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AN IOT-BASED SMART ELECTRONICS SAFETY AUTOMATION SYSTEM FOR REAL-TIME HAZARD DETECTION AND POWER ISOLATION

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ABSTRACT

Electrical and electronic equipment in server rooms, battery storage units, and industrial control panels are highly sensitive to environmental hazards such as overheating and smoke. Delayed detection of these risks can lead to equipment failure, fire accidents, and significant financial losses. Traditional monitoring methods rely heavily on manual supervision, which is often inefficient and results in delayed responses to potential dangers.

This paper presents an IoT-Based Smart Electronics Safety Automation System designed for real-time environmental monitoring and automatic hazard mitigation. The proposed system utilizes an ESP32 DevKit V1 microcontroller, integrated with a DHT11 temperature sensor and an MQ2 smoke sensor, to continuously monitor environmental conditions. When the temperature rises above 33°C or smoke levels exceed a threshold value of 20, the system automatically activates a relay module to disconnect the power supply and sends alert notifications through the Blynk IoT cloud platform.

Experimental testing using simulated smoke conditions demonstrated reliable hazard detection and immediate power shutdown. The proposed system provides a cost-effective, scalable, and intelligent solution for enhancing electrical safety in both residential and industrial environments.

Keywords: IoT, ESP32, Smart Safety System, Hazard Detection, Smoke Detection, Temperature Monitoring, Relay Automation, Blynk IoT.

1. INTRODUCTION

Modern electronic infrastructures such as server rooms, data centers, and battery storage facilities require continuous environmental monitoring to prevent overheating and fire hazards.

Electrical faults, excessive heat buildup, and smoke are among the primary causes of equipment damage and fire accidents in such environments.

Traditional monitoring methods mainly depend on manual inspections or standalone fire alarms. These systems only provide warning signals and do not implement preventive actions automatically. As a result, delayed human intervention can lead to severe equipment damage and financial loss.

With the advancement of Internet of Things (IoT) technologies, real-time monitoring and automated control systems have become more accessible and cost-effective. Microcontroller-based systems integrated with environmental sensors can continuously observe environmental conditions and respond immediately to potential risks.

This project proposes an IoT-enabled Smart Electronics Safety Automation System that performs the following functions:

- Continuously monitors temperature and smoke levels
- Sends real-time data to the Blynk IoT cloud platform
- Automatically disconnects the power supply when unsafe conditions are detected
- Activates alarms to provide early warning

The proposed system improves equipment safety through intelligent automation, real-time monitoring, and remote alert mechanisms.

2. LITERATURE REVIEW

Several researchers have explored IoT-based safety and monitoring systems.

- **Gubbi et al. (2013):** discussed IoT architecture for smart environments and emphasized real-time sensor-based automation systems.
- **Kodali and Soratkal (2016):** implemented IoT-based home automation systems using ESP8266 microcontrollers.
- **Liu et al. (2018):** proposed a smart fire detection system using temperature and gas sensors integrated with cloud monitoring platforms.
- **Al-Mutairi et al. (2020):** developed an IoT-based industrial safety monitoring system to detect abnormal environmental conditions.

3. EXISTING SYSTEM

Traditional electronic safety monitoring systems primarily depend on manual supervision, standalone fire alarms, or basic thermal protection circuits. In environments such as server rooms and electrical control panels, temperature monitoring is often carried out using simple thermostats or independent alarm devices.

Conventional fire alarm systems are capable of detecting smoke and generating warning alerts. However, these systems generally do not include automated power isolation mechanisms. As a result, human intervention is required to disconnect the electrical supply, which can lead to delays during critical situations.

In some industrial settings, monitoring and control are performed using PLC-based automation systems. Although these systems are reliable, they are typically expensive and require complex installation and maintenance. Furthermore, many existing systems lack remote monitoring capabilities through IoT platforms, which limits real-time supervision and quick response.

