test simulation is conducted by bringing the sensor close to a heat source in the form of a lit candle to increase the surrounding temperature.

The test results show that the DHT22 sensor functions properly in accordance with the system workflow flowchart, as the system issues a warning after the DHT22 sensor detects a minimum temperature increase of 35°C. The warning is delivered through the LCD screen displaying the warning text "Awas Suhu Ruangan Tinggi" (Warning: High Room Temperature), and an audible alert is emitted through the buzzer.

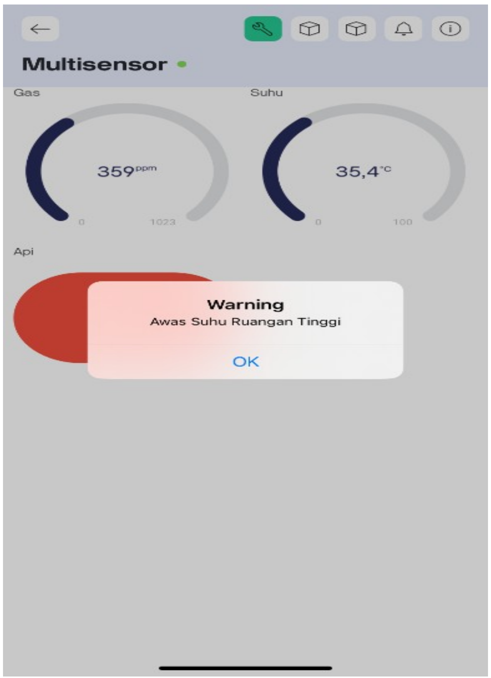

Figure 9. DHT22 Sensor Notification Display on the Blynk Application

Figure 9 shows the notification received through the Blynk application when the temperature reaches 35°C or higher. The system automatically sends a warning "Awas Suhu Ruangan Tinggi" (Warning High Room Temperature) to the user's smartphone, ensuring that the device operates according to the designed system workflow. The implementation of IoT technology through the Blynk application, as shown in Figure 9, provides effective remote temperature monitoring capability. The system successfully sends a notification to the user's smartphone when the temperature reaches or exceeds 35°C. This feature is highly useful for monitoring areas that require continuous temperature surveillance, such as residential buildings, server rooms, storage warehouses, or production areas that are sensitive to temperature changes.

Based on the test results as shown in Table 3, the sensor shows a systematic working pattern following the system workflow flowchart as presented in Figure 4. Within the temperature range of 29–34°C, the system remains in a normal condition without issuing any warnings, indicating that the system is capable of distinguishing between normal and potentially hazardous temperatures. When the temperature reaches 35°C and continues to rise to 50°C, the system consistently provides warnings through the three existing output components.

Table 3. DHT22 Temperature Sensor Test Results

Temperature	Status Blynk	Status LCD	Buzzer
29°C	Off	Normal condition no fire	Off
30°C	Off	Normal condition no fire	Off
32°C	Off	Normal condition no fire	Off
34°C	Off	Normal condition no fire	Off
35°C	Awas Suhu Ruangan Tinggi	Awas Suhu Ruangan Tinggi	On
40°C	Awas Suhu Ruangan Tinggi	Awas Suhu Ruangan Tinggi	On
42°C	Awas Suhu Ruangan Tinggi	Awas Suhu Ruangan Tinggi	On
45°C	Awas Suhu Ruangan Tinggi	Awas Suhu Ruangan Tinggi	On
48°C	Awas Suhu Ruangan Tinggi	Awas Suhu Ruangan Tinggi	On
50°C	Awas Suhu Ruangan Tinggi	Awas Suhu Ruangan Tinggi	On

Note: *Awas Suhu Ruangan Tinggi* = Warning High Room Temperature

The test results of the DHT22 sensor are consistent with the study by et al.[25], which also utilized the DHT22 sensor for temperature monitoring in a fire detection system. However, this study contributes by establishing a 35°C threshold that is optimal for early fire detection applications. The selection of the DHT22 sensor offers an accuracy advantage (±0.5°C) compared to the DHT11 sensor (±2°C) used in the study by Saputro & Tuslam[26], resulting in more precise detection and reducing the likelihood of false alarms.

The results of this study are consistent with several previous studies in the field of fire detection systems based on IoT, while also offering significant contributions and innovations. This study aligns with the research conducted by Sari et al.[27], which utilized the MQ-2 smoke sensor and DHT11 temperature sensor for fire detection with notifications delivered via SMS. Both studies demonstrate the effectiveness of using multisensors in fire detection systems; however, this study presents a significant advancement through the implementation of IoT technology using the Blynk application, enabling real-time monitoring and more responsive notifications compared to conventional SMS-based systems.

This study is also consistent with the findings of Rizaldy et al.[28], who developed a smoke and flame detection system based on IoT with alerts delivered via alarm and smartphone notifications. The similarity lies in the use of IoT technology for remote monitoring and multilayered warning systems. However, this study enhances the approach by incorporating the DHT22 temperature sensor and establishing more specific thresholds (600 ppm for gas and 35°C for temperature), providing a higher level of detection accuracy. Consistency is also found with the study conducted by Saputra & Hariman[29], which used a web-based multisensor system. The main difference lies in the monitoring platform, where this study uses the Blynk mobile application, which is more user-friendly compared to the web-based interface.

The results of this study are in line with the research conducted by Husain et al.[30], which utilized a combination of the DHT22 and MQ-2 sensors with a mobile application for real-time monitoring. Both studies demonstrate the effectiveness of using the DHT22 sensor for detecting temperature changes and the MQ-2 sensor for gas detection. However, this study provides an additional contribution through the implementation of a flame sensor, which enhances the reliability of the detection system by applying a triple-sensor approach.

This study differs from the approach used by Nirawana[31], which relied solely on simulations using Proteus software. The physical prototype implementation in this study provides concrete validation of system performance, with fire detection distance testing up to 100 cm and a gas threshold of 600 ppm, which cannot be achieved through software simulation alone.

The main contribution of this study lies in the development of a multisensor fire detection system integrated with IoT technology, which provides several important implications. The technological contribution of this study successfully integrates three types of sensors (flame sensor, MQ-2, and DHT22) into a single system that can be monitored in real time through a mobile application. This integration provides a higher level of detection accuracy compared to single-sensor systems, with the capability to detect fire at a distance of up to 100 cm, gas detection at a threshold of 600 ppm, and temperature detection starting from 35°C.

CONCLUSION

A prototype of a multisensor fire detection system based on the Internet of Things (IoT) has been successfully tested to ensure the detection performance of the sensors in accordance with the designed system workflow. Testing was conducted on three main sensors, namely the flame sensor, the MQ-2 gas sensor, and the DHT22 temperature sensor. The test results show that the flame sensor is capable of detecting fire at a maximum distance of 100 cm and provides warnings through the LCD, buzzer, and Blynk application notifications in real time. The MQ-2 gas sensor successfully detects hazardous gas at a minimum concentration of 600 ppm and provides warnings through three types of output. Meanwhile, the DHT22 temperature sensor shows an accurate response in detecting temperature increases starting from 35°C, which is considered the threshold for fire hazard. All three sensors operate stably and demonstrate good integration with the IoT system, ensuring that all warning mechanisms, both visual and auditory, function optimally. This ensures that the prototype is capable of providing early notifications to users, thereby enabling remote monitoring and rapid action to minimize fire risk. These results confirm that the sensor detection performance aligns with the designed system workflow and supports the research objective of delivering real-time information through the Blynk application.

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