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SMART FIRE & GAS SAFETY SYSTEM: AN IOT-INTEGRATED SYSTEM WITH BLUETOOTH CONTROL USING LABVIEW

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Abstract: Fire and gas leak incidents pose significant threats to safety in industrial and residential environments. This work presents a real-time fire, gas, and temperature monitoring system designed for early hazard detection and prevention. The system integrates an MQ-5 gas sensor, a single-channel flame sensor, and an LM35 temperature sensor to continuously monitor environmental conditions. In the event of a gas leak or fire detection, an alarm system comprising a buzzer, LED indicators, and an automated sprinkler system is activated to mitigate risks. To enhance system control and accessibility, Bluetooth communication allows users to manually control the sprinkler, buzzer, and LED using a mobile application via predefined commands. Additionally, the system is equipped with IoT-based remote monitoring through Firebase, enabling real-time data storage and analysis. The data transmitted to real time database which includes gas and fire status, temperature readings, and system responses, ensuring remote visibility and decision-making. The system is implemented using MyRIO as the central processing unit, interfacing with LabVIEW for real-time monitoring. The proposed system enhances safety, automation, and monitoring efficiency while providing seamless remote accessibility. Experimental results demonstrate the system's effectiveness in detecting hazards with high accuracy and rapid response time.

Keywords: Fire detection, Gas monitoring, IoT, MyRIO, Bluetooth communication, LabVIEW.

I.INTRODUCTION

Fire outbreaks and gas leaks pose severe risks to industrial facilities, residential areas, and workplaces, often leading to catastrophic losses, including damage to property, environmental pollution, and even loss of life. Early detection and rapid response are crucial in mitigating these hazards, yet many conventional systems fail to provide real-time monitoring and remote accessibility, making them less effective in dynamic environments. Furthermore, many conventional systems are wired, leading to complex installations and limited flexibility. To address these limitations, this work proposes a smart, IoT-integrated fire and gas detection system that not only identifies hazards but also provides automated and remote-controlled responses. The system employs an MQ-5 gas sensor, a single-channel flame sensor, and an LM35 temperature sensor for early hazard detection. Upon detecting a fire or gas leak, the system immediately activates buzzers, LED indicators, and a sprinkler system to contain the situation. Additionally, a Bluetooth-based manual control feature allows users to operate the system remotely via a mobile application using predefined commands. The incorporation of Firebase IoT connectivity further enhances functionality by enabling real-time data storage, remote monitoring, and accessibility from any location. This system is designed around MyRIO, which processes sensor data and controls the system's responses, while LabVIEW provides real-time monitoring and visualization. By integrating multiple hazard detection mechanisms with IoT and Bluetooth control, the proposed solution ensures faster response times, reduced false alarms, and enhanced user control over safety measures. The following sections detail the system's design, implementation, and experimental results, demonstrating its effectiveness in improving fire and gas safety standards.

II.LITERATURE REVIEW

Literature review related to gas leakage and fire detection system using IoT. Liu et al. [1] explored Bluetooth-based wireless communication, which allows quick responses, similar to the Bluetooth control used in safety systems. Zhang et al [2] discussed wired and wireless port communication, which helps in real-time data transfer, just like the UART-based Bluetooth communication in monitoring systems. Sharma et al. [3] developed a Bluetooth and ZigBee-based

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wireless notice board, showing that short-range communication is effective for quick alerts, similar to the HC-06 Bluetooth module implementation in hazard detection. Some studies have focused on remote monitoring. Deshmukh et al. [4] created a LabVIEW-based system for LPG gas leakage detection, showing that real-time monitoring improves safety, which is like Firebase IoT monitoring used in other works. Jerome et al. [5] worked on an NI myRIO-based home automation system.

Velmurugan et al. [6] used myRIO for forest fire detection, showing that it responds quickly, which is why MyRIO is often used for sensor data processing. Perilla et al. [8] combined IoT with fire safety systems, allowing real-time alerts, which is like Firebase-based monitoring in safety applications. Devan et al. [9] developed a fire alert system for railways, helping detect fires in moving trains. Han Ni Zaw et al. [10] created an automatic fire-fighting robot, showing how flame sensors can help put out fires, which is similar to flame sensor-based fire detection used in various works.

