WEARABLE SAFETY DEVICE FOR WOMEN-WITH SOS FUNCTION

Design & Fabrication Project
Group No.: DFP-31

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User/Field Study

User Field and Study for the Wearable Safety Device

Introduction

The wearable safety device is aimed at providing enhanced personal safety for women and children, addressing critical vulnerabilities faced by these user groups in their daily lives. The project was initiated with a user-centric approach, emphasizing detailed field studies and data collection to ensure the device meets the real-world needs of its target audience. This section outlines the findings from the user field study, highlighting insights that guided the design and fabrication process.

Objective of the Field Study

The primary objective of the user field study was to gather qualitative and quantitative insights to understand:

1. The contexts and scenarios where users feel most unsafe.
2. The specific features they would find most useful in a safety device.
3. Their preferences for usability, design, and functionality.
4. The limitations of existing safety solutions.

User Segments Studied

The study focused on two primary user groups:

1. **Women:**
   - Age Group: 18–60 years.
   - Key Contexts: Walking alone at night, traveling in public or private transport, working in isolated environments, and navigating crowded public spaces.
   - Specific Concerns: Threats of harassment, physical assault, and limited access to immediate help.

2. **Children:**
   - Age Group: 5–15 years.
   - Key Contexts: School commutes, outdoor activities, and time spent in public spaces without parental supervision.
   - Specific Concerns: Risk of getting lost, accidents, and potential abduction or bullying.

Study Methodology

1. **Surveys and Questionnaires**

   A structured survey was conducted with over 200 participants to gather data on:
   - Frequency of unsafe situations.
   - Features users would prioritize in a safety device.
   - Situational needs (e.g., walking alone, traveling, being in isolated areas).

Key Findings:

- 44.7% of respondents reported occasionally feeling the need for a personal safety device, while 18.4% often felt the need.
- Women reported feeling most vulnerable in isolated areas (39.1%), followed by walking alone (31.8%) and traveling at night (26.5%).
- Children's safety concerns were highlighted primarily by parents, who stressed the need for geofencing and real-time location tracking.

2. **Focus Groups**
   Focus groups were conducted with women, parents of young children, and caregivers for elderly women to gather qualitative insights.

Key Takeaways:

- A user-friendly interface and discreet design were critical for adoption.
- Parents emphasized the importance of tamper-proof mechanisms for children.
- Women highlighted the need for real-time alerts and two-way communication during emergencies.

3. **Competitor Analysis**
   The study included an analysis of existing personal safety devices to identify gaps and areas for improvement.
   Observations:
   - Most devices lacked multi-functionality, combining health and safety features.
   - Designs were often bulky or visually conspicuous, deterring consistent use.

4. **User Simulations**
   Simulated scenarios (e.g., walking in isolated areas, commuting at night) were conducted to observe user behaviour and identify potential device applications.

Insights from the Study

1. **Safety Concerns:**
   Women and children face safety challenges primarily in unaccompanied situations, such as:
   - Walking or traveling in secluded or poorly lit areas.
   - Being in public spaces with limited access to immediate assistance.

2. **Feature Prioritization:**
   The survey revealed the following preferences for device features:
   - Location sharing (88%) and SOS button (85%) were the most desired.

- Additional features like health monitoring and audio recording were rated highly by 40–50% of respondents.

3. **Design Preferences:**
   - Lightweight, ergonomic designs were preferred, especially for children.
   - Women preferred devices that could double as accessories (e.g., bracelets or watches).

4. **Technology Integration Needs:**
   - Real-time location tracking and geofencing were emphasized.
   - Tamper-proof designs and offline functionality were critical for reliability.

5. **User Limitations:**
   - Some respondents expressed concerns about the complexity of technology, especially for elderly women and young children.
   - Battery life and device durability were identified as crucial for practicality.

