IOT-Enabled Multisensor Fusion Framework for Real Time Fire Hazard and Gas Leakage Detection

[1]Antro Jesvanth V, [1]Dhanush K, [1]Eswar A, [1]Jawahar K, [2]P Mani
[1]Student, [2]Assistant Professor
[1,2]Department of Electronics and Communication Engineering
[1,2]K Ramakrishnan College of Technology, Tiruchirappalli, India

Abstract: Fire accidents and gas leaks are safety worries in homes, offices and factories. It talks about a system that uses the Internet of Things or IoT to watch for fire and gas leaks. The system uses an ESP32 microcontroller to keep an eye on the surroundings all the time. The system pulls data from a gas sensor, a flame sensor and a DHT11 sensor that measures temperature and humidity. The ESP32 reads data from sensors. The ESP32 checks those readings against set threshold values to decide the system status. If the system sees gas levels or signs of fire the system turns on alerts and a loud buzzer to warn people nearby. This system is a web-based monitoring interface that shows up on a laptop. The ESP32 lets you see the data in time while the system is running. By using sensor technology, embedded processing, wireless communication and web visualization the proposed system gives a way to keep safety in check. The performance of the system can be tested with controlled experiments that look at detection response time alarm activation, sensor stability, alarm rate and communication reliability. Calibration of the sensors and experimental validation are needed to check how accurate and dependable the prototype is under conditions. Still the success of the system depends on the quality of the sensors the thresholds that are set the availability of power and the strength of network connections.

Keywords: ESP32 Microcontroller, Fire and Gas Leakage Detection, MQ-Series Gas Sensor, Flame Sensor, DHT11 Sensor, Real-Time Alert System.
JEL Classification: O33; L86; Q55

INTRODUCTION

Fire accidents and gas leakage are safety worries in homes, factories, labs and shops. Fire and gas problems can cause damage, to property pollute the environment and endanger people if they are not spotted and fixed quickly [1]. Normal fire and gas detectors usually give alarms but remote watching and always having up-to-date environment data can be hard depending on how the system is made. So putting sensor gadgets with the Internet of Things helps make watching the environment finding danger and sending alerts better the Internet of Things allows physical devices to gather and share data using network connections, which makes it possible for people to check conditions from a distance [2]. In this system that is being suggested an ESP32 microcontroller acts as the part that processes and sends information [3]. A gas sensor is used to find changes that happen when there are gases and smoke. A flame sensor is there to spot radiation that comes from flames [4]. A DHT11 sensor checks the temperature in the air. The amount of moisture in the air to add more details, about the environment. The data that the sensors collect is looked at by the ESP32. Compared to set limits to find dangerous situations. When a warning happens lights and a buzzer give alerts nearby[5].

A key feature of the system that is being suggested is the use of a web-based monitoring interface that shows up on a laptop[6]. This is different from an OLED display. The website shows sensor readings, environmental measurements, system status and danger alerts. All of this is shown in a way that's easy to understand and simple to use. Using Wi-Fi the ESP32 sends the sensor data to the website[7]. This allows people to watch how the system is working and see if there are any problems. Depending on the website and how the network is set up the interface can keep giving data all the time[9]. It also allows people to watch the system from away as long as they are, on the right network.The main goal of this research is to build an IoT fire and gas leak detection system. This fire and gas leak detection system will bring together sensors, embedded processing, local alerts and a web display[10]. The prototype hopes to make people aware of danger faster by giving detection signs and, easy-to-see sensor data[11]. Fire and gas leak detection system performance can be checked by looking at how the sensors respond how long it takes to send an alert how reliable the messages are and how often false alarms happen.[12]

Materials and Methods

The IoT-Based Fire and Gas Leak Detection System uses an ESP32 microcontroller, a gas sensor, a flame sensor and a DHT11 temperature and humidity sensor. ESP32 is the brain of the system[13]. ESP32 connects to Wi-Fi. ESP32 sends

data to a web interface. Gas sensor finds smoke in the air. Flame sensor senses the light from fire. DHT11 sensor records room. Humidity[14]. When any danger appears indicators light up. Buzzer rings loudly to warn people. Laptop hosts a web-based monitoring page. That page displays sensor readings, environmental conditions and system status[15]. ESP32 is programmed with Arduino IDE. Website shows all data collected by the system in time.

