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Research Paper

IOT-BASED EMERGENCY RESPONSE SYSTEM FOR FIRE AND LPG GAS DETECTION WITH AUTOMATED POWER ISOLATION, GPS LOCATION SHARING, SMS AND VOICE ALERTS

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Abstract— This article presents a Smart IoT-Based Emergency Response System for Fire and LPG Gas Detection that utilizes the ESP32 microcontroller to perform real-time hazard detection and automated mitigation within a building environment. The system integrates MQ-series gas sensors and IR flame sensors to continuously monitor combustible gas leakage and fire incidents. Upon detecting an abnormal condition, the ESP32 immediately executes predefined safety actions. In the case of gas leakage, an exhaust fan relay is activated to disperse accumulated gas, while during fire detection, a power isolation relay disconnects the building's main electrical supply to prevent secondary ignition and electrical escalation.Simultaneously, a NEO-6M GPS module retrieves real-time geographical coordinates of the incident location. The system establishes secure HTTPS communication over Wi-Fi and utilizes the Twilio cloud API to transmit emergency notifications. SMS alerts and automated voice calls are sent to predefined contacts, including the building owner and fire station, with a dynamically generated Google Maps link containing precise GPS location details.By combining edge-based hardware intervention, secure cloud communication, GPS-enabled localization, and multi-channel alerting, the proposed prototype demonstrates a scalable, cost-effective, and intelligent fire safety framework designed to significantly reduce emergency response time and enhance building safety in residential and small commercial environments.

Keywords— ESP32, Internet of Things (IoT),LPG Gas Detection, Automated Power Isolation, Relay Control, NEO-6M GPS, Secure HTTPS Communication, Twilio API, SMS Alerts, Voice Call Notification, Real-Time Monitoring, Embedded Systems, Smart Safety System

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I. INTRODUCTION

Fires and gas leaks are still two of the biggest safety issues in homes and factories. Delays in finding the problem and getting in touch with emergency services often lead to serious damage to property and death. Local sounds are the main part of traditional fire warning systems, which might not call the right people if no one is at the scene. Because of this, smart, connected safety systems that can watch in real time and quickly talk over multiple channels are becoming more and more important. The technology like Internet of Things (IoT) has made it possible to create smart tracking systems that use microcontrollers, sensors, and cloud platforms. IoT-based safety networks let you keep an eye on

the environment all the time and send data instantly to computers far away. Using cloud technology and digital communication, emergency information can be viewed from anywhere. This speeds up reaction times and makes it easier for relief teams to work together.

ESP32 microcontrollers are used to build a widespread IoT-based fire safety network in this work. Flame sensors and MQ-series gas monitors are built into every unit in the building to find fires and dangerous gas leaks. When the system finds something that isn't normal, it instantly takes action to reduce the problem locally by cutting off the power source using a switch module. This stops electrical issues from getting worse. At the same time, a NEO-6M GPS instrument gets the exact location of the building that is being damaged.

The system not only detects fire and gas leaks but also immediately informs the right people using the internet. It connects securely through Wi-Fi and uses the Twilio service to send SMS messages and make automatic phone calls. If there is a fire, both the building owner and the fire station receive alerts. If

there is a gas leak, only the building owner is notified. Each message includes a Google Maps link showing the exact location of the incident using GPS, so emergency teams can quickly reach the place without typing the address.

The system also takes quick local action. If gas is detected, it turns on an exhaust fan to remove the gas and activates a loud buzzer to warn people nearby. If fire is detected, it immediately cuts off the building's main power supply to prevent electrical sparks and stop the fire from spreading. These actions happen instantly, even before remote alerts are fully delivered.

After sending alerts and taking safety actions, the system continues monitoring the environment without stopping. In this way the proposed project creates a smart and reliable safety system that reduces damage, saves time, and helps emergency responders act faster.

II. Literature Survey

Several researchers have developed IoT-based gas leakage detection systems to enhance residential and industrial safety.In recent years, a number of IoT-based solutions for detecting gas leaks and fires have been suggested to make buildings safer.

Pandey et al. [1] created a system for monitoring gas leaks that included MQ-series gas sensors, a microcontroller, and Wi-Fi. They built a system that could detect gas in real time and send alerts wirelessly. It was around 94% accurate in finding gas. But the design didn't have any active ways to stop the fire from becoming worse once it was found, such automatic power isolation.