Conclusion

The field study provided critical insights into the safety challenges faced by women and children, guiding the design and fabrication of the wearable safety device. By addressing user priorities such as real-time location sharing, fall detection, tamper-proof mechanisms, and ergonomic design, the project ensures that the device is both effective and user-friendly. These findings form the foundation for the subsequent phases of development, ensuring the product's success in meeting the needs of its target audience.

Data Analysis

Survey Analysis: User Insights for Wearable Safety Device

1. Frequency of Need for a Personal Safety Device

The survey indicates that a significant portion of respondents have occasionally felt the need for a personal safety device. Specifically:

- **44.7% of respondents** reported feeling the need "Sometimes."
- **36.8% of respondents** stated they "Rarely" felt the need.
- **18.4% of respondents** noted they "Often" felt the need.

This data suggests that while a consistent need may not be universal, a considerable number of individuals experience scenarios where a safety device would provide reassurance. This highlights an opportunity for promoting the device as a precautionary tool for unpredictable situations.

2. Situations Where Users Feel Most Vulnerable

Respondents identified specific situations in which they feel particularly vulnerable, emphasizing the importance of context-specific safety features:

- **39.1% of respondents** feel most vulnerable in isolated areas, indicating a strong demand for emergency alerts and location-sharing capabilities in environments with limited external assistance.
- **31.8% of respondents** feel vulnerable when walking alone, further underscoring the importance of personal safety mechanisms for individual users in everyday scenarios.
- **26.5% of respondents** identified traveling at night as a concern, suggesting the need for features that ensure safety during low-visibility periods.
- A smaller percentage, **2.6% of respondents**, mentioned vulnerability in public transport, reflecting a lesser but still relevant concern.

This data establishes the necessity for a versatile device adaptable to various environments and user-specific vulnerabilities.

3. Preferred Features in a Personal Safety Device

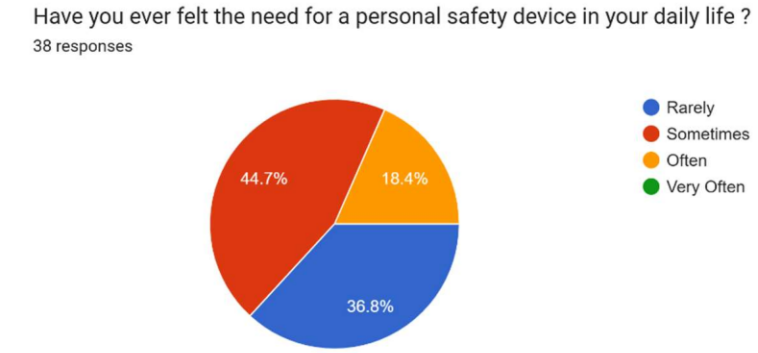
The survey identified key features that users value in a wearable safety device:

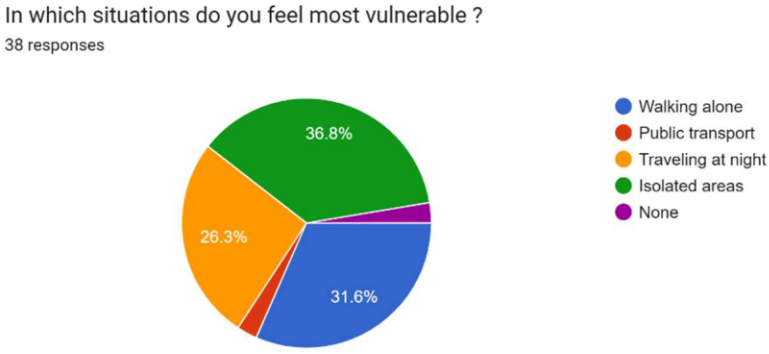
- **Location Sharing (85%)**: The most sought-after feature, emphasizing the importance of real-time location tracking for emergencies.
- **Trigger Buttons (80%)**: A critical feature for activating safety protocols quickly and easily.
- **Heart Rate Monitoring (50%)**: A moderately preferred feature, useful for health monitoring and detecting signs of distress.
- **Audio Recording (50%)**: Highlighted as a valuable feature for documenting events during emergencies.