Jualayba et al. [11] introduced a hazardous gas detection and notification system, ensuring early alerts, similar to MQ-5 gas sensor implementation in safety monitoring. Montiel Vázquez et al. [12] worked on gesture-driven mobile manipulators, showing how hands-free control can improve safety. Singh et al. [13] applied IoT to pollution monitoring, proving that it helps track harmful gases, which is similar to Firebase-based gas detection systems. Bharath Prabu et al. [14] used myRIO and LabVIEW to create an IoT-based LPG leakage monitoring system, allowing remote access, which is directly related to MyRIO and LabVIEW-based monitoring approaches. Singh et al. [15] developed a Bluetooth-based home automation system, making it easier to control devices remotely, like Bluetooth-based manual control in various safety applications.

Arthiya et al. [16] built an automatic fire rescue system for railways using myRIO, combining sensors for quick detection, which relates to sensor integration for fire and gas monitoring. [17] B. Puthillath et al. (2021) propose a gas leakage detection and alert system for homes and industries using sensors and alert mechanisms to enhance safety.
[18] Muhammad Ahmad Baballe et al. (2021) present an automatic gas leakage monitoring system utilizing the MQ-5 sensor for real-time detection and alert generation. Manasa et al. [19] also worked on fire and gas leakage detection using myRIO, proving that it works well for real-time hazard monitoring, supporting the use of MyRIO in safety applications. IoT-based systems have made safety monitoring better. Rahman et al. [20] designed a gas and fire detection system with mobile control, making monitoring easier, which is similar to mobile-based Bluetooth and IoT monitoring in various safety systems.

Vernekar et al. [21] worked on flow-rate-controlled sprinklers using myRIO, making sure water is used properly for firefighting, which is like sprinkler activation in safety monitoring. Bhagat et al. [22] built a gas, fire, and temperature detection system, proving that using multiple sensors together improves safety, just like multi-sensor approaches used in various hazard detection application. Okokpujie et al. [23] developed an MQ-5 sensor-based system for pipeline gas leak detection, showing that it helps in industrial safety, similar to MQ-5 sensor implementation in gas monitoring. Kumar [24] worked on real-time vehicle emission monitoring using myRIO, showing how gas sensors can be used in different areas.

Wurood Fadhil et al. [25] created a fire and gas detection system using Arduino, offering another way to monitor hazards, but some approaches improve on it by using MyRIO for better processing and LabVIEW for clear data display. From the literature, it is observed that most systems focus on only one aspect—Bluetooth control, IoT monitoring, or standalone detection. Few systems combine automatic detection, manual control, and remote monitoring in a single setup. Bluetooth for local control and Firebase for IoT-based remote monitoring, making them more efficient and reliable. In this work, a fire and gas detection system are monitored using IoT.

III.IoT BASED FIRE AND GAS DETECTION SYSTEM

The IoT based fire and gas detection system is designed to provide early detection and rapid response to fire, gas leaks, and abnormal temperature changes. It combines sensor-based detection, automated safety measures, Bluetooth manual control, and IoT-based remote monitoring to ensure a reliable and efficient safety solution. The MQ-5 gas sensor detects combustible gases, the single-channel flame sensor identifies fire, and the LM35 temperature sensor monitors heat levels. Table 1 shows the specification of sensors.

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Table I Specification of sensors

S.NO	Name of the sensor	Detection type	Model make	Range
1	LM35	Temperature	LM35DZ	-55°C to 150°C @ 4 to 20 v
2	MQ5	CH4, LPG	MQ5 module	300 to 10000 ppm @ 0.1 to 4.5 V
3	Flame sensor	Fire	1 Channel YG1006 Photo Transistor module	-25°C to 85°C @ 3.3 to 9V
4	Bluetooth module	Commands	H-06	speed up to 2.1Mb/s. 2.402 GHz to 2.480GHz.

