



Department of  
Electronic  
Systems  
Engineering



# Intrusion Detection System



Course: E3-258: Design for IoT

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Principal Research Scientist

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# Motivation

## Aim:

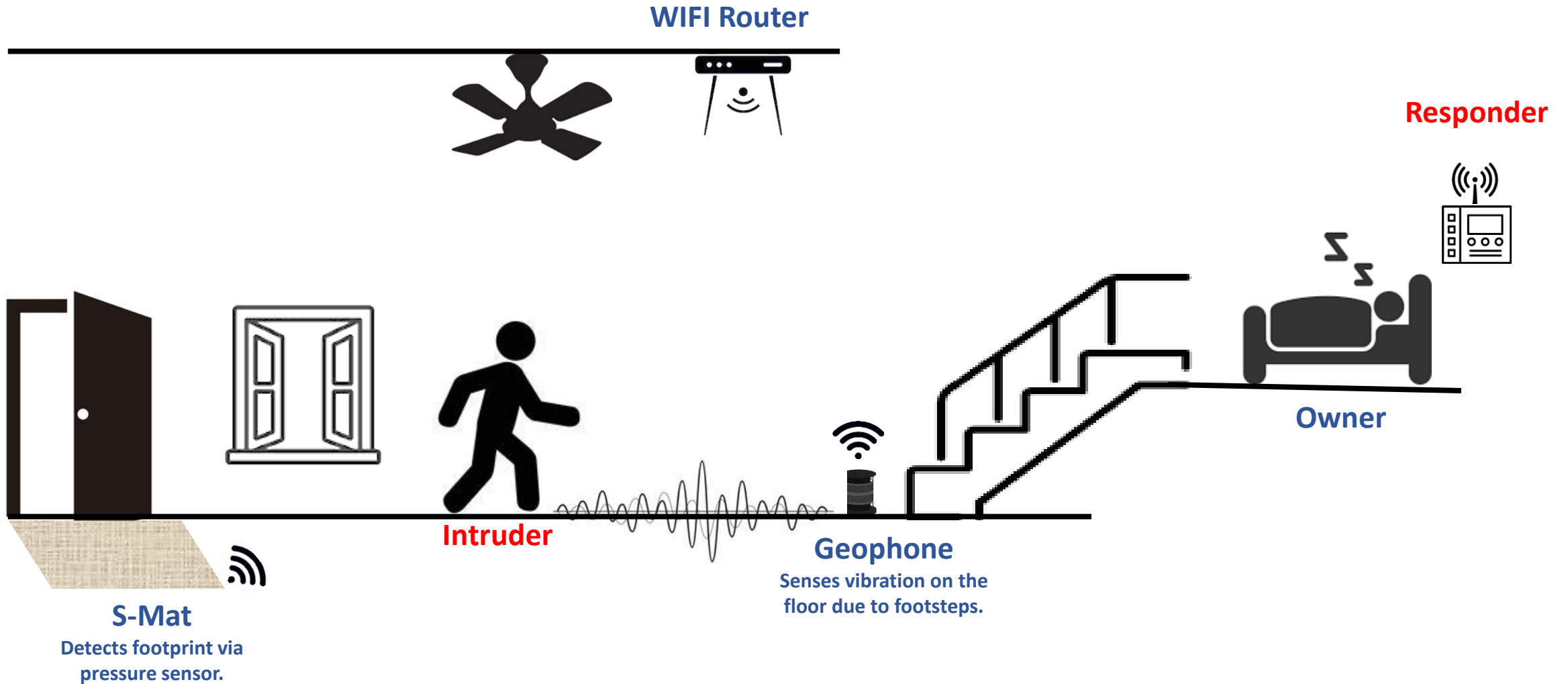
- Develop an efficient intrusion detection system for designated areas, designed to monitor unauthorized access and promptly alert the relevant personnel upon any breach.
- System integrates advanced sensors and detection algorithms to ensure high accuracy in identifying unauthorized entries, minimizing 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



# 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.



```
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:
```

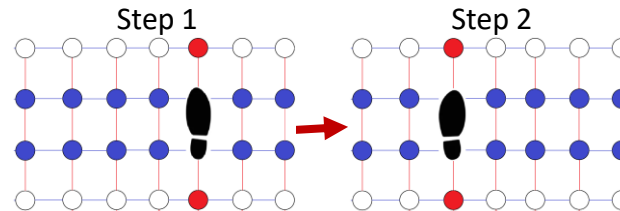
```
    Authentication failed
    ESP32_Modem -> ON
    send a message to the user via Telegram
    ESP32_Modem -> OFF
    Read nodes sequentially;
    Check whether a step is detected.
    If yes :
```

```
      ESP32_Modem -> ON
      send a message to the user via Telegram
      ESP32_Modem -> OFF
```