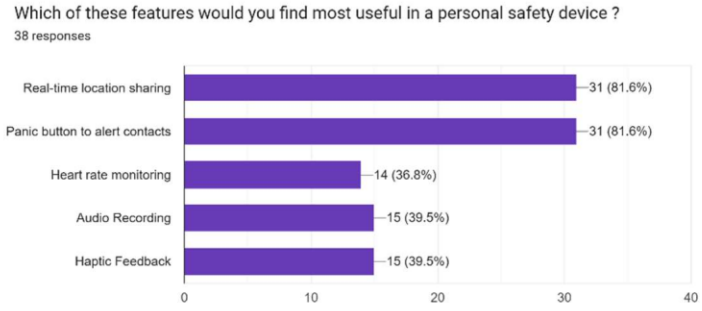
- **Haptic Feedback (45%)**: A functional enhancement that ensures users receive physical confirmations of alerts or activation.

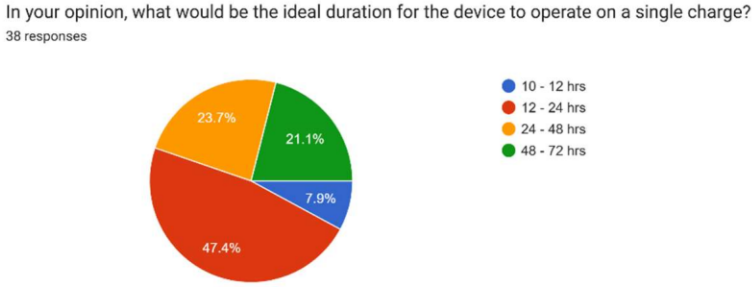
This data reinforces the need to prioritize location-sharing and trigger buttons in the design, with additional features like heart rate monitoring and audio recording as supplementary capabilities.

Visual Representation of Data:



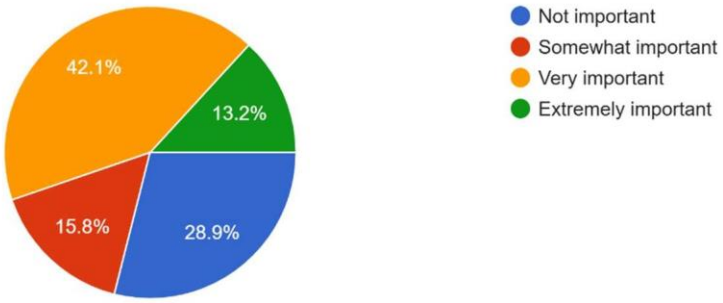






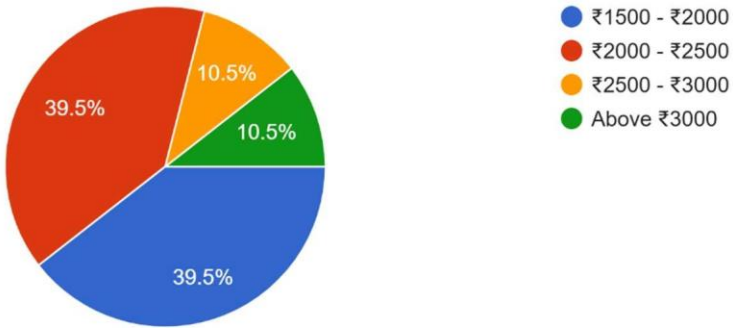
How important is it to you that the device is discreet and doesn't attract attention ?

38 responses



What is the maximum amount you would be willing to spend on this device?

38 responses



Conclusion

The survey results provide actionable insights into the development of the wearable safety device. The primary focus should be on creating a device equipped with robust location-sharing and intuitive trigger mechanisms, as these address the most common vulnerabilities expressed by users. Secondary features such as heart rate monitoring, audio recording, and haptic feedback can enhance the overall utility and appeal. By addressing these needs, the device can cater to diverse scenarios and user demographics, ensuring maximum effectiveness and market acceptance.