If any hazard is detected, the system automatically activates a buzzer, LED, and sprinkler to minimize risks. To improve user control, the system includes Bluetooth functionality using an HC-06 module, allowing users to operate the buzzer, LED, and sprinkler manually through a mobile application (Serial Bluetooth Terminal). This communication is established through UART, ensuring quick execution of commands. Additionally, the system integrates Firebase for IoT-based monitoring, where real-time data on gas status, fire detection, temperature readings, system ON/OFF status, and sprinkler activation is continuously updated and can be accessed remotely. Figure 1 shows the flow chart of the IoT based fire and gas detection system.

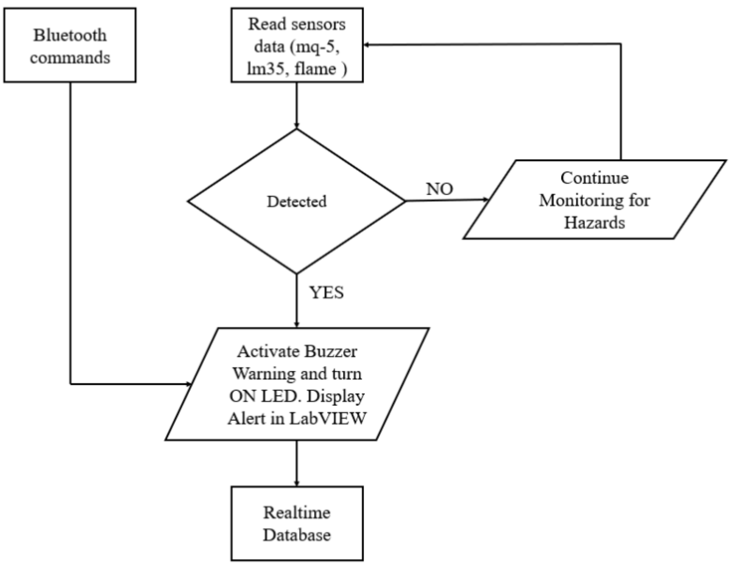

Figure. 1 Flow chart of the IoT based fire and gas detection system

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The system is developed using LabVIEW, with different sections handling specific tasks. The main section processes sensor readings and controls responses, the Bluetooth section manages UART communication, and the IoT section ensures Firebase connectivity. Shared variables allow smooth data exchange between these sections, ensuring all components work together without delays. By combining automated detection, manual control, and remote accessibility, the proposed system provides a flexible, efficient, and reliable approach to fire and gas safety monitoring, improving both response time and user control.

IV.METHODOLOGY

The IoT based fire and gas detection system is designed to continuously monitor environmental conditions and respond to potential hazards such as fire, gas leaks, and temperature fluctuations. It integrates multiple sensors, real-time data processing, and both automatic and manual control mechanisms to enhance safety. The system relies on an MQ-5 gas sensor to detect the presence of combustible gases, a single-channel flame sensor to identify fire, and an LM35 temperature sensor to monitor temperature variations. When a gas leak is detected, the system automatically activates a buzzer and LED to alert people in the vicinity. Similarly, if a fire is detected, an alarm is triggered, and the sprinkler system is activated to contain the flames. The temperature sensor plays a crucial role in detecting unusual heat levels, allowing the system to identify fire risks before they escalate. At the core of the system is the MyRIO unit, which processes data from all the sensors and makes real-time decisions based on the readings. The Main VI in LabVIEW serves as the central processing hub, continuously analyzing sensor inputs and determining the appropriate response. It follows a structured approach where different tasks are handled separately to ensure smooth execution. The Main VI is responsible for collecting and processing sensor data, making safety decisions, and activating necessary responses. It updates the system status on the LabVIEW interface, allowing users to monitor operations in real-time. Figure 2 shows the front panel window of the IoT based fire and gas detection system.