Bagwe et al. [2] enhanced traditional detection systems by including cloud-based data recording, facilitating historical trend analysis and remote monitoring. The system showed a delay of less than 3 seconds, which meant that alerts were sent almost in real time. Even while the framework worked well with the cloud, it relied largely on internet access and didn't have any built-in local mitigation procedures in case the network went down.

Lakshmi et al. [4] suggested a cheap way to detect LPG leaks using a MQ-6 sensor, a GSM module, and a buzzer that sends SMS alerts right away. The technology responded in less than 10 seconds and made homes safer for less money. But it could only detect LPG and didn't have fire sensing or automatic electrical load regulation to keep hazards contained.

Subramanian et al. [6] created an IoT-enabled gas and fire monitoring system that used ESP8266 and a cloud platform to send warnings to several buildings at once. The system was able to send alerts around 90% of the time. Still, it depended completely on outside power sources and didn't have any local mitigation mechanisms, such relay-based power termination, to stop further harm from happening.

Lashmi and Pillai [8] introduced an ambient intelligence-driven fire detection system that integrated flame sensors with a decision support algorithm to improve detection precision, attaining an efficacy of approximately 92%. The system had smart event categorization, but it didn't provide emergency responders GPS-based location information to help them find the specific site of the incident.

Gupta et al. [9] created a single monitoring system that included gas and fire safety utilizing MQ-2 and infrared flame sensors. The system had a reaction time of around 2.5 seconds, which showed that it could effectively identify many hazards. But it didn't include hardware-level control systems like relay modules that might cut off the power grid in an emergency.

Jadhav and Patil [10] created a system for monitoring home safety in real time utilizing smoke sensors and ESP32. The system was up and running over 99% of the time. The system provided steady monitoring, but it did not include multi-channel alerting methods like email messages or GPS-based position mapping for coordinating emergency response.

Most of the research that is already out there is mostly on finding hazards and rudimentary warning systems. Most systems don't have a single framework that includes integrated mitigation measures, GPS-based localization, redundant multi-channel communication, and distributed multi-building design. These constraints show how important it is to have a complete IoT-based fire protection network that includes real-time detection, automatic power separation, cloud synchronization, and accurate location-based alerts, as this study suggests.

III. Proposed System

The proposed architecture (shown in Figure 1) is a smart IoT-based fire and LPG gas emergency response system designed for real-time hazard detection and automated mitigation within a building environment.

The system is built around an ESP32 microcontroller interfaced with MQ-series gas sensors and an IR flame sensor to provide continuous environmental monitoring. When gas concentration or flame intensity

exceeds predefined safety thresholds, the ESP32 immediately initiates local mitigation procedures.

In gas leakage scenarios, an exhaust fan relay is activated to disperse accumulated gas, while during fire detection, a power isolation relay disconnects the building's electrical supply to prevent secondary ignition and electrical escalation.Simultaneously, a NEO-6M GPS module acquires precise geographical coordinates of the affected location.

The ESP32 then establishes a secure HTTPS connection over Wi-Fi and communicates with the Twilio cloud API to transmit structured emergency notifications. Multi-channel alerting is implemented through SMS and automated voice calls sent to predefined contacts, including the building owner and fire station, along with a dynamically generated Google Maps link containing accurate location details.

Unlike distributed cloud-monitoring systems, this architecture eliminates the need for a dedicated receiver unit by directly notifying emergency personnel through secure cloud-based communication. The layered framework integrates real-time detection, automated hardware mitigation, GPS-enabled localization, and secure API-based alert transmission within a scalable, cost-effective, and robust embedded safety system designed to minimize emergency response time.