Technical/Product Specifications

Objective:
The objective of the Project is to design and develop a wearable safety device that provides real-time tracking of vital signs (such as heart rate, and trigger button) for women individuals and people with safetyrequirements. The system is aimed at improving safety outcomes through give alerts and early interventions to emergency response teams through via SOS feature.

Hardware Specifications
Technical specifications:

1. Force Impact Sensor (FSR):
- **Type:** Resistive sensor
- **Purpose:** Detects pressure or impact.
- **Output:** Analog signal proportional to applied force.
- **Applications:** Trigger emergency signals upon sensing excessive force.

2. Heartbeat Sensor (MAX30102):
- **Type:** Optical pulse oximeter and heart rate sensor.
- **Features:** Integrated LEDs, photodetector, and AFE.
- **Interface:** I2C (SCL, SDA pins).
- **Purpose:** Measures heart rate and blood oxygen levels.
- **Voltage Requirement:** 1.8V (logic) and 3.3V (power).

3. Battery Management (TP4056):
- **Type:** Lithium-ion battery charger module.
- **Input Voltage:** 4.5V - 5.5V.
- **Battery Supported:** 3.7V Li-ion battery.
- **Features:** Overcharge and over-discharge protection.

4. Microprocessor (ESP32-PICO-D4):
- **Type:** Wi-Fi and Bluetooth-enabled microcontroller.
- **Core:** Dual-core Xtensa® 32-bit LX6.
- **GPIO Pins:** Multiple I/O pins for analog and digital inputs/outputs.
- **Interfaces:** UART, I2C, SPI, and PWM support.
- **Voltage Requirement:** 3.3V.

5. GPS Module (NEO-M8N):
- **Type:** GNSS receiver.
- **Purpose:** Provides real-time location coordinates.
- **Interfaces:** UART/SPI/I2C.
- **Operating Voltage:** 3.3V.

6. GSM Module (SIM800C):
- **Type:** Quad-band GSM/GPRS module.
- **Frequency Bands:** GSM 850/900/1800/1900 MHz
- **Interfaces:** UART.
- **Features:** SMS and call capabilities for emergency communication.

7. Power Supply (3.7V Battery):
- **Type:** Lithium-ion battery.
- **Capacity:** 3700mAh.
- **Voltage:** 3.7V.
- **Purpose:** Powers the entire circuit.

8. Vibration Motor (U6):
- **Type:** DC vibration motor.
- **Purpose:** Provides haptic feedback or alerts.

9. Push Button:
- **Type:** Normally open tactile switch.
- **Purpose:** Manual input to trigger certain operations.
- **Resistor:** 1kΩ pull-down.

10. Transistor (2N2222):
- **Type:** NPN transistor.
- **Purpose:** Acts as a switch to control the vibration motor.
- **Voltage/Current Rating:** 40V/800mA.

Software Specifications

1. User Interface (UI) Requirements
1. **Mobile Application (Companion App)**
   - **Platform**: Compatible with iOS and Android.
   - **Features**:
     - Real-time device monitoring.
     - Settings to customize alerts, emergency contacts, and sensitivity levels.
     - Dashboard for health and safety reports.
2. **Wearable Device Interface**
   - Simple LED/Buzzer feedback for alerts or status changes.
   - Vibrations or haptic signals for user confirmations.

2. System Integration and Compatibility
1. **Third-Party APIs**
   - Support for emergency response services and healthcare systems.
   - Integration with messaging platforms for alerts (e.g., SMS, WhatsApp).
2. **Device Updates**
   - Over-the-Air (OTA) updates for firmware and software improvements.
3. **Cross-Device Compatibility**
   - Ensure seamless integration with smartphones, tablets, and other wearable devices.