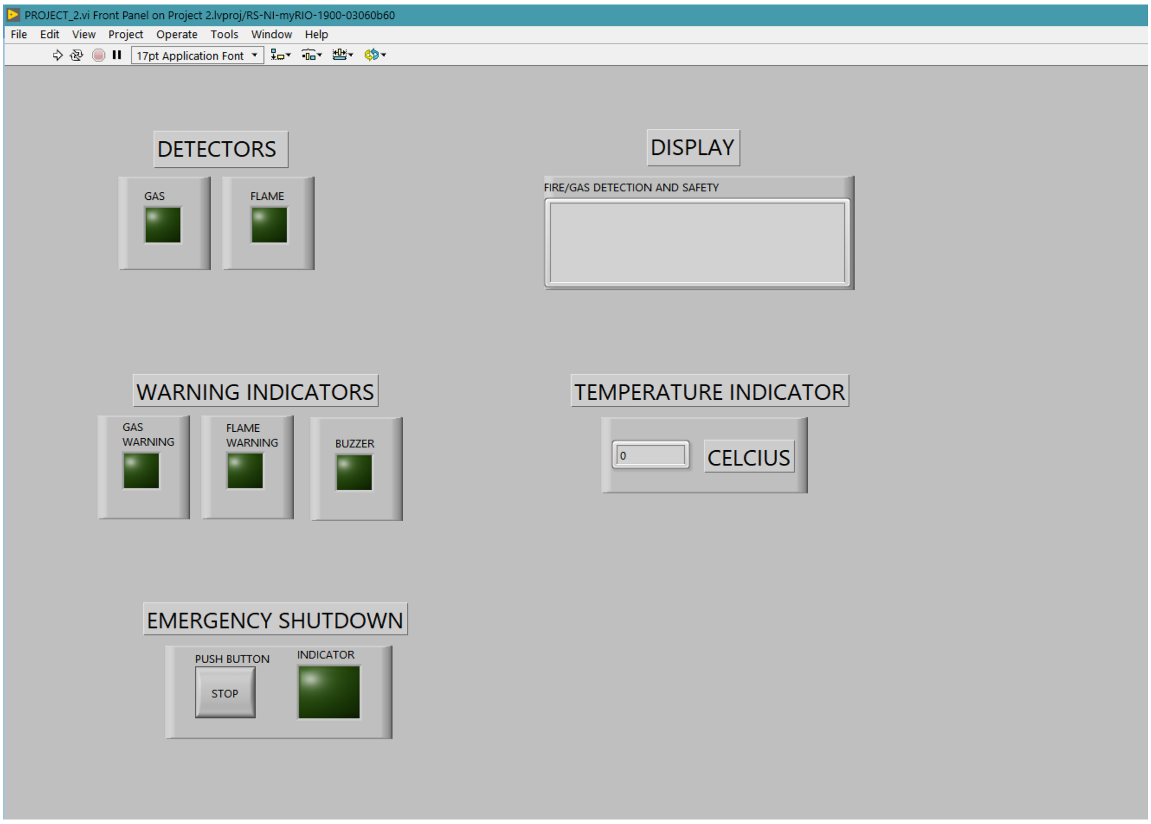

Figure. 2 Fron panel window of the IoT based fire and gas detection system

The decision-making logic is built on predefined conditions, ensuring that the system reacts automatically to any detected hazard while minimizing false alarms. Figure 3 shows the block diagram window of the IoT based fire and gas detection system.

