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A Real-Time Emergency Response System Using IoT for Women Protection

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Abstract
Womens safety has emerged as a top priority on a global scale. Reliable, real-time security solutions must be developed in light of the rising incidence of violence and harassment. In order to offer prompt assistance in emergency situations, this paper describes the design and implementation of the Raksha Band, a smart wearable safety device that is connected with a mobile application. A small wearable band with GPS, GSM, an SOS button, and an audio recording module makes up the suggested system. When enabled, it notifies pre-registered emergency contacts of the user's current location in real time. The system also captures ambient audio, which can be used as proof in court.Using Internet of Things technology, the Raksha Band ensures quick communication between the wearable gadget and the mobile app. Real-time synchronization and safe data storage are made possible by Firebase integration.The systems hardware includes an Arduino Nano microcontroller, a GPS (Neo-6M) for tracking location in real time, a GSM (SIM800L) for emergency communication, an SOS button for instantly activating a distress signal, and an audio recording module to record audio in real time for supporting documentation. The system instantly notifies law enforcement and pre-configured emergency contacts with real-time location information when the SOS button is pressed. The React Native-developed mobile app offers alert notifications and real-time tracking.

1. INTRODUCTION

Wearable electronics such as smartwatches, glasses, and wristbands offer a wide range of features to support daily activities. As these technologies become increasingly prevalent, their application has expanded beyond fitness and health tracking. One vital area where they can make a significant impact is **women's safety**—an issue of growing urgency globally. The rising cases of abuse, violence, and harassment have left many women feeling vulnerable and unsafe. Ensuring the safety and security of women is not only essential for their personal development but also for the well-being and progress of society as a whole.

To address this, we propose the **Raksha Band**, a user-friendly, accessible, and affordable wearable safety device paired with a mobile application. Designed for women from all socio-economic backgrounds, the device is equipped with a rechargeable battery to ensure long-term functionality. The mobile application will be available for both Android and iOS platforms.

Our goal is to leverage the power of technology to make a meaningful social impact in the domain of women's safety. By enabling real-time assistance and monitoring, we believe the Raksha Band can empower women to feel more secure, confident, and self-sufficient. We are committed to the success and sustainable deployment of this project, and we aspire to collaborate with like-minded individuals and organizations who share our vision of creating a safer world for women and girls. Together, we can build a more secure and equitable society.

2. LITERATURE REVIEW

In recent years, women's safety has become a critical concern worldwide, prompting the development of

numerous technological solutions aimed at enhancing security. Among these, wearable devices, particularly women's security bands, have garnered significant attention. These systems commonly integrate various sensors and communication technologies to provide real-time assistance and emergency response. A review of existing literature highlights several key contributions, technologies employed, and limitations of current systems.

2.1 Key Studies and Existing Solutions

1. K. Tirupathaiah et al. (2017) – *Hiding Security System for Women*
Technologies Employed: GPS, GSM
Overview:
This system leverages GPS and GSM modules to track a woman's location in real time. In emergencies, a hidden emergency button triggers alerts to pre-registered contacts, transmitting the user's geographical coordinates.
Limitations:

- Primarily focuses on location tracking and alerts, lacking additional safety features such as voice recording or physical deterrents.
- Requires manual activation of the emergency button, which may be difficult in high-risk situations.

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2. Snehal Bhagwat et al. (2018) – *Women Safety and Alert System*
Technologies Employed: Arduino, GPS, GSM, Accelerometer
Overview:
This system integrates Arduino with GPS, GSM, and an accelerometer to detect abnormal movements, such as sudden falls or attacks. Upon detection, alerts are sent to emergency contacts.
Limitations:

- High-cost components make the system less affordable for widespread use, particularly in low-income regions.
- Complexity and size of the system may hinder usability, especially for older adults or less tech-savvy users.

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3. J. Sriram Pavan et al. (2019) – *Women Safety Device with GPS Tracking*
Technologies Employed: GPS, Arduino, GSM
Overview:
This device offers real-time GPS tracking activated in emergencies, sending the user's location via SMS to authorities or emergency contacts.
Limitations:

- Heavy reliance on a continuous power supply; the device becomes ineffective if the battery depletes.
- Limited to location tracking without supplementary safety features such as alarms or live communication with authorities.