Performance Metrics and Key Specifications

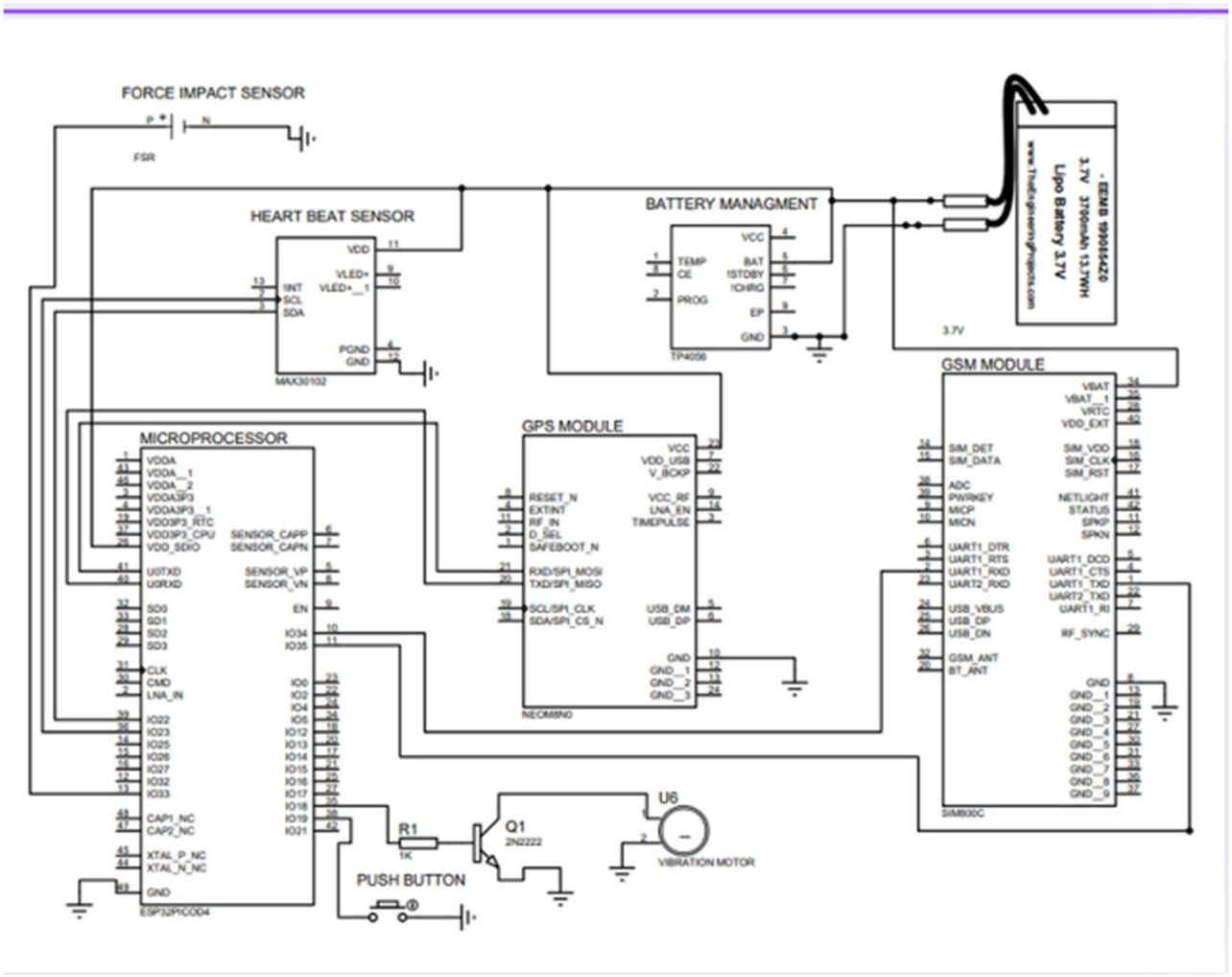
1. Battery Life
- Continuous operation for up to 12-24 hours on a single charge, with power-saving modes reducing energy consumption during inactivity.