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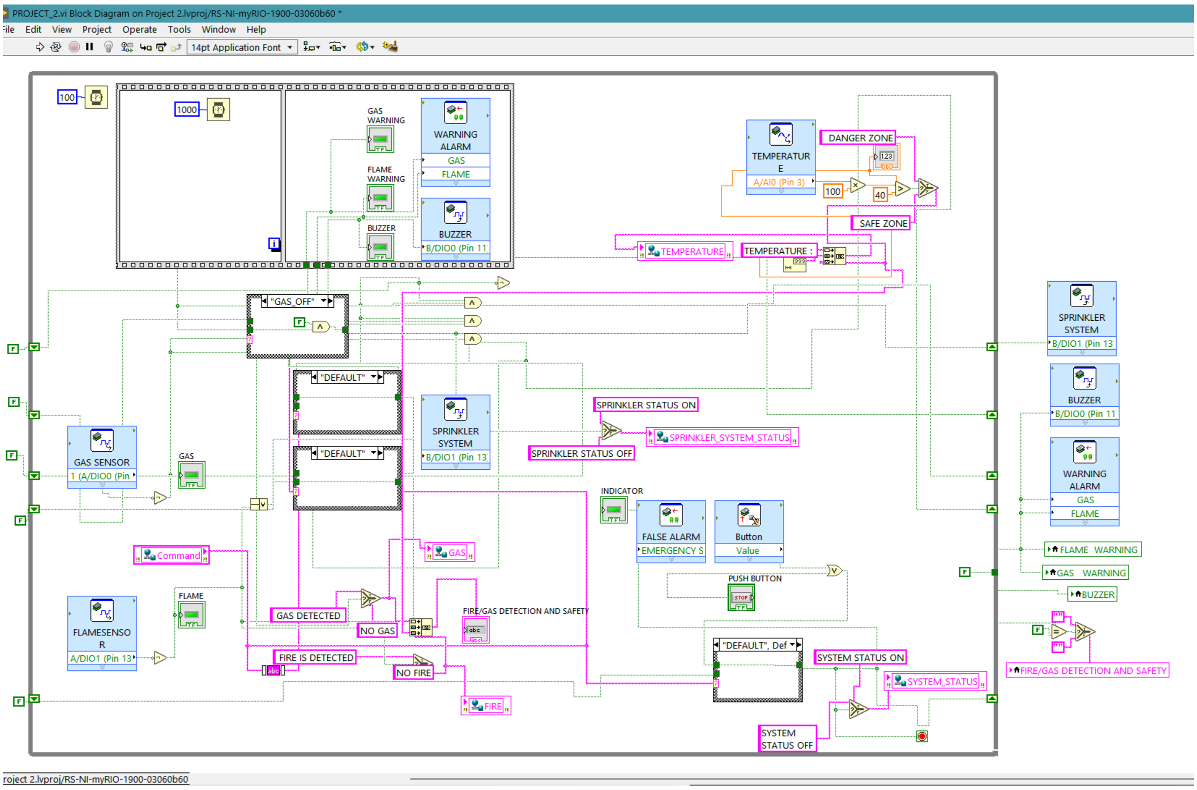

Figure. 3 Block diagram window of the IoT based fire and gas detection system

In addition to its automated functions, the system also allows for manual control through Bluetooth communication. A HC-06 Bluetooth module is connected to MyRIO via the UART (Universal Asynchronous Receiver-Transmitter) protocol, enabling users to send specific commands from a mobile application called Serial Bluetooth Terminal. Figure 4 shows the UART block diagram window of the IoT based fire and gas detection system.

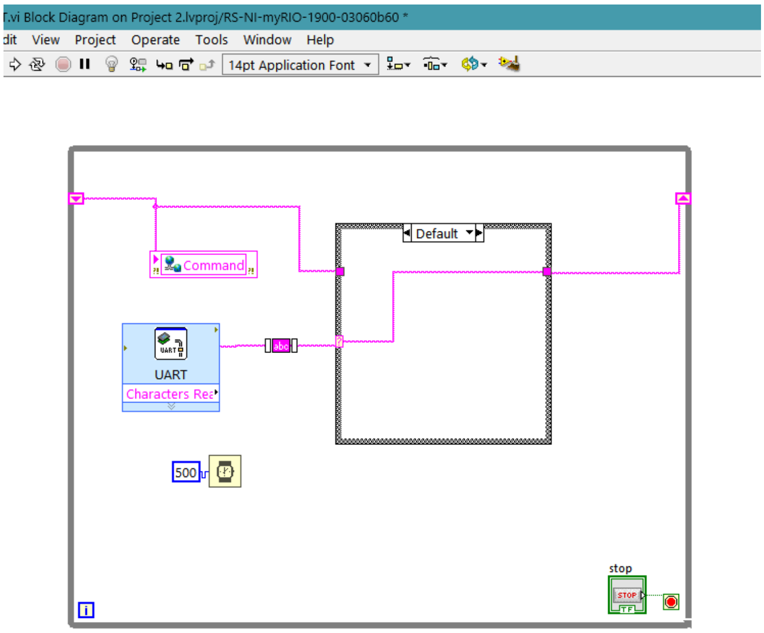

Figure. 4 UART Block diagram window of the IoT based fire and gas detection system