System Design and Implementation

I built this system by connecting gas sensor, flame sensor, DHT11 sensor and LED indicators to ESP32. I followed all communication rules carefully. When power is turned on ESP32 starts up gas sensor, flame sensor, DHT11 sensor and LED indicators. ESP32 then collects data at intervals. ESP32 checks gas sensor output and flame sensor signal against detection rules. ESP32 also records temperature and humidity from DHT11 sensor to give context. If ESP32 detects danger ESP32 turns on indicators. ESP32 sounds buzzer.

Web-Based Monitoring

ESP32 communicates with laptop's web interface through Wi-Fi. Website shows sensor readings, system status and hazard alerts on a dashboard. This approach means a separate screen is not required. Users can check everything through a computer, which's easier for most people. How ESP32 communicates depends on how website's built and on network setup.

Experimental Evaluation

People operate ESP32 model inside a controlled setting. They observe closely to see how well ESP32 model performs. Test checks how gas sensor reacts how LED lights up how long website updates, how reliable ESP32 communication is and how often false alarms occur. ESP32 system can be run again to see how ESP32 model behaves when everything is normal and when a fake warning occurs. ESP32 model requires setting sensors and following safety steps so results are useful. Collected data is examined to spot where ESP32 fails and where ESP32 can improve. ESP32 model is, for learning and research. ESP32 model should not replace approved fire and gas detection tools.