Proposed system architecture

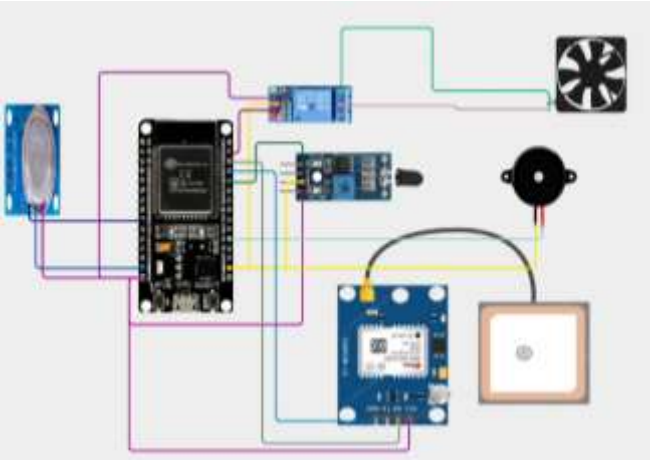


Fig 1 Architecture

IV. Components and Discussion

A. Hardware Components:

a) ESP32 Microcontroller

The ESP32 microcontroller serves as the central processing unit of the proposed system. It is a high-performance, low-power embedded controller with integrated Wi-Fi and Bluetooth capabilities, enabling seamless cloud connectivity and dual-node communication. The ESP32 continuously reads sensor data, processes threshold conditions, controls the relay module. Its built-in wireless communication eliminates the need for external networking modules, making the system compact, scalable, and cost-effective.



Fig2 ESP32 microcontroller

b) MQ-5 Gas Sensor

The MQ-5 sensor is a semiconductor-based gas sensor designed for the detection of LPG, natural gas, and other combustible gases. It operates by measuring changes in resistance when exposed to gas concentrations above safe levels. In the proposed system, the MQ-5 sensor continuously monitors ambient air quality and provides analog output signals to the ESP32. When gas levels exceed predefined safety thresholds, the microcontroller initiates mitigation and alert mechanisms.



Fig3 MQ 5 Sensor

c) IR Flame Sensor

The infrared (IR) flame sensor is used for rapid detection of fire by sensing infrared light wavelengths typically emitted by open flames. It provides a digital or analog output signal upon detecting flame radiation within its sensitivity range. Due to its fast response time and high sensitivity, the IR flame sensor enables early fire detection, allowing immediate system activation before the fire spreads.



Fig4 IR sensor

d) 5V Relay Module

The 5V relay module acts as an electromagnetic switching device that enables automated control of the building's electrical power supply. Upon receiving a trigger signal from the ESP32, the relay disconnects the main power line, thereby isolating the electrical grid. This automated power isolation protocol reduces the risk of short circuits, electrical sparks, and further fire escalation during hazardous conditions.



Fig5 Relay

e) NEO-6M GPS Module

The NEO-6M GPS module provides real-time geographical coordinates, including latitude and longitude, using satellite-based positioning. In the event of fire or gas leakage detection, the GPS module transmits precise location information to the ESP32, which is then included in cloud updates and emergency notifications. This ensures accurate localization, enabling emergency responders to reach the incident site without delay.



Fig6 NEO-6M GPS Module

f) Buzzer/Alarm

The buzzer or alarm module provides a high-decibel audible alert to notify occupants of potential danger. It is activated immediately upon detection of fire or gas leakage, ensuring rapid evacuation of the premises. In addition to local alerts within the building, the buzzer in the fire station receiver unit serves as a hardware-based emergency indicator, providing instant awareness to emergency personnel.



Fig7 Buzzer

V. WORKING

i. The system operation begins with initialization, during which the ESP32 microcontroller powers on and establishes Wi-Fi connectivity. All connected hardware modules, including the MQ gas sensor, IR flame sensor, 5V relay module, buzzer, and NEO-6M GPS module, are configured and verified for proper functioning. The gas sensor is allowed to stabilize and calibrate according to predefined threshold limits, while the GPS module begins acquiring satellite signals to ensure location readiness. Communication services for SMS and automated voice calls are also initialized to ensure immediate alert transmission when required.

ii. After successful initialization, the system enters a continuous monitoring loop. In this mode, the ESP32 continuously reads gas concentration values from the MQ sensor and simultaneously checks the

flame detection status from the IR sensor. The measured gas levels are compared with predefined safety thresholds, and the flame sensor output is evaluated to determine whether a fire is present. If the gas concentration remains within safe limits and no flame is detected, the system continues normal environmental monitoring without triggering any alerts.

iii. When a hazardous condition is detected, such as gas concentration exceeding the threshold or flame detection, the system immediately transitions into emergency mode. The ESP32 activates the 5V relay module to isolate the building's electrical power supply, thereby preventing ignition and reducing fire escalation risk. At the same time, the buzzer is triggered to provide a high-decibel local alert for occupant evacuation. The system then retrieves real-time latitude and longitude coordinates from the NEO-6M GPS module to accurately identify the incident location.

iv. Based on the type of hazard detected, the system applies a differentiated communication protocol. In the case of fire detection, SMS alerts and automated voice calls are sent to both the building owner and the fire station using the fire-specific TwiML configuration. In the case of gas leakage, SMS and a voice call are sent only to the building owner using the dedicated gas-leak TwiML script. After successfully transmitting the alerts, the system automatically returns to continuous monitoring mode, ensuring real-time, uninterrupted safety surveillance.