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4. S. K. Anisha et al. (2020) – *Women's Wearable Security and Safety Device*
Technologies Employed: GPS, Pi Camera, GSM
Overview:
A wearable device equipped with a Pi camera to capture real-time video during emergencies, combined with GPS tracking and GSM-based alert systems.
Limitations:

- Bulkiness due to the camera integration makes prolonged wear uncomfortable.
- High power consumption and dependency on cloud storage raise privacy and data management concerns.

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5. Shivani Mishra et al. (2020) – *Smart Safety Band for Women Using IoT*
Technologies Employed: IoT, GPS, GSM, Bluetooth
Overview:
An IoT-based safety band integrating GPS, GSM, and Bluetooth to communicate with the user's smartphone, enabling automated distress calls and tracking functionalities.
Limitations:

- Raises significant security and privacy concerns due to IoT connectivity and potential unauthorized data access.
- Dependence on smartphones limits usability among individuals without access to compatible devices.

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6. R. S. S. Sundaram et al. (2021) – *Multi-featured Wearable Women Security Device*
Technologies Employed: GPS, GSM, Touch Sensors, Panic Button

Overview:
This solution incorporates multiple safety features, including GPS tracking, touch sensors, and a panic button to promptly alert nearby authorities during emergencies.
Limitations:

- Touch sensors may not consistently detect distress if the user is incapacitated.
- Dependence on GSM and GPS networks renders the device less effective in remote or low-signal areas.

2.2 Summary of Key Findings

A thorough review of the literature reveals several common technological strategies and recurring limitations in existing women's security devices:

- **Technologies:** GPS, GSM modules, and various sensors (accelerometers, touch sensors, cameras) are predominantly used to facilitate location tracking, distress monitoring, and emergency communication.
- **Common Limitations:**
  - **Power Dependency:** Most systems require a continuous power source, posing a risk of failure during prolonged use.
  - **Size and Usability Issues:** Some devices are bulky, complex, or expensive, limiting their widespread adoption and comfort.
  - **Privacy and Security Risks:** Especially in IoT-based solutions, concerns about unauthorized access to sensitive data are prevalent.
  - **Lack of Active Defense Mechanisms:** Few systems integrate features such as alarms, voice recording, or mechanisms to physically deter attackers.

***2.3** Existing Systems*

1. S. K. Anisha et al. | Women's Wearable Security and Safety Device | GPS, Pi Camera | Bulky, requires cloud storage

2. K. Tirupathaiah et al. | Hiding Security System for Women | GPS, GSM | Limited self-defense features

3. Snehal Bhagwat et al. | Women Safety and Alert System | Arduino, GPS, GSM, Accelerometer | Expensive components

4. J. Sriram Pavan et al. | Women Safety Device with GPS Tracking | GPS, Arduino, GSM | Dependent on power supply

2.4 Limitation of existing system or research gap

Key Limitations of Current Systems:

1.Limited Self-Defense Features (K. Tirupathaiah et al.):While some systems focus on sending alerts to emergency contacts, they lack integrated self-defense features, such as automatic alarm triggers or disabling potential attackers.

2.High Cost of Components (Snehal Bhagwat et al.):Some systems utilize expensive components like advanced sensors, accelerometers, and Arduino boards, making them less affordable for wide-scale implementation, especially for those in low-income regions.

3.Power Dependency (J. Sriram Pavan et al.):Reliance on constant power supply limits the usability of safety devices. In case of battery failure, the safety system may stop functioning, rendering it ineffective during crucial times.

4.Bulky and Storage-Dependent Devices (S. K. Anisha et al.):Devices that rely on additional equipment like Pi Cameras are often bulky and require external storage (such as cloud storage) for data management, which complicates the design and usability

RESEARCH GAP

1.Lack of compact and discreet wearable options: Most existing solutions are bulky and inconvenient for daily use.

2.High cost and complex setup: Many solutions involve expensive components and complex configurations.