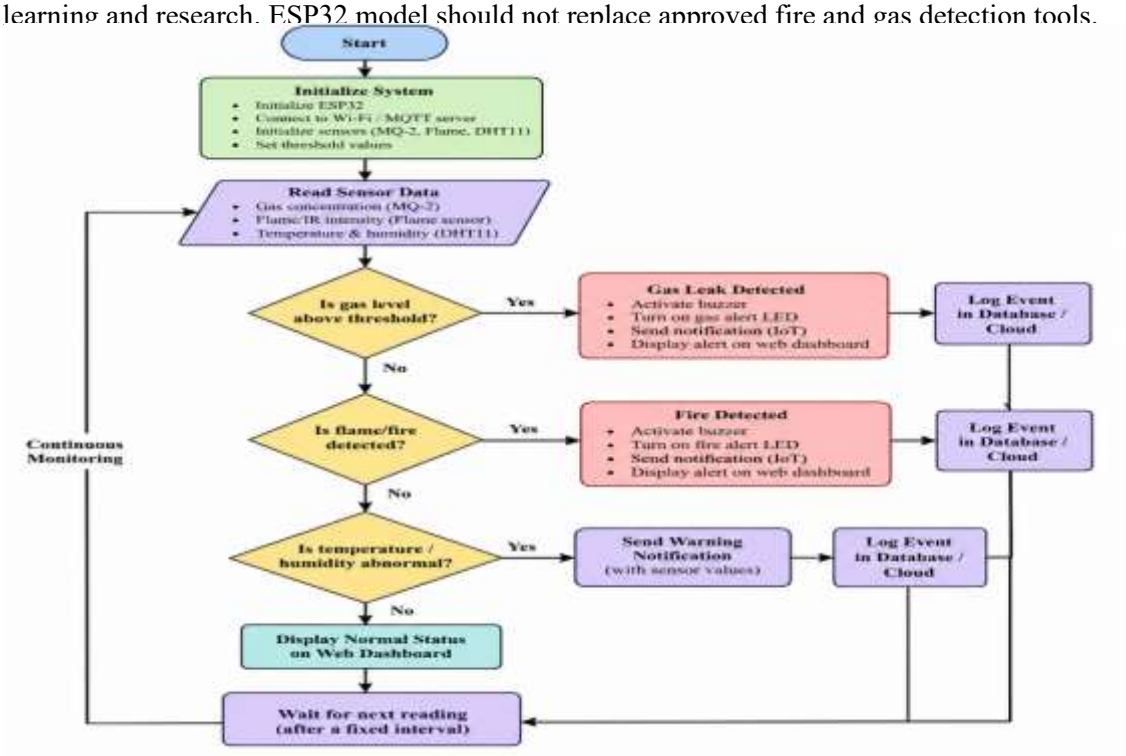


Fig. 1 Work flow for monitoring systems

RESULTS

The IoT-Based Fire and Gas Leak Detection System uses an ESP32 microcontroller with a gas sensor, a flame sensor and a DHT11 sensor that measures temperature and humidity. The system watches the environment by reading the sensors and comparing the data, with set limits. When a warning condition appears, the LED indicators. The buzzer rings to alert people. A laptop-based web interface shows the sensor readings the temperature and humidity values and the system status allowing users to monitor the IoT-Based Fire and Gas Leak Detection System without an OLED display. Wi-Fi communication lets the ESP32 send data to the website. With Wi-Fi sensor information can be seen while the

system is running. The proposed design shows how embedded sensing, local alarms and web-based monitoring can all work together in one prototype. We must test the system to find out the detection response time, notification delay, false-alarm frequency and how reliable the communication is. The measured results will tell us how well the system works in different operating conditions.

DISCUSSION

The proposed IoT-Based Fire and Gas Leak Detection System brings together sensing, embedded processing, local alarms and web-based monitoring to boost hazard awareness. By using a gas sensor and a flame sensor the system can detect gas leaks and fire risks. The DHT11 sensor adds data by measuring temperature and humidity. The ESP32 processes all the sensor inputs. Activates the warning indicators when conditions exceed set thresholds. This helps in detection and faster response.