V. Experimental Results

The effectiveness of the proposed Distributed LPG and Fire Emergency Response System was experimentally validated through multiple controlled test scenarios. The system successfully demonstrated real-time hazard detection, automated mitigation, and multi-channel emergency alert delivery under different fire and gas leak conditions.

The outgoing call records triggered automatically during hazard detection (showun in Figure 8). The logs show completed and attempted calls, validating correct TwiML configuration and successful API-based voice alert activation.

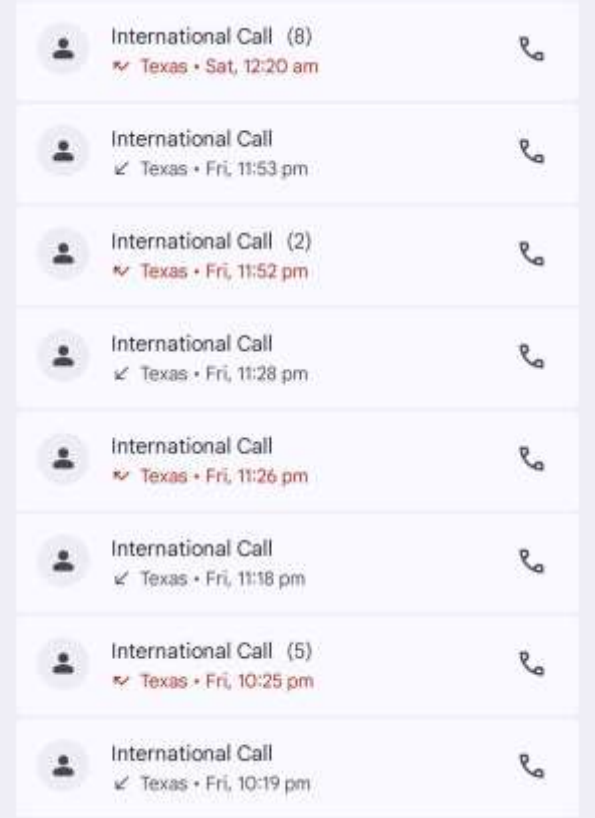


Fig 8 Twilio Voice Call Logs Confirming Emergency Call Initiation

Figure 9 shows the emergency SMS notification generated during fire detection. The message includes the hazard type and a dynamically generated Google Maps link containing live latitude and longitude coordinates retrieved from the NEO-6M GPS module.

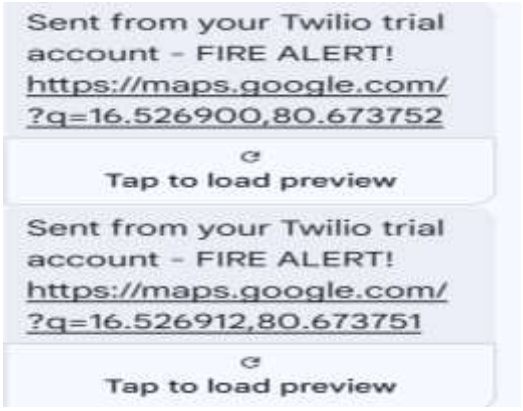


Fig 9 Fire Alert SMS with Dynamic Google Maps Integration

Figure 10 illustrates the Gas Leak Alert SMS with Dynamic Google Maps Integration.and the SMS alert transmitted when combustible gas concentration exceeded the predefined safety threshold. The message confirms successful sensor detection, Twilio API communication, and GPS-based location embedding.

