Department of Electronic Systems Engineering

भारतीय विज्ञान संस्थान

Intrusion Detection System

Course: E3-258: Design for IoT

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Principal Research Scientist

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*Codes: https://github.com/kirteymanr/Intruder_Detection_System

Motivation

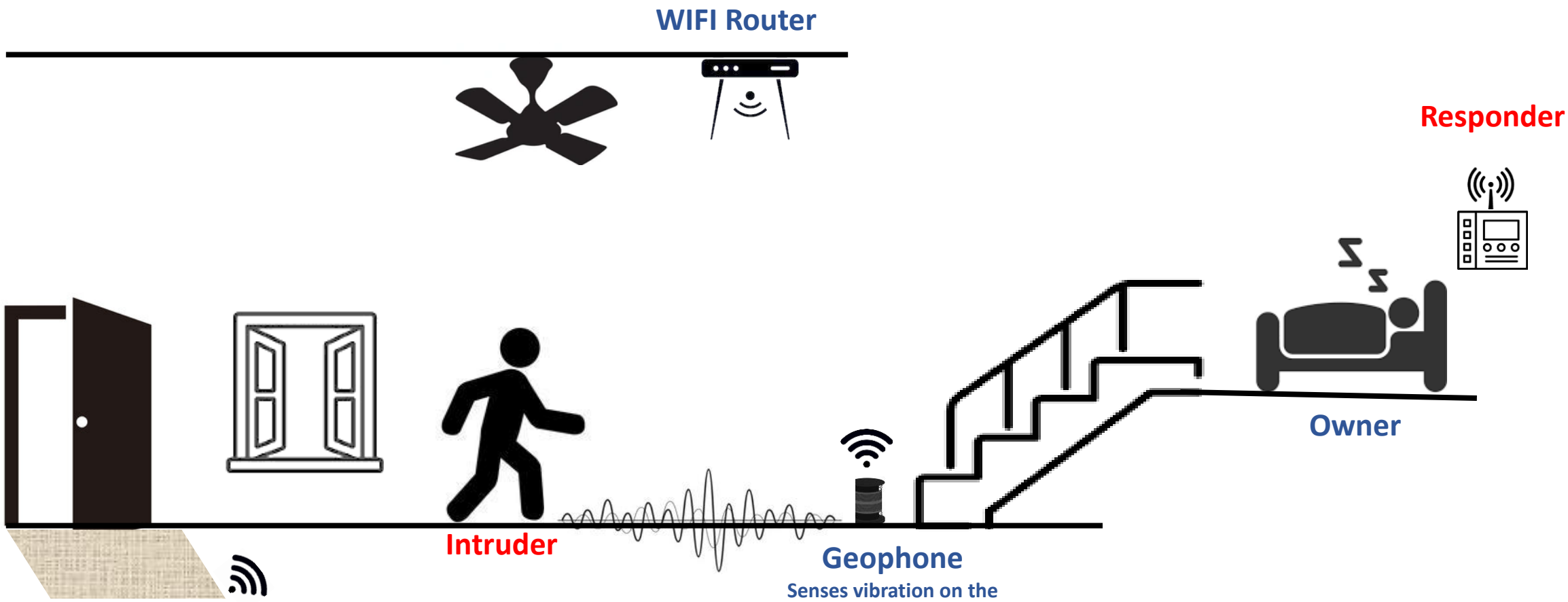
Aim:

- Develop an efficient intrusion detection system for designated areas, designed to monitor unauthorized access and promptly alert the relevant personnel upon any breach.
- System integrates advanced sensors and detection algorithms to ensure high accuracy in identifying unauthorized entries, minimizing false alarms while maintaining real-time responsiveness.
- Notifications are delivered immediately to the appropriate parties, enabling swift action to secure the premises.

Challenges:

- We want to detect vibrations and pressure sensitivity.
- Even the smallest amplitude signal – high sensitivity and resolution.
- In any environment, e.g., sun, dark, fog, dust, temperature.
- With minimum power consumption.
- With a small form factor.

Proposed Solution



Methods to detect foot steps:

S-Mat (Smart Mat)

Seat cover fabric with copper tapes stuck.