3.Limited self-defense mechanisms: Current systems primarily focus on alerts rather than actively stopping an assailant.

4.Power dependency issues: Many devices require a continuous power supply, making them unreliable in long-duration scenarios.

2.5 Problem statement and objectives

Women face an increased risk of harassment, especially during late hours. Existing safety measures often fail due to accessibility issues, slow response time, or lack of self-defense capabilities. There is a need for a smart, compact, and efficient wearable system that can alert authorities and provide immediate self-defense mechanisms.

Objectives

- To design and develop a **wearable women's safety device** using GPS and GSM technology.

- To create a **compact and cost-efficient system** that integrates with daily wearables.

- To provide **real-time location tracking** and instant emergency alerts.

- To incorporate **an electric shock generator** for self-defense against assaulters.

3. PROPOSED SYSTEM

This section outlines the architecture, components, and functionalities of the proposed women's safety system. The solution consists of a **wearable hardware device (band)** integrated with a **mobile application**, working in tandem to enhance the user's safety through real-time monitoring, location tracking, and emergency communication.

3.1 System Overview

The primary objective of the proposed system is to provide a **reliable, accessible, and user-friendly safety solution** for women. The system architecture comprises two key components:

1. **Wearable Band:**
   A compact, lightweight device designed to be worn on the wrist. It is equipped with:
   - **GPS Module (Neo-6M):** For real-time location tracking.
   - **GSM Module (SIM800L):** To send emergency messages and alerts.
   - **SOS Button:** For immediate activation of the distress alert system.
   - **Audio Recording Module:** Captures ambient audio for potential use as evidence in legal proceedings.
2. **Mobile Application:**
   Developed using **React Native**, the mobile application manages:
   - Real-time **location monitoring**.
   - **Alert notifications** to pre-configured emergency contacts.
   - Synchronization of user data and location with **Firebase cloud storage**.
   - Secure communication between the wearable device and the cloud.

This **integrated system design** ensures a holistic approach to women's safety, enabling immediate response in emergency situations. When the SOS button is pressed, the system performs the following actions simultaneously:

- Sends the user's live location via SMS and app notification.
- Records surrounding audio.
- Updates the location data in the Firebase cloud.
- Notifies both **emergency contacts** and **local law enforcement authorities** (if integrated with local services).

The Raksha Band's **IoT-based architecture** ensures low-latency data transmission, secure storage, and quick user response—all while maintaining portability and ease of use.

3.2 Hardware Component

A small, wearing band that is intended for continuous, discrete use serves as the hardware component.
It includes the following essential elements: Audio Recorder: An integrated microphone records background noise, which could be used as evidence in the event of an incident. For safe and convenient data storage, recordings are kept on a local SD card.
SOS Button: Emergency notifications can be instantly activated by pressing a physical button on the bracelet.
Bluetooth Connectivity: The mobile application and Bluetooth Low Energy (BLE) provide a smooth connection.
Power Supply: The gadget is powered by a compact, effective rechargeable battery that guarantees extended functioning.
Local Indication: When SOS is activated, the band's LED or vibration motor gives the user local input.

3.3 Software component

The main center for system administration and user engagement is the mobile application. Important features include:

User authentication and registration: safe login and registration processes for emergency contacts and user profiles.

Management of Emergency Contacts: A list of reliable emergency contacts can be added and maintained by users.

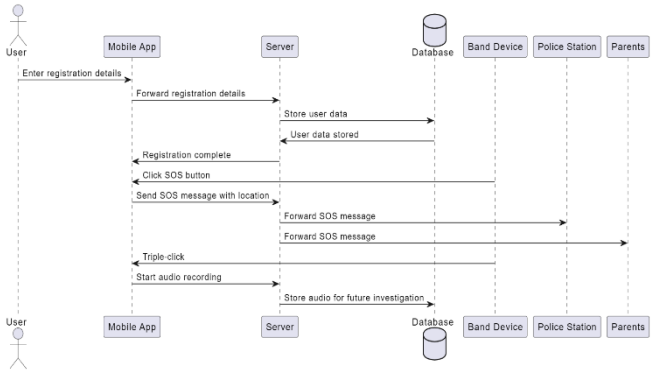
Real-Time position Tracking (GPS): In an emergency, the app uses GPS to deliver precise position information.