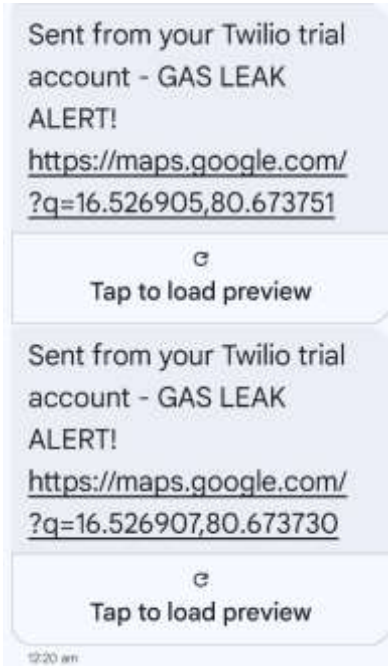


Fig 10 Gas Alert SMS with Dynamic Google Maps Integration

During gas leakage simulations, the MQ-5 sensor accurately detected hazardous gas concentrations well before reaching the Lower Explosive Limit (LEL), confirming its high sensitivity and rapid response characteristics. Similarly, controlled flame exposure experiments validated the fast detection capability of the IR flame sensor under varying environmental conditions. In all critical scenarios, the system successfully activated the relay modules within sub-second mitigation latency. During gas leakage events, the exhaust fan relay was triggered promptly to disperse accumulated gas, while in fire scenarios, the power isolation relay disconnected the main electrical supply, significantly reducing ignition risks and preventing secondary escalation.Communication performance was evaluated by measuring the time required to establish secure HTTPS connectivity and transmit emergency notifications using the Twilio cloud API. The results indicated minimal communication latency between hazard detection and successful SMS and voice call initiation. Emergency alerts were delivered almost immediately after local mitigation, confirming the efficiency of the secure API-based communication framework.

The NEO-6M GPS module was assessed for coordinate accuracy and satellite acquisition time. Experimental observations demonstrated consistent and reliable latitude and longitude reporting with acceptable fix times under open-sky conditions. The dynamically generated Google Maps link embedded in the Twilio SMS alert enabled emergency responders to navigate directly to the incident site without manual address entry, significantly reducing dispatch time during critical emergency scenarios.Network resilience testing confirmed that the ESP32 automatically re-established Wi-Fi connectivity after temporary signal interruptions, ensuring uninterrupted monitoring and alert capability. Multiple communication trials demonstrated a high success rate for both SMS delivery and automated voice call initiation through the Twilio API. Secure HTTPS transmission and authenticated API communication ensured reliable and protected data exchange during emergency events.

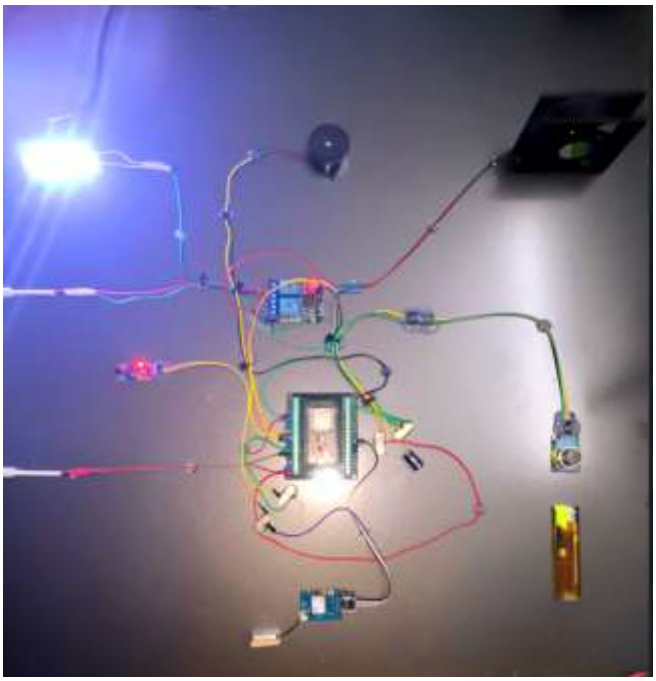


Fig 10:Prototype

Conclusion

This paper presented a Smart IoT-Based Emergency Response System for Fire and LPG Gas Detection built on an ESP32-based embedded architecture for real-time hazard monitoring, automated mitigation, and secure multi-channel communication. The system integrates MQ-series gas sensors and an IR flame sensor to ensure continuous environmental surveillance and early detection of combustible gas leaks and fire incidents within residential and small commercial environments.Upon hazard detection, the proposed system performs immediate local mitigation through relay-based control mechanisms. In gas leakage scenarios, an exhaust fan relay is activated to reduce gas concentration, while in fire conditions, a power isolation relay disconnects the building's main

electrical supply to prevent secondary ignition and electrical escalation. This proactive hardware intervention significantly enhances safety by transitioning from passive alarm systems to active hazard containment.

