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ESP 32 BASED LAB ENHANCED SAFETY & GAS DETECTION USING IOT

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ABSTRACT

Modern laboratories consists of harmful gases, high-temperature equipment, electrical instruments, & flammable materials that pose significant safety risks. Any unobserved gas leakage, fire outbreak, or irregular temperature rise can result in severe accidents, property damage, & health threats. The project termed “ESP32 Based Lab Enhanced Safety & Gas Detection Using IoT” is developed to constantly monitor environmental conditions inside laboratories & automatically take defensive actions when unsecure situations\conditions are detected. The system uses an ESP32 microcontroller integrated with multiple sensors like DHT11 (Temperature & Humidity), MQ-series Gas Sensor (MQ-2/MQ-135), and Flame Sensor to detect or identify environmental irregularities. In case of gas leakage, fire detection, or temperature rise, the system enables a buzzer alarm, displays warnings on a 16×2 LCD screen, & automatically switches ON an exhaust fan through a relay module to remove harmful & hazardous gases. Additionally, IoT connectivity via Wi-Fi enables real-time data transmission to a cloud dashboard for remote monitoring. This system ensures immediate detection, automatic response, & continuous supervision, significantly increasing laboratory safety.

INTRODUCTION

Laboratories in educational institutions, research centers, hospitals, & industries handle chemicals, gases, & high-temperature equipment that can generate hazardous conditions if

not correctly monitored. Gas leakage, fire accidents, or excessive heating may occur surprisingly & cause serious injuries, health threats, or infrastructure damage. Traditional safety systems often rely on manual supervision, which may delay emergency response.

The introduced ESP32-based safety system gives an automated & intelligent solution for laboratory safety. The ESP32 microcontroller offers built-in Wi-Fi ability, creating it ideal for IoT-based applications. By integrating temperature, gas, & flame identification sensors, the system constantly monitors environmental conditions. If irregular values are detected, it automatically enables warning systems & preventive measures.

The addition of IoT monitoring enables lab officials to remotely supervise environmental parameters through cloud dashboards or mobile devices. This combination of real-time monitoring, automated response, & remote supervision ensures improved safety & decreases dependency on manual inspection.

LITERATURE SURVEY

Recent studies displays that microcontroller-based systems using sensors like MQ-series gas sensors & DHT11 temperature sensors give more precise environmental monitoring. The integration of IoT platforms permits cloud-based logging & real-time alerts.

Research in safety monitoring systems has inncluded from simple gas detection alarms to intelligent IoT-based monitoring platforms. Earlier systems used standalone gas detectors with buzzer alarms but lacked remote monitoring & automation attributes.

Research articles published by IEEE highlight the importance & need of IoT-based smart safety systems in industrial & laboratory environments. Studies by Elsevier illustrate that automated exhaust systems significantly decrease harmful gas concentration in enclosed spaces. The ESP32 microcontroller has become popular due to its dual-core processing ability & built-in Wi-Fi, as reported by Espressif Systems. The literature confirms that combining multi-sensor detection with IoT monitoring enhances early hazard detection & response time compared to conventional systems.

PROPOSED SYSTEM

The proposed system integrates multiple sensors with the ESP32 to constantly monitor laboratory environmental conditions & automatically respond to unsecure situations.

A. System Overview

1. DHT11 monitors temperature & humidity levels.
2. MQ-2/MQ-135 gas sensor detects harmful & hazardous gases such as LPG, smoke, CO, or ammonia.
3. Flame sensor detects fire presence.
4. ESP32 processes sensor data regularly.
5. If irregular conditions are detected:
   - Buzzer enables
   - LCD displays warning message
   - Relay switches ON exhaust fan
6. Data is transmitted via Wi-Fi to a cloud dashboard for remote monitoring.

