1. Project Overview

Team: HardCoreCoding | Project Ideation
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Project Name: ***Wi-Detect***

We are building Wi-Detect, a non-invasive guardian designed specifically for Women's Safety. By using the Wi-Fi signals already in the room, our system detects violence, struggles, or falls in real-time. It ensures safety in sensitive areas where cameras are banned. By studying the scattering of electromagnetic waves to and from the source, effectively mapping the human body, we train our model to detect falls and assaults in real time.

2. Problem

Beyond the Reach of CCTV

The Conflict: We cannot install cameras in private spaces, such as bedrooms, hostels, or washrooms, due to strict privacy laws. This leaves the most vulnerable areas completely unmonitored**.**

- **The Void(Violence & Accidents):** Whether it is a security threat (harassment/intrusion) or a medical emergency (like fainting), incidents inside a locked room often go undetected until it is too late.
- **The Flaw:** Panic buttons and phones fail when they are needed. If a victim is unconscious or injured during a struggle, they cannot physically call for help.

3. The "Tech" (Physics + ML)

Layer 1: The Physics (Hardware)

- **Device: ESP32 (Smart Wi-Fi Node)**.
  It is a tiny, programmable computer chip that has a built-in Wi-Fi transmitter. ○ *Role:* not for the internet. Instead, we use it to broadcast a continuous "Sensing Signal" across the room, acting like a mini-radar.
- **Technique: Channel State Information (CSI)** analysis.
- **The Science:** We use the concept of Wave disturbance in motion.
  Imagine an invisible **elliptical bubble** connecting the two ESP32 nodes. When a human moves inside this bubble, they disturb these invisible Wi-Fi waves (Scattering & Multipath Fading).
  Different actions (walking vs. falling) create unique "Wave patterns" that our system recognises.

Layer 2: Machine Learning (Software)

Python Deep Learning (using TensorFlow or PyTorch).

- *Role:* The Deep Learning model acts as a pattern decoder, identifying the 'pattern' of human movement within the signal."

Step 1: Preprocessing

- ***The Problem****:* Wi-Fi signals fluctuate naturally. It could have jitters (due to electrical noise or tiny vibrations). If we feed this error data to our model, it will get confused. It might think the jitter is a "struggle."
- ***The Fix:*** We apply digital filters (like a **Butterworth Low-Pass Filter**) from the scipy library in Python to strip away the random noise. This leaves us with a clean, smooth wave that represents *only* human movement. **The logic:** the jitter is of **High frequency**, but the human motion is relatively slow. Hence, the Butterworth filter receives the signal without distorting the shape of the walking/falling wave.

Step 2: Understanding "Time" (The Model)

- *The Tech:* We use a **Long Short-Term Memory (LSTM)** network or a **1D-CNN**. ● A standard model looks at a photo. But a fall or a struggle is an *event* that happens over time (3-5 seconds).
- *Working:* The LSTM has "memory." It remembers what the wave looked like 2 seconds ago and compares it to now. It understands the *sequence* of the motion—recognising a fall.
- For **CNN**(Convolutional Neural Network) works like **Pattern Matcher.** It analyses the whole signal and looks for specific wave patterns, like a sine wave for walking. It is like a ***Fourier transformation*** to find specific frequencies, or looking for a specific Pulse shape.

Step 3: The Decision (Classification)

- *The Output:* The model outputs a probability score in real time.

4. The "User Experience" (Feature Breakdown)

Feature A: Activity & Incident Detection

The system is always on. It monitors the room's Wi-Fi signals.

- **Trigger:** Sudden high-frequency signal distortion.
- **Action:** Immediate alert.

Feature B: False Alarm Prevention

False alarms happen (e.g sudden jump). We solve this with a **"Fixed Gesture."**

- **Scenario:** Alarm triggers accidentally.
- **User Action:** Stand still and wave a hand in a 'Z' shape
- **Response:** The Model recognises this specific rhythmic phase shift and cancels the alarm.

Feature C: Breathing Detection (Future Scope)

If we get the basic system working well, we can try and detect breathing rates (since chest movement causes small phase shifts in the signal). This could help us know if a person is unconscious after a fall.

5. Projected Timeline or Roadmap

- **Week 1-2: ESP32 Deep Dive**

  Installation of the ESP32 chip and getting it ready for usage.

- **Week 3: CSI Data Collection**

  Initiate data collection protocols for Wi-Fi Channel State Information.

- **Week 4: LSTM & Preprocessing**

  Integrating LSTM and setting up the initial signal preprocessing pipeline.

- **Week 5-6: Node Optimisation & Noise Testing**

  Optimise ESP32 node placement and conduct thorough noise testing in various environments.

- **Week 7: Violence Model Training**

  Train machine learning models specifically for violence detection using collected CSI data.

- **Week 8: System Integration & Stress Testing**

  Integrate all hardware and software components into a cohesive system. Conducting stress testing to evaluate system robustness and accuracy under various conditions.