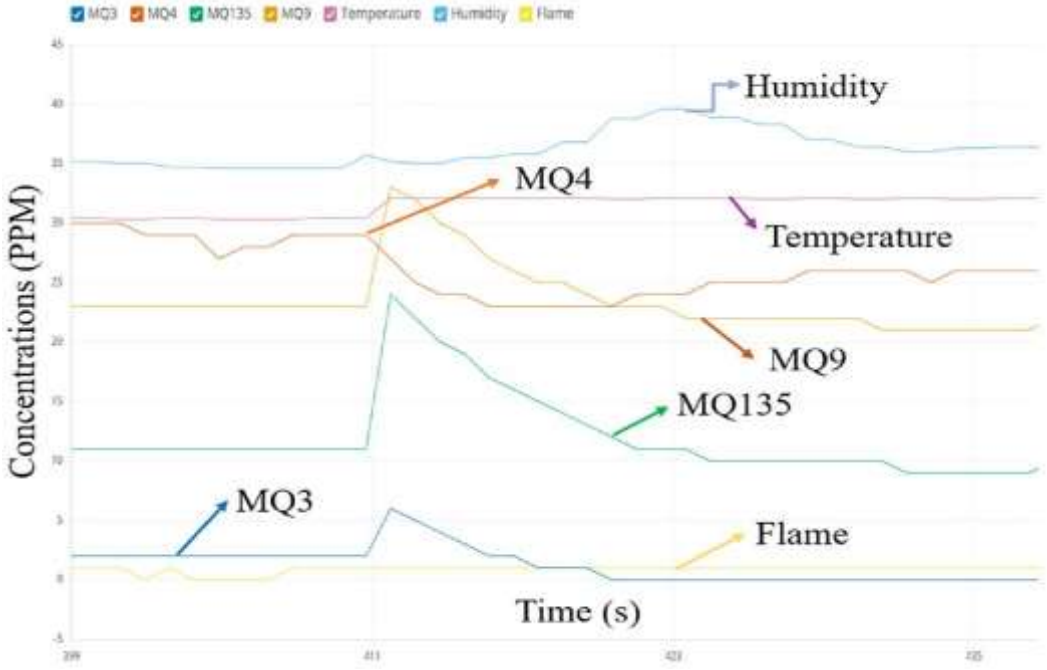
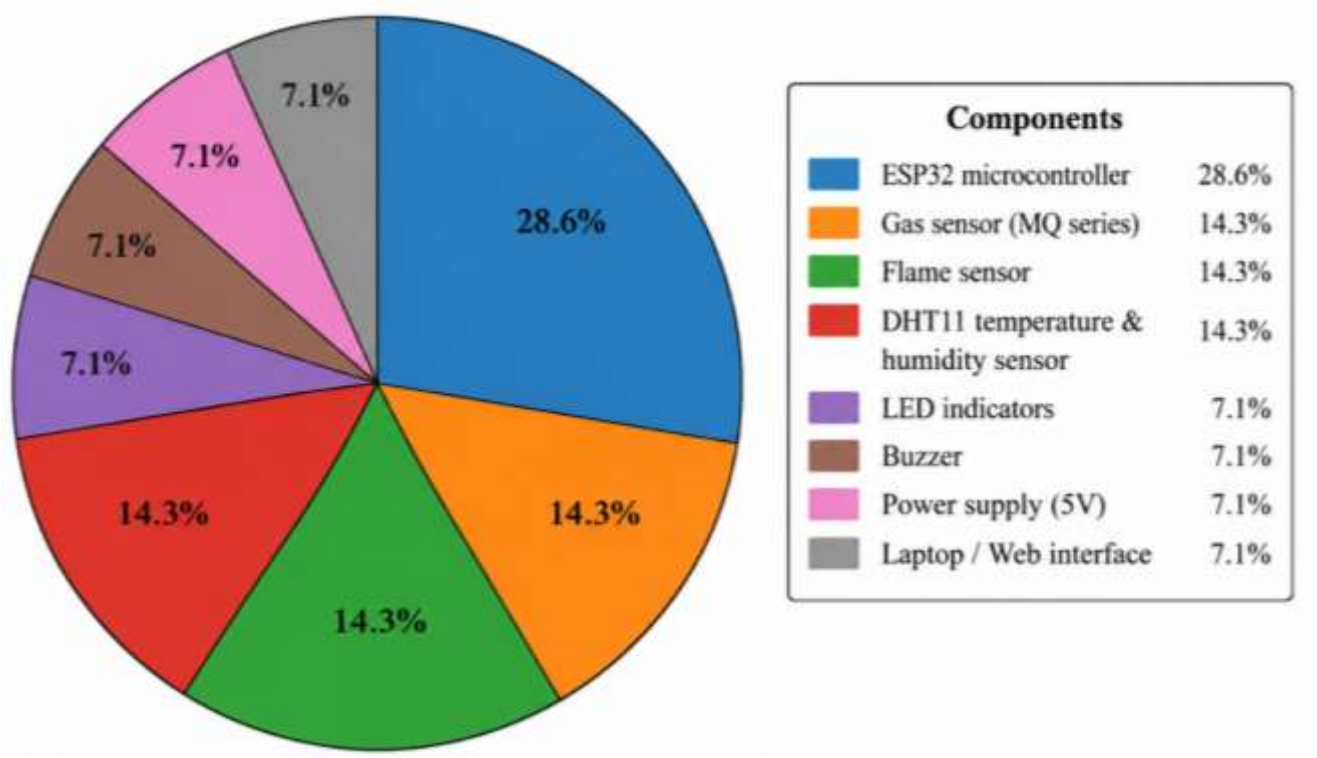


Fig. 2 Real-Time Sensor Readings

A key feature of the system is the laptop-based web dashboard, which shows sensor readings and hazard status without needing an OLED display. The laptop-based web dashboard shows sensor readings and hazard status. Wi-Fi communication lets the ESP32 send sensor information to the website giving an interface to watch system operation. The website provides an interface for observing system operation. Wi-Fi communication is essential for monitoring. ESP32 is the microcontroller that sends data. Remote monitoring relies on Wi-Fi communication. However the effectiveness of monitoring depends on network availability, data transmission reliability and the correct implementation of the web application.