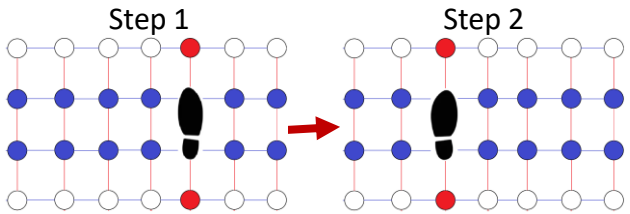
Pressure-sensitive conductive Sheet sandwiched between cover fabrics.

S-Mat integrated with ESP32 for step detection and wireless alert transmission.

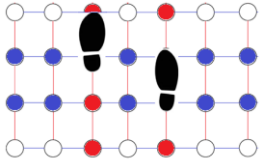
Algorithm

```
ESP32_Modem -> ON
Send init message
ESP32_Modem -> OFF
while (1) :
        read all nodes
        check with the auth_key
        if true:
                Authentication successful
                ESP32_Modem -> ON
                send a message to the user via Telegram
                ESP32_Modem -> OFF
        else:
                Authentication failed
                ESP32_Modem -> ON
                send a message to the user via Telegram
                ESP32_Modem -> OFF
                Read nodes sequentially;
                Check whether a step is detected.
                If yes :
                        ESP32_Modem -> ON
                        send a message to the user via Telegram
                        ESP32_Modem -> OFF
                else :
                        nop
```

Authentication Pattern



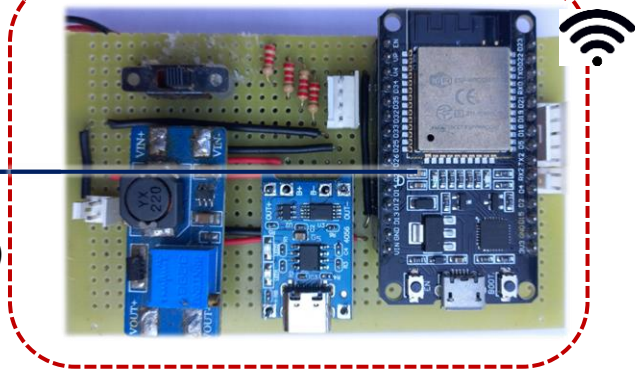
Unauthenticated Pattern



Current Consumption

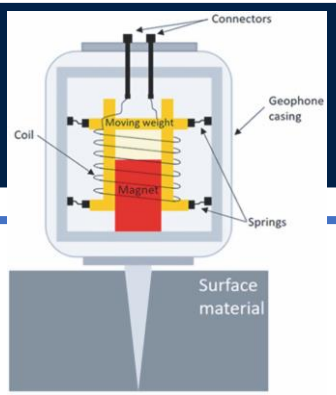
Active Mode:
IDLE(Blank code dumped in ESP32): 79 mA
WiFi and BLE ON: 90 mA

Modem Mode
WiFi ON (While sending Message) $16 \sim 20\ mA$
WiFi OFF: $7.3\ mA$



Methods to detect foot steps:

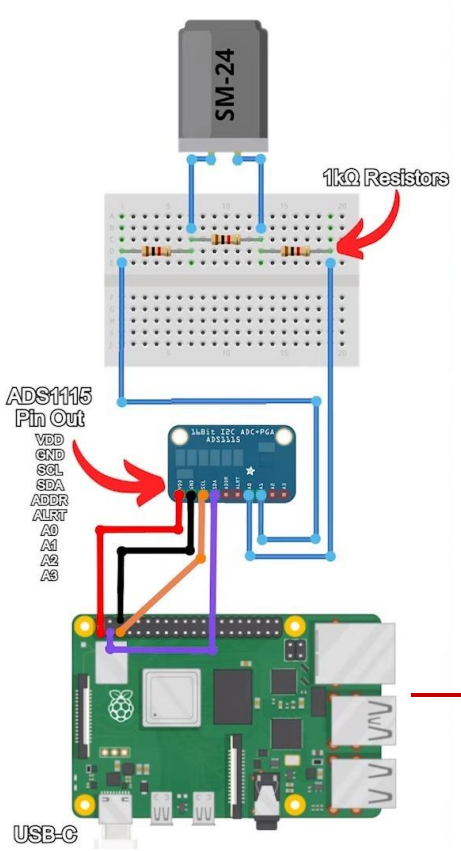
Geophone



Source: Springer Nature

Seismic geophone is a device that converts ground movement or any kind of vibrations into voltage, which may be recorded by a recording instrument.