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This feature allows users to manually control system components such as the gas alarm, fire alarm, buzzer, and sprinkler system. Commands such as GAS_ON, GAS_OFF, FIRE_ON, FIRE_OFF, BUZ_ON, BUZ_OFF, SHUTDOWN, and DEFAULT allow remote operation of the system. A dedicated section in LabVIEW continuously listens for incoming commands from the HC-06 module, processes the received instructions, and updates the system accordingly. The use of UART communication ensures that commands are transmitted and executed quickly without delays. Figure 5 shows the IoT block diagram window of the IoT based fire and gas detection system.

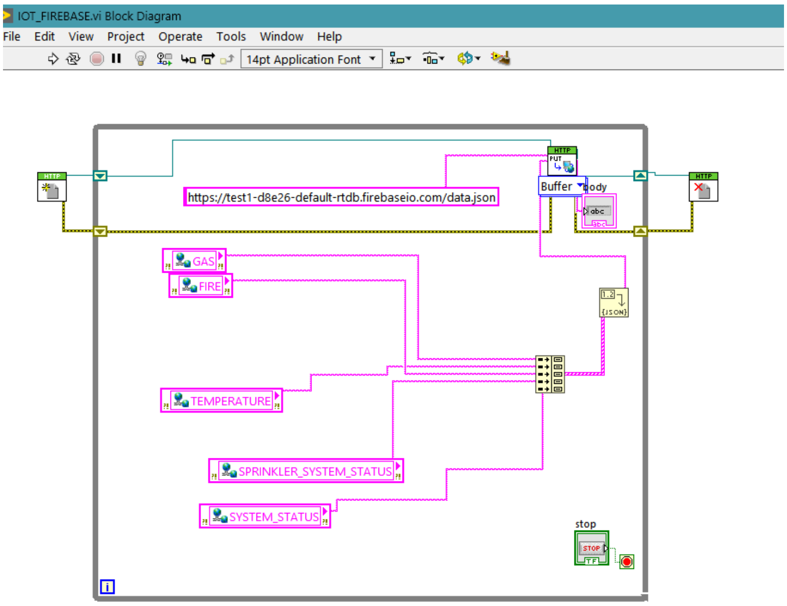

Figure. 5 IoT Block diagram window of the IoT based fire and gas detection system

To extend the monitoring capabilities beyond physical presence, the system is integrated with Firebase using IoT technology. This allows real-time sensor data to be stored and accessed remotely using the HTTP protocol. The system continuously updates five critical data points in Firebase, including gas detection status, fire detection status, temperature readings, system ON/OFF status, and sprinkler ON/OFF status. A separate section in LabVIEW is dedicated to handling Firebase communication, ensuring that sensor readings are properly transmitted and stored in the cloud. Since Firebase operates on a cloud-based platform, users can monitor the system from anywhere, enhancing its reliability and convenience. Figure 6 shows the experimental setup of the IoT based fire and gas detection system.