Therefore, many of the current safety solutions fall into one of the following categories:

- Alert-only systems that provide warnings but do not take preventive actions
- High-cost industrial solutions that are not suitable for small or medium setups
- Systems without cloud-based monitoring and remote access
- Systems that do not include automatic power disconnection during hazardous conditions

3.1 Disadvantages

Lack of Automatic Power Cut-Off:
Most traditional alarm systems only provide warning signals without isolating power supply automatically

Delayed Human Response:
Manual intervention may cause critical delay during overheating or fire incidents.

No Remote Monitoring:
Conventional systems do not provide cloud-based monitoring or mobile dashboard access.

High Installation Cost:
Industrial PLC-based monitoring systems are expensive and not suitable for small-scale setups.

Limited Scalability:
Many systems are not easily expandable for additional sensor integration.

4. PROPOSED METHODLOGY

The proposed system integrates IoT hardware components with cloud-based monitoring for real-time safety automation

4.1 System Architecture

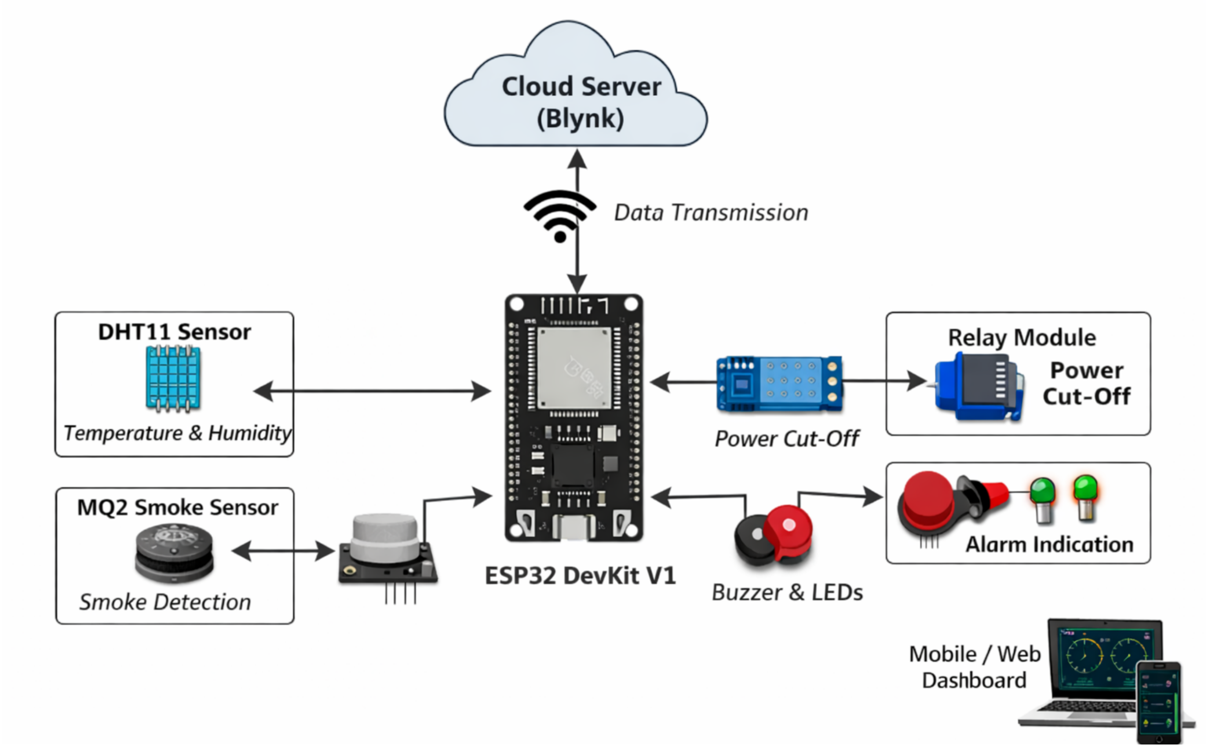

Fig Proposed IoT Based Smart System Architecture

The hardware components used include:

- ESP32 DevKit V1 microcontroller
- DHT11 Temperature and Humidity Sensor

- MQ2 Smoke Sensor
- Relay Module
- Buzzer
- Status LEDs
- Blynk IoT Cloud Platform

The ESP32 acts as the central controller. Sensors continuously transmit environmental data to the microcontroller. The ESP32 processes these values and compares them with predefined threshold levels.