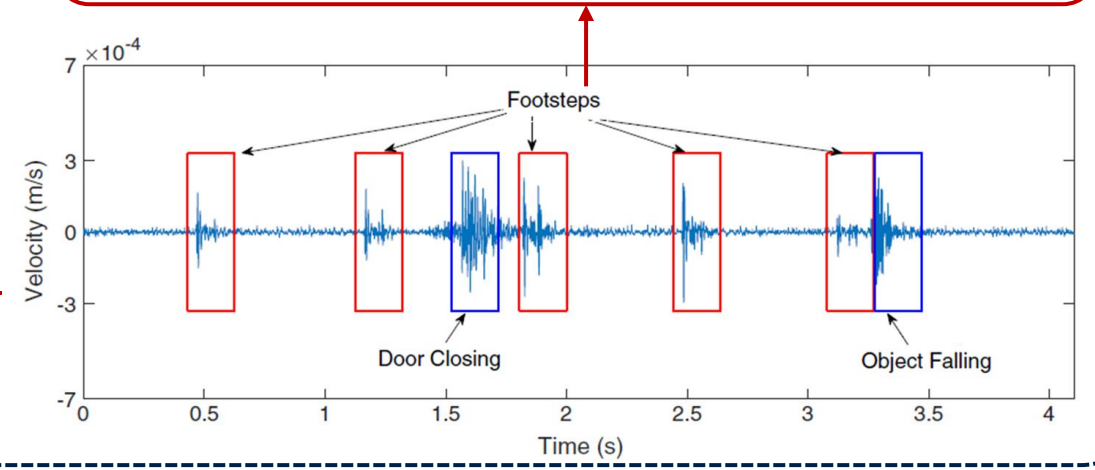
System Design



$$Kurtosis = \frac{1}{N}\sum_{i=1}^{N}\left(\frac{x_i - \mu}{\sigma}\right)^2 - 3$$

where N is the number of samples, xi is the data points, μ is the mean of the data, and σ is the standard deviation.

If Kurtosis > 5: leptokurtic distribution
Footstep detected: Yes
If Kurtosis < 5: flatter distribution
Footstep detected: No