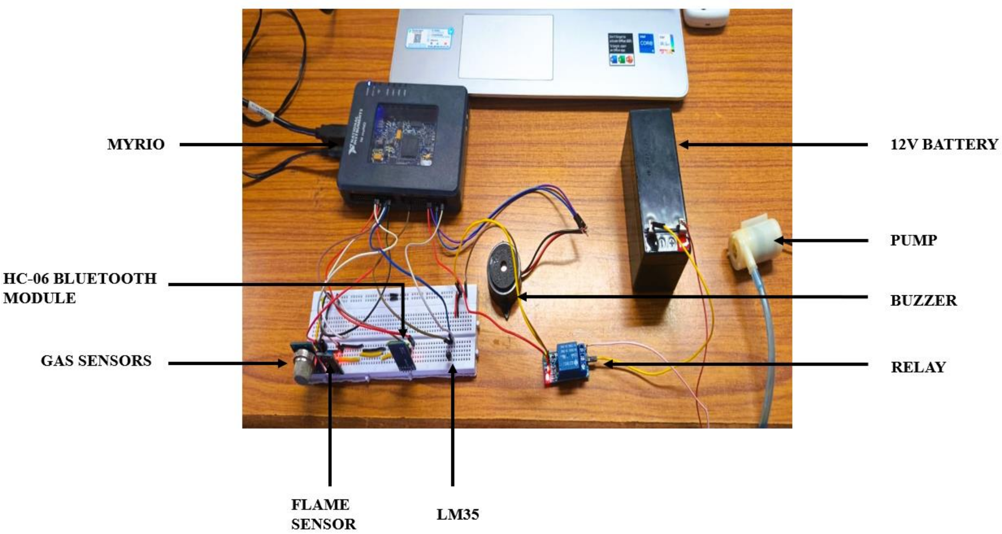

Figure. 6 Experimental setup the IoT based fire and gas detection system

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To ensure seamless communication between different sections of the LabVIEW program, the system uses shared variables for data exchange. These shared variables allow the Main VI, Bluetooth communication module, and Firebase integration module to function independently while still sharing essential information. The Main VI uses shared variables to access sensor readings and make real-time decisions, while the Bluetooth module updates the system status based on received commands. Similarly, the Firebase module continuously retrieves the latest sensor values and uploads them to the cloud. This system works continuously, detecting hazards and responding in real time while giving users the ability to control certain functions manually. Since all sensor data is available remotely through Firebase, it also allows monitoring from a distance. By dividing the system into different sections and using shared variables to manage information flow, it becomes efficient, reliable and easy to control.

V.RESULT AND DISCUSSION

The system was tested to detect gas leaks, fire, and temperature changes while ensuring quick response and remote monitoring. When LPG or butane gas was released near the MQ-5 sensor, the system successfully detected it and immediately activated the buzzer and LED. Similarly, when a flame was introduced near the fire sensor, the system triggered an alarm and turned on the sprinkler within seconds. The LM35 temperature sensor accurately measured temperature variations, providing continuous updates. Bluetooth communication through the HC-06 module worked reliably, allowing users to manually control the buzzer, LED, and sprinkler system using a mobile application. The system also transmitted real-time data to Firebase, where gas, fire, and temperature readings were updated and accessible remotely. Figure 7 shows the real time database window of the IoT based fire and gas detection system.