2. Real-Time Data Processing
- Data from the sensors is processed in real time on the wearable device, with immediate feedback and alerts sent to the mobile app or cloud.

3. Emergency Response Time

- SOS Response: Alerts are sent to caregivers within (but depends upon network and location) of triggering the SOS system.

Circuit Diagram:



Concepts Generated

Introduction

The development of a wearable safety device for women and children addresses critical safety challenges faced in daily life. The device aims to provide real-time safety features, health monitoring, and seamless communication during emergencies. This report highlights the key concepts integrated into the device and their relevance to the target audience.

Concepts and Detailed Explanations

1. **Emergency Alert System**
   - **Overview:** A button pushing mechanism related activated alert system.
   - **Functionality:** Users can quickly send an SOS signal to pre-registered contacts or local emergency services.
   - **Application:**
     - For women: Alerts authorities or family members in dangerous situations like harassment or assault.
     - For children: Automatically notifies guardians in emergencies, such as getting lost.

2. **Real-Time Location Tracking**
   - **Overview:** Integration of GPS technology for continuous location updates.
   - **Functionality:** Live tracking ensures users' locations can be accessed anytime by trusted individuals.
   - **Application:**
     - For women: Ensures safety during nighttime travel or in isolated areas.
     - For children: Parents can track movements and receive alerts if the child enters unsafe zones.

3. **Haptic Feedback for Silent Alerts**
    - **Overview:** Vibrations provide discreet notifications.
    - **Functionality:** Confirms alert activation without drawing attention.
    - **Application:**
        - For women: Ensures subtle activation of safety features without alerting potential threats.
        - For children: Serves as a non-intrusive way to ensure the device is functioning correctly.

4. **Tamper Detection**
    - **Overview:** Detects if the device is forcefully removed or tampered with.
    - **Functionality:** Sends immediate alerts to the user's trusted contacts.
    - **Application:** Ensures continuous safety monitoring by preventing unauthorized removal.

5. **Customizable Aesthetic Ornament-like Design**
    - **Overview:** Offers stylish, ergonomic designs for users of all ages.
    - **Functionality:** Provides interchangeable straps, patterns, and sizes.
    - **Application:**
        - For women: Aesthetic appeal encourages consistent use.
        - For children: Vibrant, playful designs increase adoption and engagement.

6. **Offline Functionality**
    - **Overview:** Key features operate without internet connectivity.
    - **Functionality:** SOS alerts, fall detection, and health monitoring remain functional offline.
    - **Application:** Ensures reliability in areas with poor network coverage, such as rural areas or basements.

Rough Design:

Front View:

Backside View:

Manufacturing & Assembly Process

1. Component Procurement
– All sensors, modules, and materials were sourced online and tested individually.
– Budget-friendly components ensured affordability without compromising functionality.

2. Circuit Assembly
– All modules (ESP32, SIM800C, GPS, FSR, etc.)
– Internal wiring was arranged for minimal interference and signal integrity.