B. Key Components

- **ESP32 Development Board –** Main controller with built-in Wi-Fi.
- **DHT11 Sensor** – Measures temperature & humidity.
- **16×2 LCD Display –** Displays real-time environmental data**.**
- **Relay Module –** Controls exhaust fan.
- **MQ-2 / MQ-135 Gas Sensor –** Detects smoke& hazardous gases.
- **Flame Sensor** – Detects fire presence.
- **Exhaust Fan** – Removes harmful & hazardous gases.
- **Buzzer / Alarm** –Gives audible warning.
- **Power Supply –** Gives regulated voltage.
- **Connecting Wires –** Circuit integration.

C. Working Principle

1. The ESP32 constantly reads data from DHT11, MQ sensor, & Flame sensor.
2. Sensor values are compared with predetermined safety thresholds.
3. If gas concentration exceeds the secure limit:
   - Buzzer turns ON
   - LCD displays “Gas Leakage Detected”
   - Relay enables exhaust fan
4. If flame is detected:
   - Alarm sounds
   - LCD shows “Fire Alert”

5. If temperature exceeds threshold:
   - Warning message displayed
   - Optional cooling action triggered
6. All data is transmitted via Wi-Fi to IoT dashboard for remote monitoring.
7. Continuous & constant monitoring ensures real-time safety control.

D. Advantages

- Enhances laboratory safety
- Low cost & simple installation
- Scalable for industrial use
- Real-time multi-parameter monitoring
- Early detection of fire & gas leakage
- Automatic exhaust system activation
- Remote monitoring via IoT
- Decreases human intervention

E. Application

- Hospital labs
- College & research laboratories
- Chemical laboratories
- Industrial plants
- Smart building safety systems
- Pharmaceutical industries
- Storage rooms with flammable materials

Block Diagram:

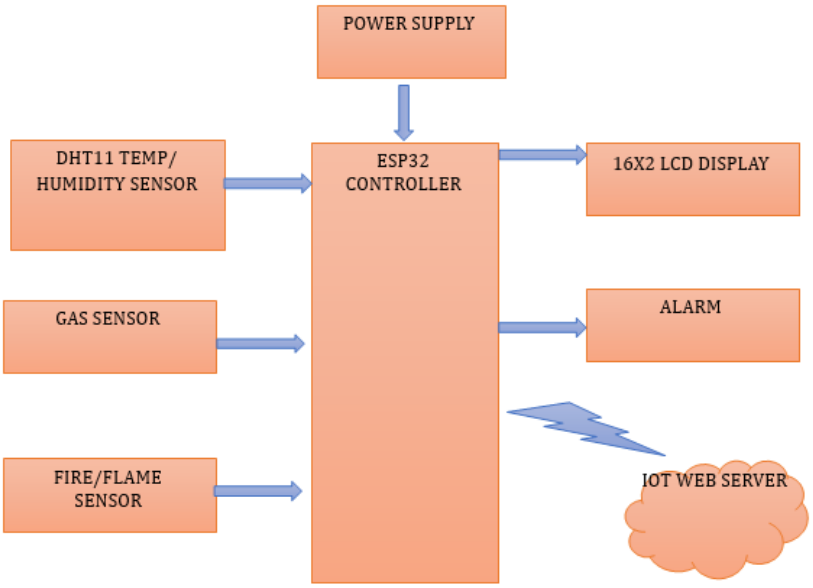

Figure:

