Web-Based Motion-Activated Security System Using ESP32 with Buzzer and LED Alerts

# 1. Industry: Security

# 2. Introduction

In today’s world, security is a fundamental need for homes, hostels, offices, and small businesses. However, most effective security systems are either expensive or difficult to deploy and maintain. This project presents a low-cost, web-based motion detection security system built using ESP32 that provides real-time alerts through sound and light, and displays live status on a web page. The simplicity and expandability of this system make it ideal for small-scale applications.

# 3. Problem Statement

Many individuals and small institutions lack access to affordable and effective real-time intrusion detection systems. Basic surveillance tools like CCTV often require expensive subscriptions and constant monitoring, which are impractical for budget-limited environments. There is a need for a simple, low-cost system that can detect unauthorized movement and alert users instantly — both physically (on-site) and remotely (via web status).

# 4. Proposed Solution

This project introduces a motion-activated security system using the ESP32 microcontroller, a PIR motion sensor, a buzzer, and an LED for local alerts. The system also hosts a web-based interface that displays the real-time status of motion detection ("Motion Detected!" or "No Motion") using a clean and responsive interface. This eliminates the need for external servers or internet services while still providing an interactive and remotely accessible status monitor.

# 5. Technical Description

## 5.1. Hardware Components

|  |  |
| --- | --- |
| Component | Function |
| ESP32 Dev Board | Main controller with Wi-Fi capabilities |
| PIR Motion Sensor (HC-SR501) | Detects infrared motion |
| LED (with 220Ω resistor) | Visual alert indicator |
| Buzzer | Audible alert when motion is detected |
| USB cable or battery | Power supply for the ESP32 |

## 5.2. Wiring Connections

|  |  |
| --- | --- |
| ESP32 Pin | Connects To |
| 5V / VIN | PIR VCC |
| GND | PIR GND, Buzzer -, LED - |
| GPIO 13 | PIR OUT |
| GPIO 14 | Buzzer + |
| GPIO 12 | LED + (through 220Ω resistor) |

## 5.3. Software Features

- The ESP32 reads data from the PIR sensor to detect motion.  
- When motion is detected:  
 - The buzzer sounds.  
 - The LED lights up.  
 - The web server updates the status on a hosted page.  
- When no motion is detected:  
 - The buzzer and LED are turned off.  
 - The status is updated to “No Motion”.

## 5.4. Web Interface

- Hosted directly on the ESP32 using its built-in web server.  
- HTML and CSS display the current status of the system.  
- The page automatically refreshes every 2 seconds.  
- Color-coded display: Green for “No Motion” and Red for “Motion Detected!”

# 6. Key Features

- Standalone operation (no external server or cloud needed)  
- Real-time web-based status view  
- Cost-effective and energy-efficient  
- Expandable (can be upgraded with a camera, SMS alerts, etc.)

# 7. Limitations

- Web interface works only on the same local network unless port-forwarding is configured.  
- No data logging or historical records.  
- Buzzer volume is limited by the type of buzzer used.

# 8. Expected Outcomes

- A fully functional, interactive security prototype  
- Real-time motion detection and alerts  
- A professional web interface hosted by the ESP32  
- Simple deployment and maintenance

# 9. GitHub Repository

https://github.com/GAT301-2024/Awany-Joseph-Bill\_Security-Alert-System

# 10. Conclusion

The proposed motion-activated security system offers an efficient and low-cost solution for basic intruder detection. It is designed to be simple to build, easy to maintain, and expandable. The inclusion of a web-based status monitor makes the system interactive and suitable for small institutions, hostels, and homes seeking affordable security options.