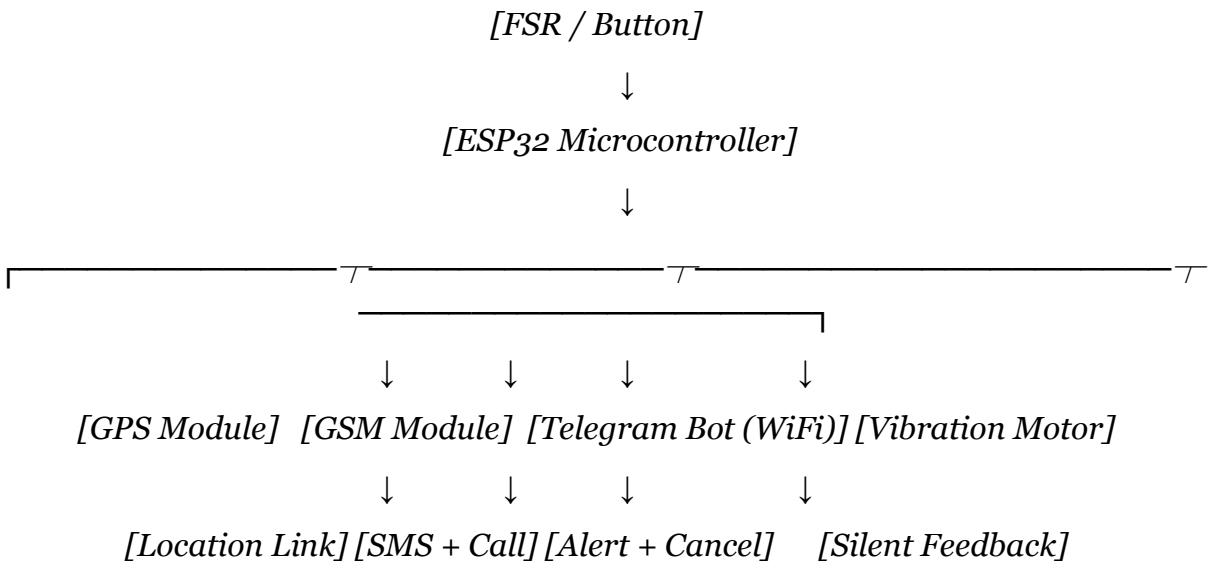
3. Enclosure Design
– Designed using CAD tools for ergonomic wrist fit.
– Casing fabricated using 3D printing (ABS/PLA material) — lightweight and durable.
– Magnetic strap added for tamper detection.

4. Integration & Testing
– Assembled device tested in real-world scenarios (low network, isolated zones).
– Verified proper functioning of:

- SOS trigger
- SMS & call
- Telegram bot + cancel feature
- Vibration alert

– Heartbeat sensor planned but currently disabled due to calibration errors.

Sakhiya System Architecture



1. FSR / Button– Emergency Trigger

- **What It Does:** Detects physical activation by the user.
- **Types Used:**
  - FSR Sensor – Trigger via strong press or force (discreet).
  - Push Button – Manual and direct trigger.
- **Why It's Used:**

  - Allows the user to quickly and silently initiate an emergency alert in any situation (e.g., walking alone, feeling threatened).

2. ESP32 Microcontroller– The Brain

- **Role:** Acts as the central control unit of Sakhiya.
- **Functions:**
  - Reads input from the FSR/button.
  - Communicates with GPS, GSM, Telegram Bot, and vibration motor.
  - **Controls the entire logic:** trigger, location fetch, sending alerts, timing cancel option.
- **Why ESP32:** It supports WiFi, Bluetooth, multiple serial interfaces, and low power consumption.

3. [GPS Module (NEO-M8N)] – Real-Time Location

- **Triggered by:** ESP32 upon emergency activation.
- **What It Does:**
  - Fetches live GPS coordinates (latitude and longitude).
  - Sends those values back to ESP32 to be embedded in alerts.
- **Use in Alert:**
  Creates a Google Maps link like:
  https://www.google.com/maps?q=lat,long
- **Why GPS?:** Helps responders locate the user instantly, even if they can't speak.

4. [GSM Module (SIM800C)] – Offline Communication

- Triggered by: ESP32 after receiving location.
- What It Does:
  - Sends SMS to pre-stored emergency contacts.
  - Automatically calls the emergency number for attention.
- Why It's Important:
  - Works without internet
  - Sends alert instantly in rural or network-restricted areas

5. [Telegram Bot (via WiFi)] – Smart Messaging with Cancel Option

- **Activated if:** WiFi is available and connected.
- **What It Does:**
  - Sends the same emergency message and location to a Telegram contact or group.
  - Adds a "Cancel Alert" button.
  - If clicked within 10 seconds, it stops all further alerts (no call, no SMS).