To ensure rapid emergency response, the system incorporates a NEO-6M GPS module for real-time location acquisition. The ESP32 establishes secure HTTPS communication over Wi-Fi and utilizes the Twilio cloud API to transmit structured emergency notifications. SMS alerts containing dynamically generated Google Maps links, along with automated voice calls, are delivered to predefined emergency contacts, including the building owner and fire station. This dual-channel communication mechanism enhances alert reliability and minimizes response delays.Experimental validation confirmed high sensor sensitivity, sub-second mitigation latency, reliable GPS localization, secure API-based communication, and consistent SMS and voice call delivery performance. The system also demonstrated strong network resilience through automatic Wi-Fi reconnection capability.

REFERENCES

[1] R. C. Pandey, M. Verma, and L. K. Sahu, "Internet of Things (IoT) Based Gas Leakage Monitoring and Alerting System," International Journal of Engineering Development, vol. 5, no. 2, pp. 10–15, 2017.

[2] C. Bagwe, V. Ghadi, V. Naik, and N. Kunte, "IoT Based Gas Leakage Detection System with Database Logging and Smart Alerting," IOSR Journal of Engineering, vol. 8, no. 12, pp. 11–16, 2018.

[3] V. Tamizharasan, T. Ravichandran, M. Sowndariya, R. Sandeep, and K. Saravanavel, "Gas Level Detection and Automatic Booking Using IoT," in Proc. IEEE International Conference on Advanced Computing & Communication Systems (ICACCS), Coimbatore, India, pp. 922–925, 2019.

[4] P. K. M. Lakshmi, P. S. G. Aruna Sri, and P. Gopi Krishna, "An IoT Based LPG Leakage Sensing and Alerting System," International Journal of Innovative Technology and Exploring Engineering (IJITEE), vol. 8, no. 6, pp. 1234–1238, 2019.

[5] S. Bhoir, S. Goregaonkar, and S. Satre, "IoT Based Gas Detection System," International Journal of Engineering Science and Computing, vol. 7, no. 4, pp. 10231–10235, 2017.

[6] M. Athish Subramanian, N. Selvam, S. Rajkumar, R. Mahalakshmi, and J. Ramprabhakar, "Gas Leakage Detection System using IoT with Integrated Notifications," in Proc. IEEE Fourth International Conference on Inventive Systems and Control (ICISC), pp. 359–362, 2020

[7] A. R. Al-Ali, I. A. Zualkernan, F. Aloul, and R. T. Al-Hassan, "A Smart Home Energy Management System Using IoT," in Proc. IEEE International Conference on Smart Grid and Smart Cities, 2019, pp. 1–6

[8] K. Lashmi and A. S. Pillai, "Ambient Intelligence and IoT Based Decision Support System for Fire Detection," in Proc. IEEE ICECCT, Coimbatore, India, 2019, pp. 1–4.

[9] R. Gupta, A. Singhal, and S. K. Sharma, "IoT Based Gas and Fire Safety System Using Low-Cost Sensors," in Proc. International Conference on IoT and Applications (ICIoTA), 2020, pp. 376–380.

[10] S. R. Jadhav and P. Patil, "IoT-Based Real-Time Safety Monitoring System for Residential Applications," International Journal of Engineering Research, vol. 9, no. 3, pp. 56–61, 2020.

[11] M. Z. Rahman, F. Ahmed, and A. N. Bari, "Cloud-Based Event Monitoring Using IoT Sensors," in Proc. IEEE ICECE, 2021, pp. 399–404.

[12] L. Chen, Y. Yin, and X. Ding, "Cloud-Enabled IoT Safety Monitoring System Using Low-Cost Sensors," Measurement, vol. 184, p. 109953, 2021.

[13] N. V. Abhishek, T. J. Lim, B. Sikdar, and A. Tandon, "An Intrusion and Event Detection System for IoT Networks," in Proc. IEEE CQR Workshop, 2018, pp. 1–6.

[14] A. Singh and B. Tudu, "IoT Enabled Safety and Emergency Response Systems," in Springer Lecture Notes in Networks and Systems, vol. 241, pp.321–330,20.

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