4.2 Working Mechanism

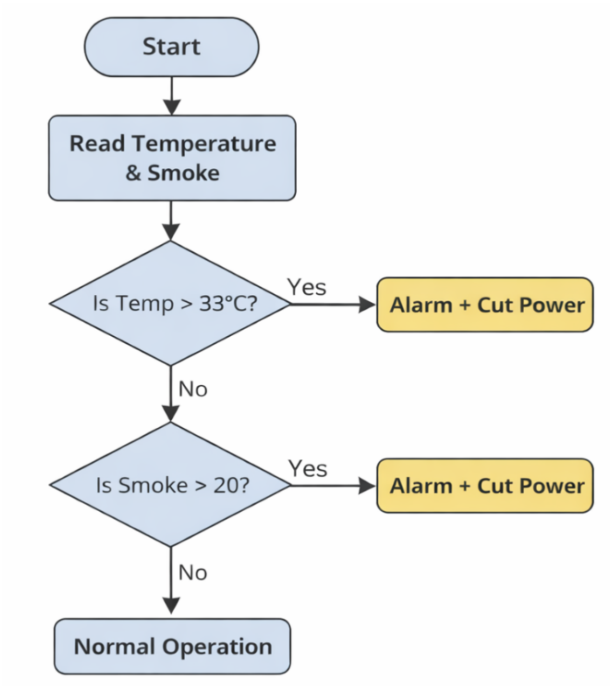

Fig. 2. System Workflow Diagram

The system operates in the following sequence:

1. The DHT11 sensor continuously monitors temperature.
2. The MQ2 sensor detects smoke concentration.
3. Sensor readings are transmitted to ESP32.
4. Data is uploaded to Blynk cloud via WiFi.
5. If:
   - Temperature > 33°C
   - Smoke Level > 20

The system performs:

- Activates Red LED
- Triggers buzzer alarm
- Deactivates relay to cut off power supply

If values remain within safe limits:

- Green LED remains ON
- Power supply continues normally

Threshold values can be dynamically modified in the program code for different environmental requirements.

4.3 IoT Cloud Integration

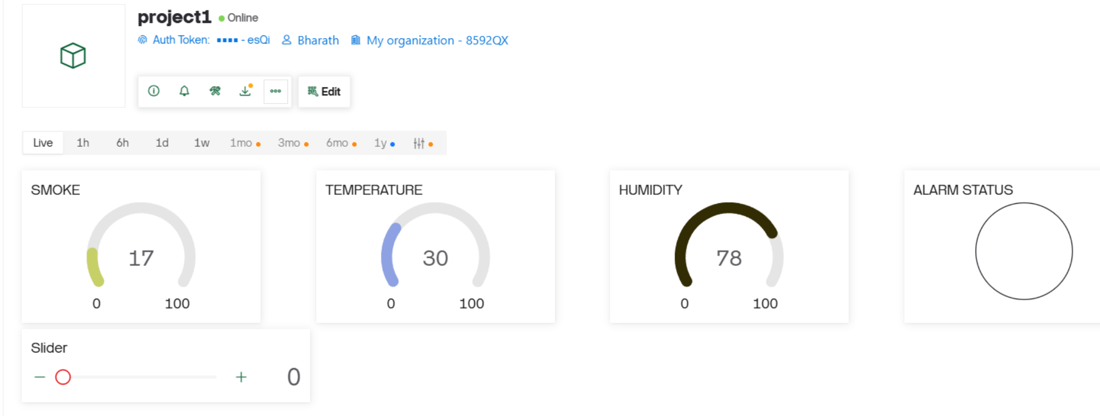

Fig.3. Blynk IoT Dashboard Showing Real-Time Sensor Data

The system uses the WiFi connection from the ESP32 to send sensor readings to the Blynk IoT dashboard.