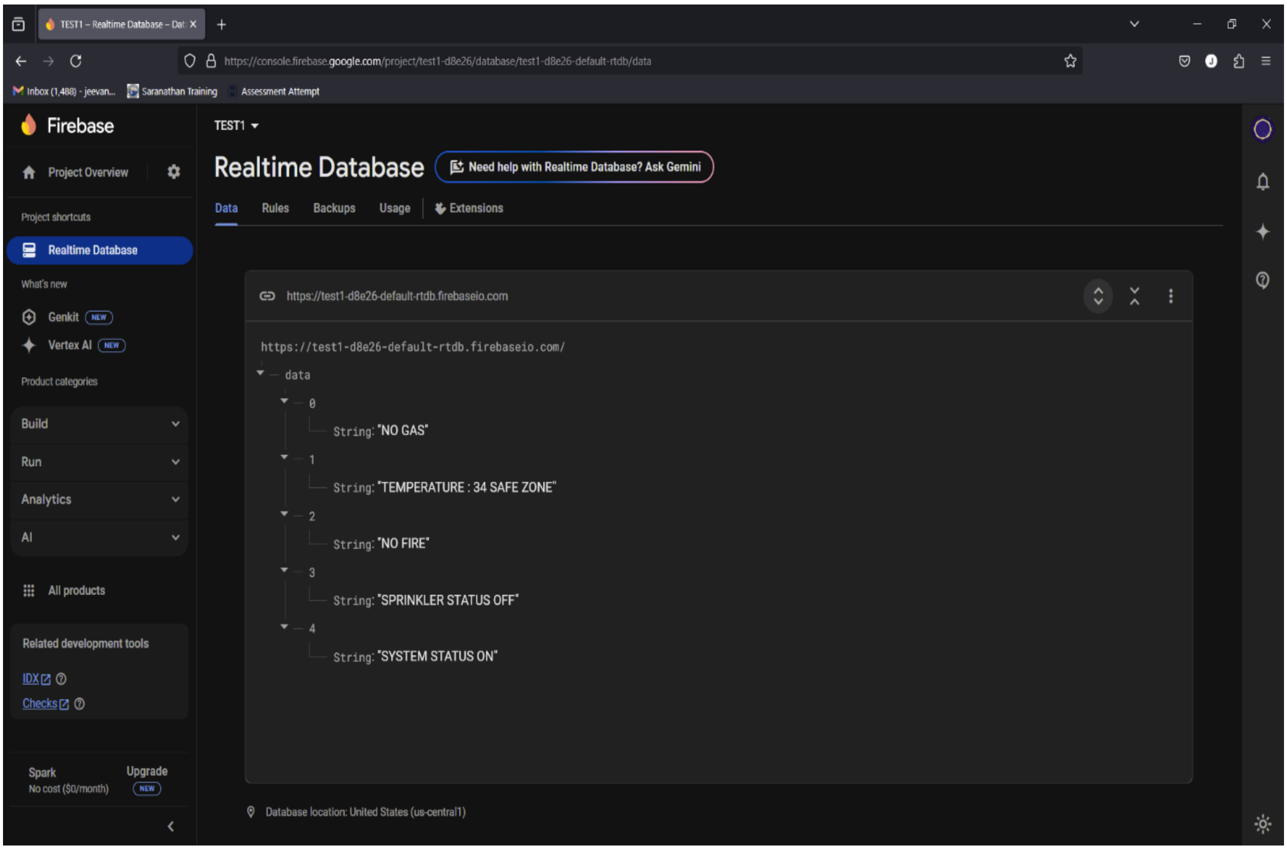

Figure. 7 Realtime database window of the IoT based fire and gas detection system

Data exchange between different sections of the system using shared variables ensured smooth operation without delays. Overall, the system demonstrated high accuracy, fast response time, and reliable remote monitoring, making it effective for early hazard detection and prevention. Table 2 shows output responses of the IoT based fire and gas detection system.

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Table II. Output responses of the IoT based fire and gas detection system

Sensors	Range	Commands	Threshold value	actuator	Ture	False
Gas sensor (MQ5)	300 ppm to 10000ppm	-	>300ppm	Buzzer	Red	Green
Flame sensor	25°C to 85°C	-	>60°C	Buzzer and Sprinkler system	Red	Green
LM35	-55°C to 150°C	-	>50°C	-	Danger zone	Safe zone
HC-06 Bluetooth module	speed up to 2.1Mb/s. 2.402 GHz to 2.480GHz.	GAS_ON, GAS_OFF, FIRE_ON, FIRE_OFF, BUZ_ON, BUZ_OFF, SHUTDOWN, DEFAULT.	-	Buzzer, Sprinkler system and System shutdown	Red	Green

VI.CONCLUSION

The system effectively detects gas leaks, fire, and temperature changes while providing both automatic responses and remote monitoring. It quickly identifies the hazards using MQ-5, flame, and LM35 sensors, activating the buzzer, LED, and sprinkler when needed. Bluetooth control with HC-06 allows users to manually operate these components through a mobile application, making the system more flexible. With Firebase integration, real-time sensor data can be accessed remotely, helping users stay informed and react quickly. MyRIO processes all data, while LabVIEW manages different tasks, with shared variables ensuring smooth communication between system parts. The system was tested successfully, showing fast response, accuracy, and reliability. In the future, improvements can include more sensors, AI-based predictions, and better remote-control features to enhance safety and performance.

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