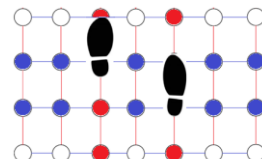
```
  else :
    nop
```

## Algorithm

### Authentication Pattern



### Unauthenticated Pattern



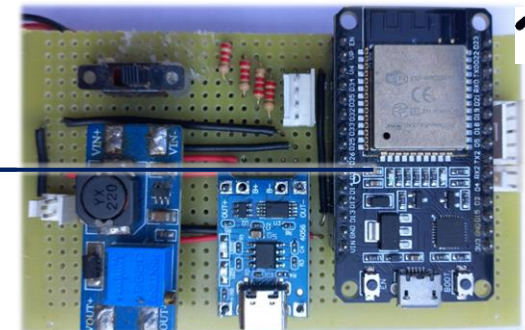
### Current Consumption

#### Active Mode:

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

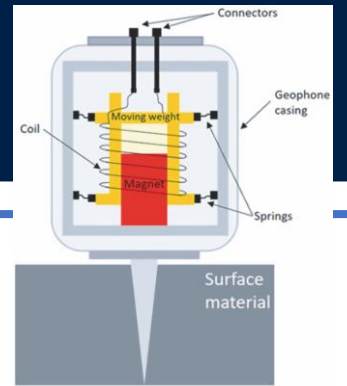
#### Modem Mode

WiFi ON (While sending Message): 16 ~ 20 mA  
WiFi OFF: 7.3 mA





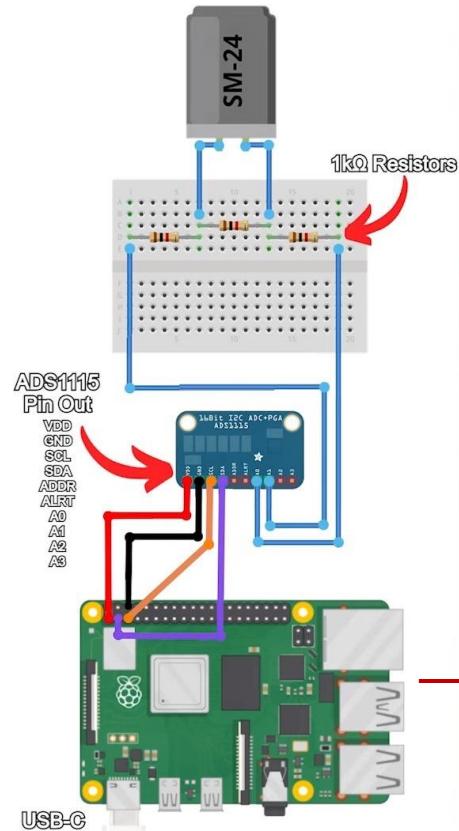
# Geophone



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,  $x_i$  is the data points,  $\mu$  is the mean of the data, and  $\sigma$  is the standard deviation.