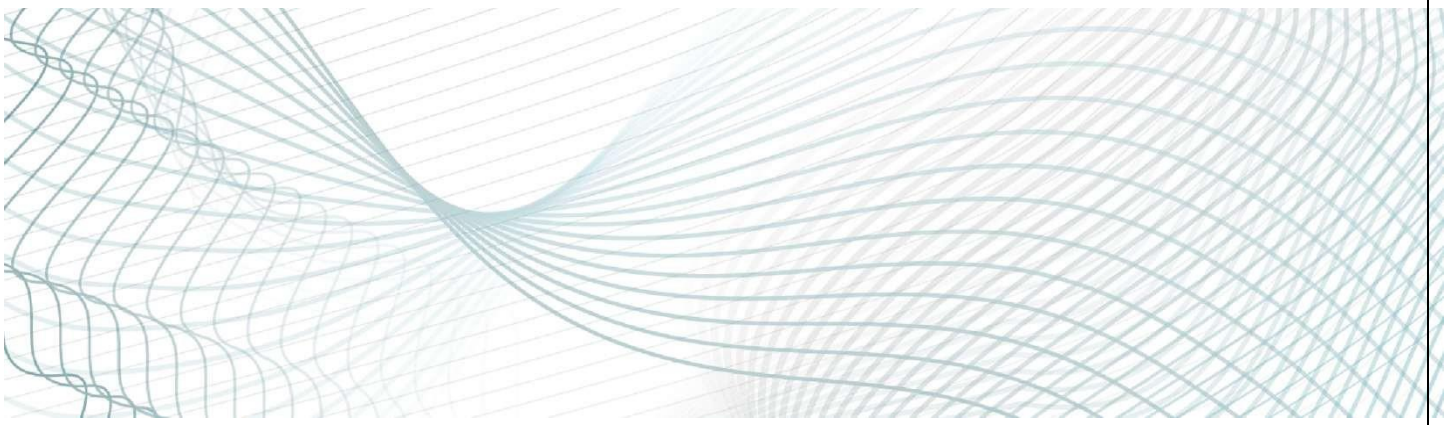
- **Why Telegram?**
  - Fast, modern, and customizable
  - Works across devices (mobile, desktop)
  - Prevents false triggers

6. [Vibration Motor] – Silent Confirmation

- **Controlled by:** ESP32 through a transistor (2N2222)
- **What It Does:**
  - Vibrates briefly when SOS is triggered.
  - Tells the user that the alert was successfully sent.
- **Why It's Used:**
  Discreet feedback — especially useful in situations where sound or light might alert an attacker.

◆ How the Whole System Works Together

1. User presses button or squeezes device (FSR).
2. ESP32 activates → starts SOS sequence.
3. GPS gets live coordinates.
4. SMS and call are sent via GSM module.
5. Telegram Bot sends location with cancel option (if WiFi is available).
6. Vibration motor buzzes silently to confirm.
7. If Cancel button is not clicked within 10 seconds, full alert continues.



Conclusion

In a world where personal safety can never be guaranteed, **Sakhiya** stands as a reliable, intelligent, and user-friendly solution that empowers women and children to seek help instantly — without drawing attention or needing complex devices.

Our prototype demonstrates how **technology, empathy, and design** can come together to build something truly impactful. With features like **real-time GPS tracking**, **SMS and call alerts**, **Telegram bot with cancel option**, and **offline functionality**, Sakhiya ensures that help is always just a touch away.

Though some features like heartbeat monitoring are yet to be fully integrated, the core system performs robustly in real-world scenarios.

Sakhiya is more than a gadget — it's a silent companion, a shield in emergencies, and a promise of protection.

As we move forward, we envision enhancing its capabilities further with mobile app support, AI-based alerts, and integration with public safety networks — making it a complete safety ecosystem for vulnerable individuals.