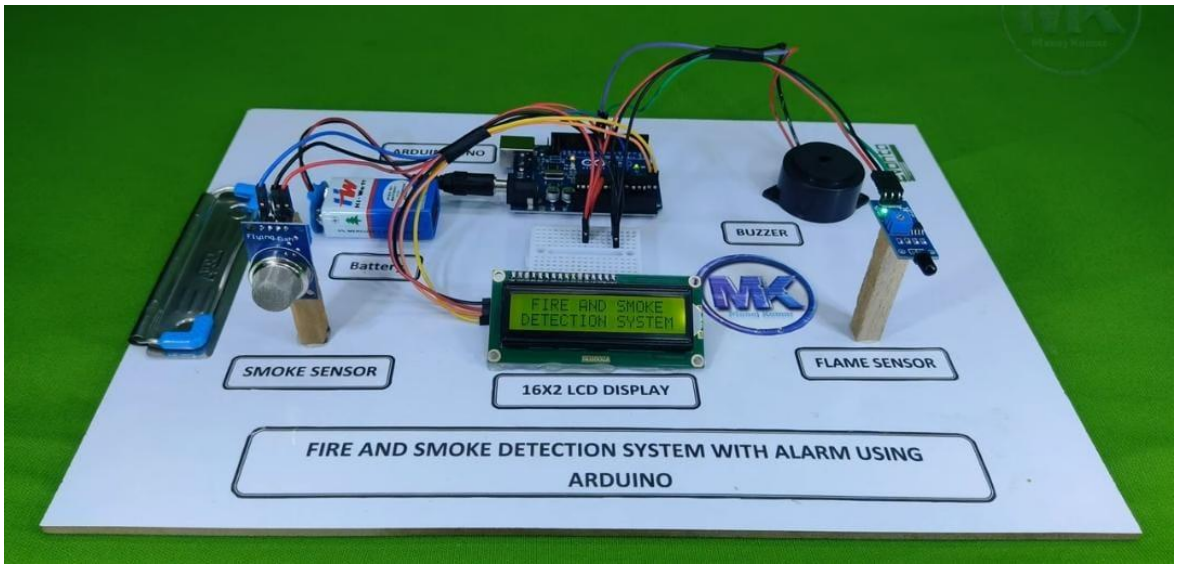

Fig: Hardware Prototype of ESP32 Based Lab Enhanced Safety & Gas Detection Using IOT

RESULTS AND DISCUSSION

The ESP32-based lab safety system was examined under controlled conditions to evaluate its operation. The MQ gas sensor successfully detected gas appearance beyond threshold levels, triggering the buzzer & enabling the exhaust fan automatically. The flame sensor precisely responded to fire sources within its detection range. The DHT11 sensor monitored temperature & humidity effectively, displaying real-time data on the LCD screen. IoT

monitoring through Wi-Fi allowed real-time data visualization on the dashboard without visible delay. The system illustrated fast response time & reliable performance in hazardous scenarios. Minor limitations observed involve sensitivity calibration requirements for MQ sensors & dependency on steady Wi-Fi for remote monitoring. Overall, the system verified efficient, reliable, & proper for improving laboratory safety.

CONCLUSION

The ESP32 Based Lab Enhanced Safety & Gas Detection System gives a reliable & intelligent safety solution for laboratories. By integrating gas detection, fire detection, temperature monitoring, & IoT connectivity, the system ensures constant supervision & automatic response to hazardous & harmful conditions. The activation of alarms & exhaust systems reduces risks associated with gas leakage & fire. Remote monitoring adds an additional layer of supervision, making the system compatible for modern smart laboratories. The project illustrates how IoT & embedded systems can significantly enhance safety standards in sensitive environments.

FUTURE WORK

- AI-based predictive harm detection.
- Mobile app development for real-time or current alerts.
- Integration of SMS/email alerts for emergency notifications.
- Use of advanced gas sensors with higher precision.
- Backup battery system for power failure situations.
- Integration with centralized building management systems.
- Integration with automatic fire suppression systems.

REFERENCES

1. Elsevier, “IoT-Based Fire and Gas Detection Systems,” International Journal of Safety Engineering.
2. Springer, “Smart Environmental Monitoring Systems Using IoT,” Springer Publications.
3. IEEE, “IoT-Based Smart Laboratory Safety System,” IEEE Xplore, 2021.
4. Espressif Systems, ESP32 Technical Reference Manual.
5. Texas Instruments, DHT11 Sensor Datasheet.
6. Winsen Electronics, MQ-2/MQ-135 Gas Sensor Datasheet.