If Kurtosis > 5: leptokurtic distribution

**Footstep detected: Yes**

If Kurtosis < 5: flatter distribution

**Footstep detected: No**

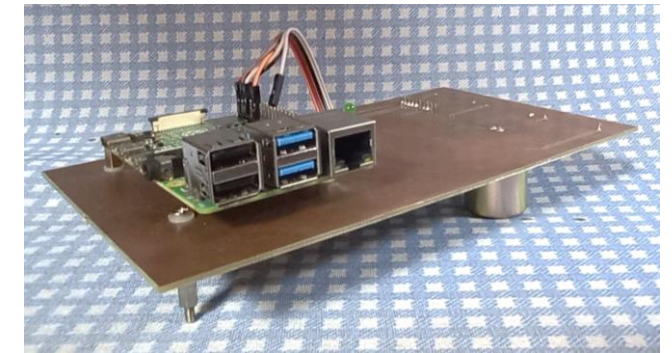
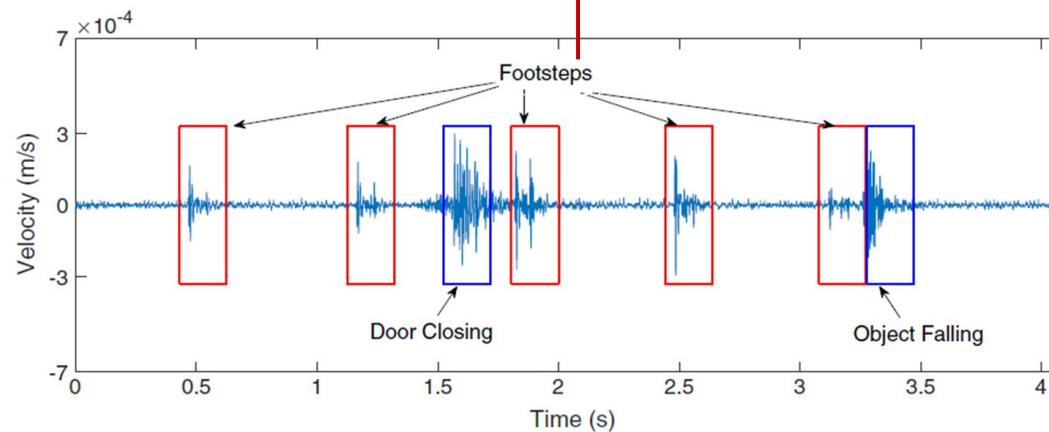
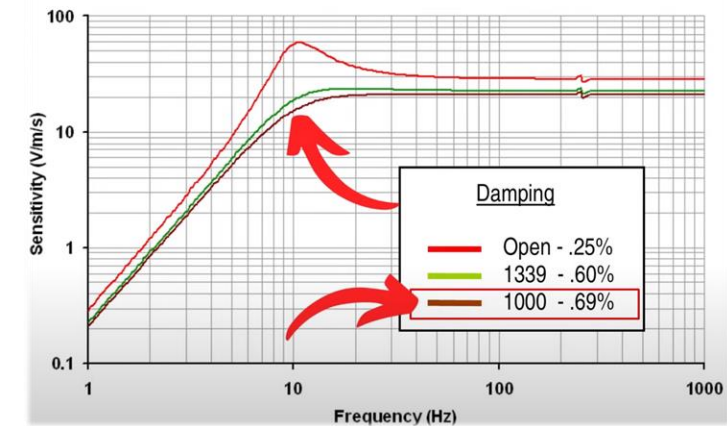
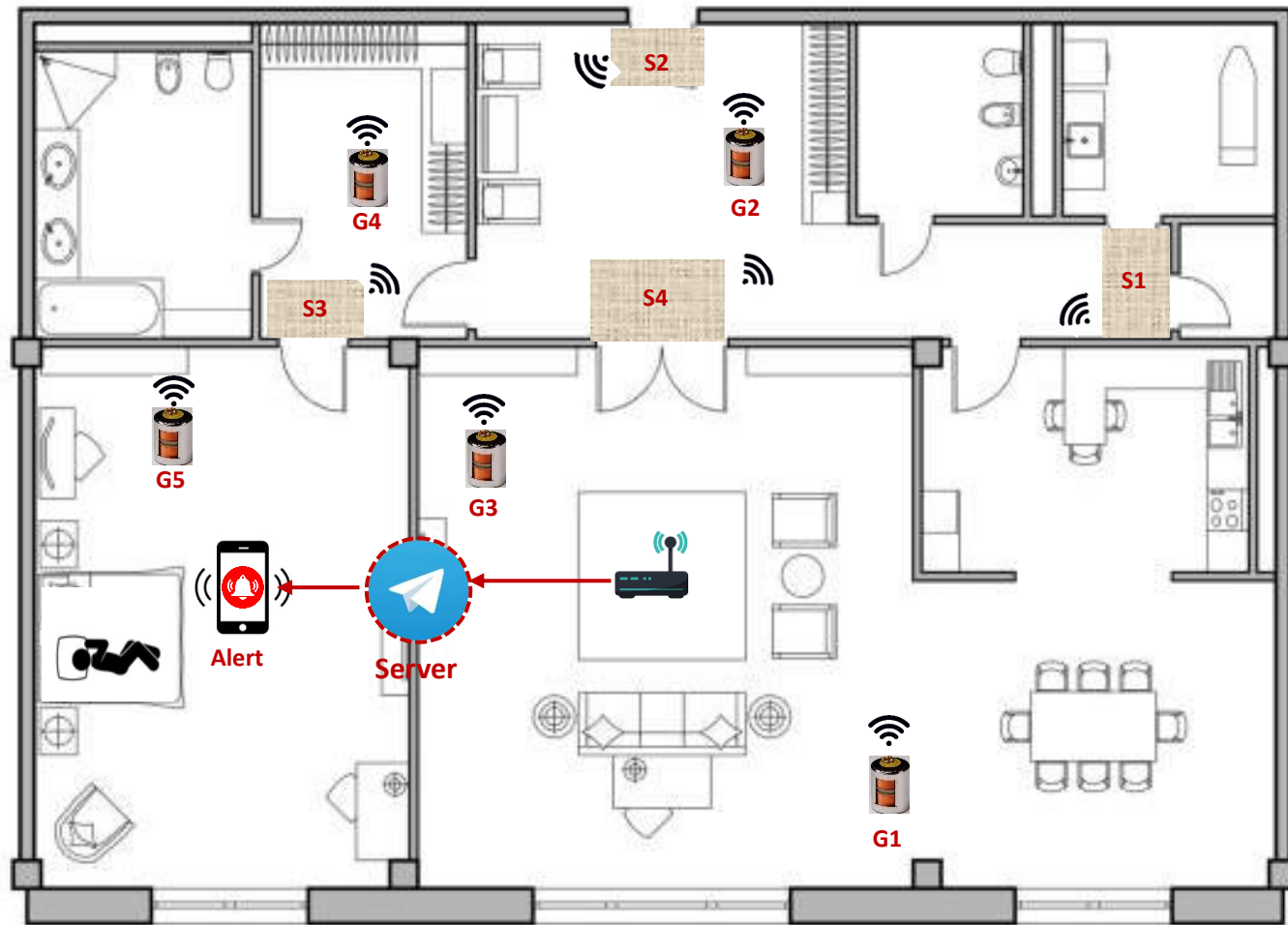


Fig: Developed geophone device

Geophone Response Curve – SM-24 10 Hz



# WIFI Module



**S1, S2, S3, S4: S-Mat**

**G1, G2, G3, G4, G5: Geophone**

**Thank you**