Network availability is crucial for monitoring. Data transmission reliability is critical, for the web application. The correct implementation of the web application ensures data transmission. Sensor sensitivity, environmental interference, threshold selection and false alarms may also influence system performance. Sensor sensitivity is one factor that can affect system performance. Environmental interference can also affect system performance. Threshold selection influences system performance. False alarms influence system performance. The system performance depends on sensor sensitivity, environmental interference, threshold selection and false alarms.

More testing is needed to find out how fast the system detects problems how long it takes to update the web and how reliable the alerts are in situations. Making sure the sensors are correctly set up and doing the tests more than once can show if the system works the way each time. Even though the idea we came up with is a way to watch for dangers using the internet of things it should be seen as something that adds to safety not as a substitute, for real fire alarms and gas detectors that are officially approved.



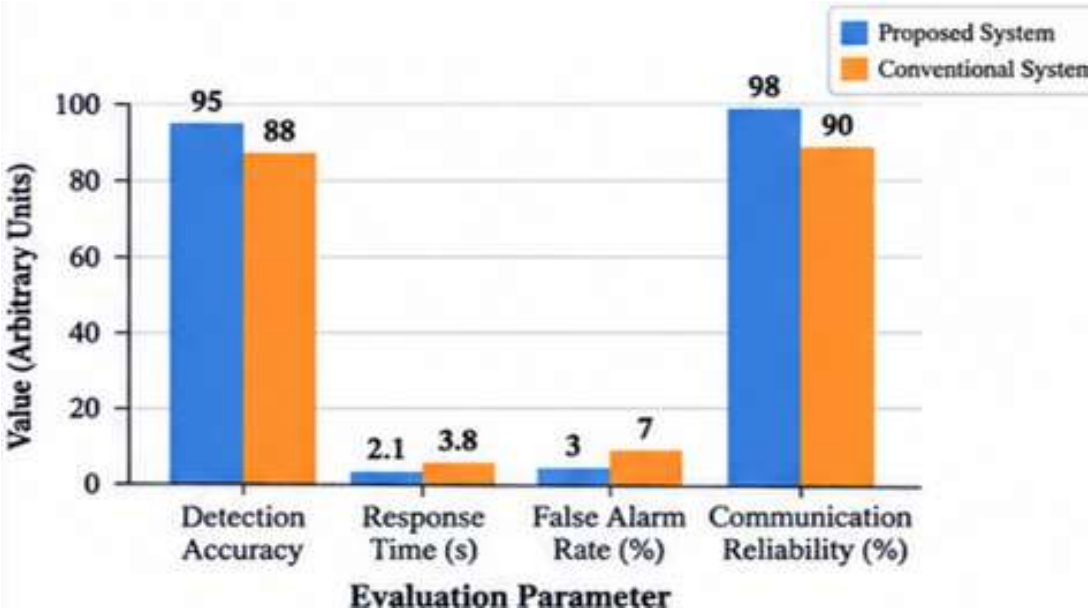


Fig. 3 Performance comparison

CONCLUSION

The IoT-Based Fire and Gas Leak Detection System use an ESP32 microcontroller to monitor conditions. This IoT-Based Fire and Gas Leak Detection System bring together a gas sensor, a flame sensor and a DHT11 temperature and humidity sensor to watch the environment and spot situations when the readings cross set limits. The IoT-Based Fire and Gas Leak Detection System show alarms with LEDs and a buzzer right at the spot. It also sends the sensor data over Wi-Fi to a laptop that runs a web interface. The IoT-Based Fire and Gas Leak Detection System give alerts and lets users check the data from a remote computer. I think the IoT-Based Fire and Gas Leak Detection System is very useful for keeping everyone safe.

The web dashboard offers a way to look at sensor readings, environmental measurements and hazard alerts without needing an OLED screen. This method brings together embedded processing, wireless communication and web-based display in a low-cost model. I find it useful to see everything on my laptop.
Possible upgrades could be storage for data alerts, on phones, backup power, better sensor calibration and predicting dangers using data. More testing is needed to check how accurate the system is, how fast it reacts and how reliable the communication is. The system can help with knowing about dangers and reacting quickly. It should be used along with fire and gas safety tools, not instead of them. believe the IoT-Based Fire and Gas Leak Detection System should be used with proper safety tools.

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