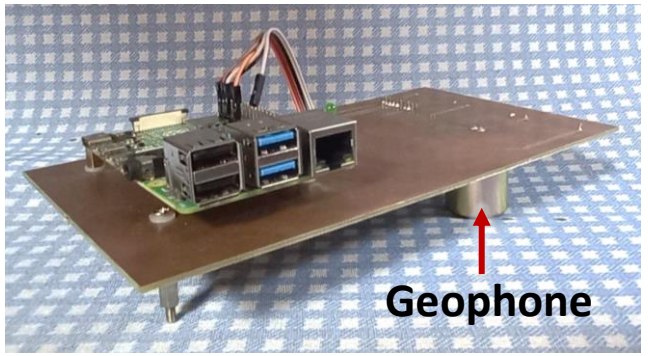
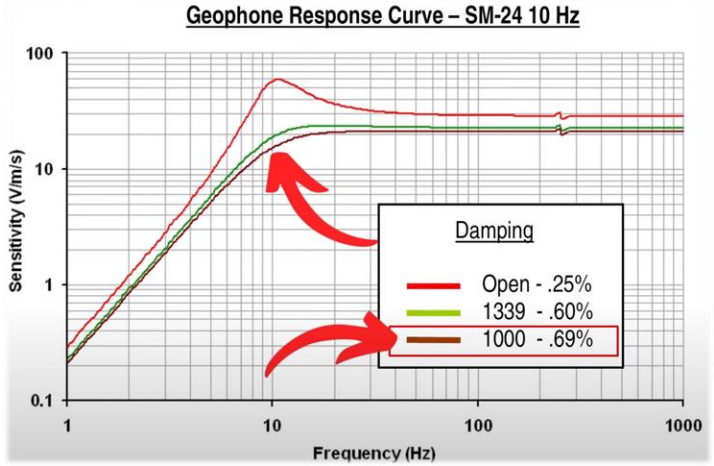
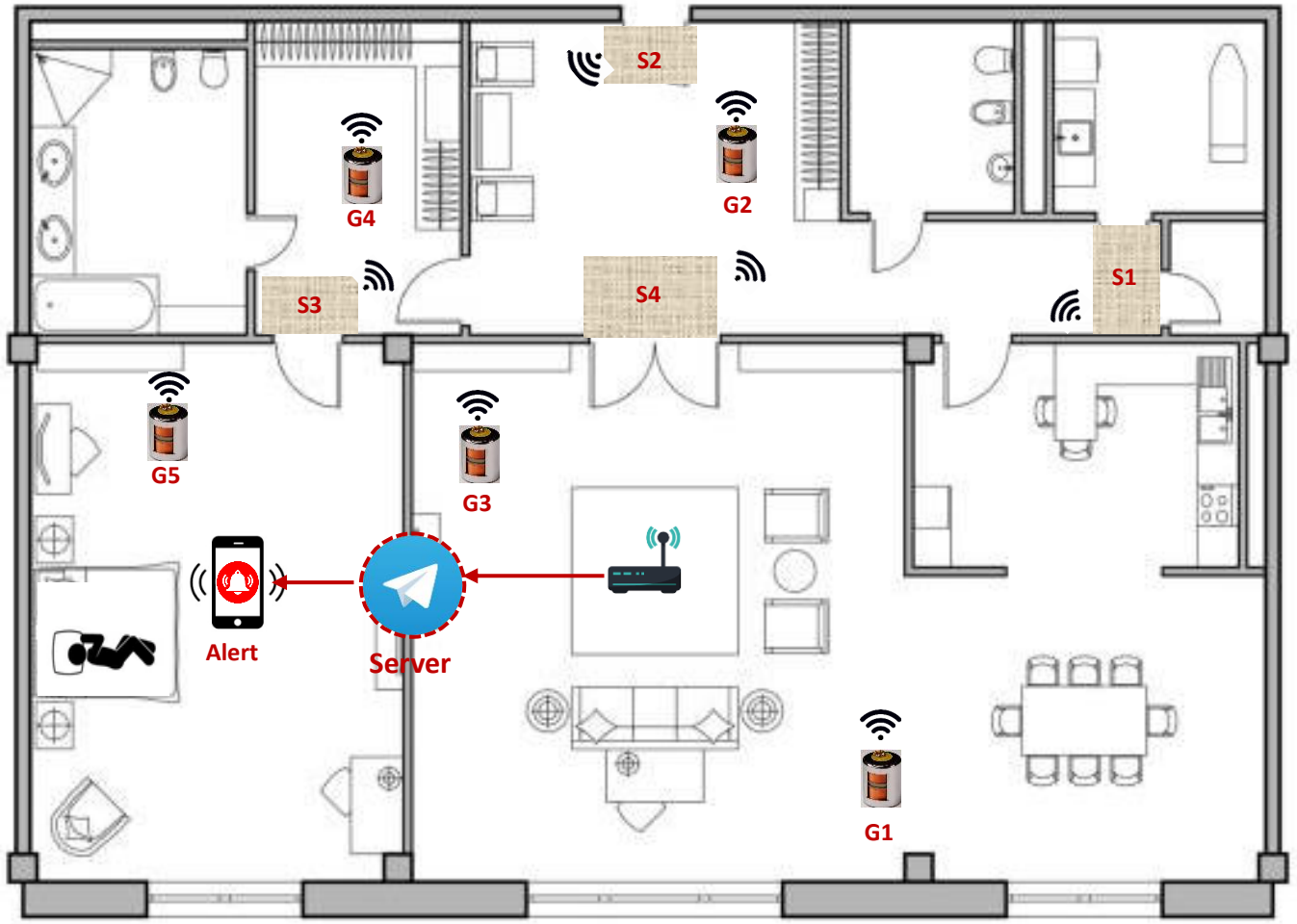


Fig: Developed geophone device



WIFI Module



S1, S2, S3, S4: S-Mat

G1, G2, G3, G4, G5: Geophone

Thank you