The dashboard displays:

- Live temperature readings
- Live smoke values
- System status (Safe / Hazard Detected)

This allows for remote monitoring through a web interface.

5. EXPERIMENTAL SETUP AND RESULTS

The team built the system and tested it several times in controlled conditions.

5.1 Temperature Testing

The temperature was set to 33°C.

When it rose above that level, the system triggered the alert mechanisms successfully.

5.2 Smoke Testing

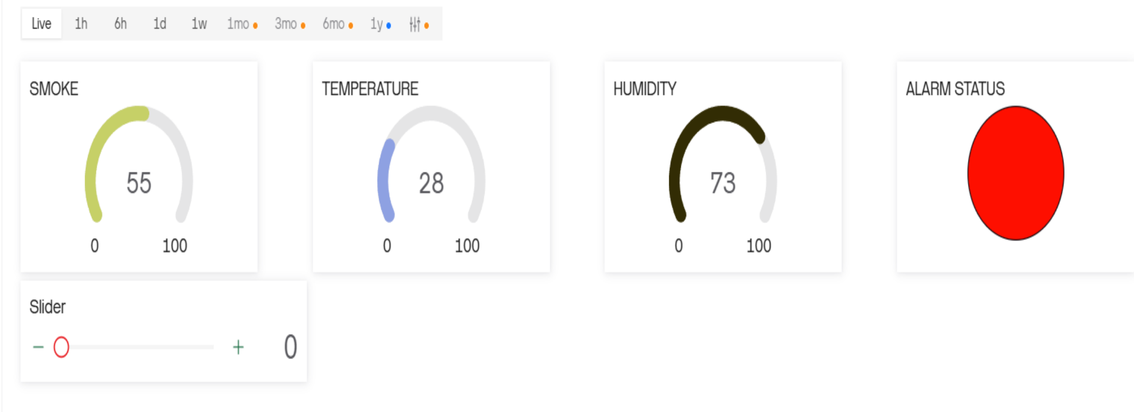

Fig. 4. Smoke Detection Using Simulated Incense Stick

Smoke was created using an incense stick near the MQ2 sensor. When the smoke level exceeded the threshold value of 20, the relay immediately cut off the power supply.

5.3 Observations

Test Condition	Sensor Value	Threshold	System Response
Normal Room	29°C	33°C	No Action
Heated Condition	35°C	33°C	Alarm + Power Cut

No Smoke	8	20	No Action
Incense Smoke	27	20	Alarm + Power Cut

The system consistently reacted to unsafe conditions and isolated the power supply effectively. The response was quick when thresholds were crossed, showing reliable hazard detection ability.

6. CONCLUSION

The proposed IoT-Based Smart Electronics Safety Automation System provides an effective solution to prevent equipment damage caused by overheating and smoke hazards. By integrating an ESP32 microcontroller, DHT11 temperature sensor, and MQ2 smoke sensor with the Blynk IoT platform, the system enables continuous environmental monitoring along with automated preventive actions.

The relay-based automatic power isolation mechanism enhances safety compared to traditional alarm-only systems by immediately disconnecting the power supply when hazardous conditions are detected. In addition, the system is cost-effective, scalable, and suitable for applications such as server rooms, data centers, and electrical control environments.

This implementation demonstrates how IoT technologies can significantly enhance electrical safety management through intelligent monitoring and smart automation.

7. FUTURE ENHANCEMENT

Future improvements may include:

1. SMS and Email notification integration.
2. Integration of camera module for visual monitoring.
3. AI-based predictive overheating analysis.
4. Cloud-based data logging and analytics dashboard.
5. Integration with fire suppression systems.

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