SOS Alert Transmission: The program notifies pre-specified emergency contacts—including the user's current location—when the SOS button is pressed.

Audio Recording Management: The application allows users to access and manage audio recordings that are kept on the band's SD card. Pre-configured Emergency Services: Contact information for pertinent emergency services, such as the police and ambulance, is included in the program.

Firebase Database Integration: For safe data storage and real-time updates, the application easily communicates with a Firebase database.

3.4. UML Sequence Diagram



3.5 The Benefits of Technology IoT Integration

Bluetooth allows the band and the mobile application to communicate seamlessly. Real-time GPS tracking: Precise position information for prompt emergency action. Firebase databases are used for safe user data and audio recording storage. Reliable audio recording is made possible via local SD card storage.

Competitive Pricing: Because the system is made to be reasonably priced, a larger user base can access it.

3.6 Firebase Integration

Firebase serves as the system's backend database. It offers a dependable and expandable framework for keeping user information, contact lists for emergencies, and voice recordings. Real-time synchronization between the database and the mobile application is guaranteed by Firebase, allowing for quick changes and effective data retrieval. Using the advantages of IoT technology and emphasizing affordability and dependability, this suggested system provides a complete and intuitive way to improve women's safety.

4. DETAILS OF HARDWARE AND SOFTWARE

4.1 Software

In recent years, mobile navigation apps have grown in popularity, and due to the rise in cross-platform software development, many developers have turned to frameworks such React Native to construct these apps. React Native is a robust framework that enables developers to create mobile applications with JavaScript and React that can be delivered to Android as well as iOS. This method has various advantages to traditional native app creation, including one code base, shorter periods of development, and the potential to tap into a big and active developer community. In addition to these advantages, React Native provides various already constructed navigational libraries that can assist developers in quickly and efficiently creating navigation applications. These libraries include already-constructed elements and navigational patterns that developers may utilize to construct high-quality, user-friendly navigation experiences. In general, React Native provides a robust and versatile basis for constructing navigation apps, and its advantages make it a good choice for developers trying to create cross-platform programs which are efficient, adaptable, and simple to maintain.

React Native is a JavaScript framework that may be used to construct, design, and deploy complex user interfaces for mobile and online apps. It is a popular open-source programme used for constructing various types of Web, Android, and iOS applications. One of the most intriguing aspects of React Native is its ability to delivers contemporary web strategies to mobile without sacrificing much in terms of features or performance. This framework is utilised in the project's front end. To use React Native in the development of various types of apps, one needs first have a basic understanding of HTML, CSS, JavaScript, NodeJS, and ReactJS. Organisations all over the world utilise React

Native to develop multi-platform phone/tablet apps with a single code base

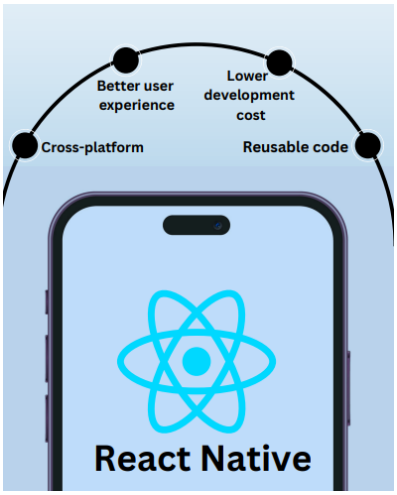


Fig 1. React Native Features

Firebase is a real-time database and also acts as a Backend-as-a-Service(BaaS). It allows to store a list of objects. Google Firebase is Google-backed application development software which allows developers to develop applications for **Android, iOS,** and **Web apps**. Firebase is a web application development platform created by Google. It lets you to developed the whole application on the front-end without any server-side code. At the same time, it does let you set up some server-side logic through Firebase Functions if you need to react to certain events (Creation of data or files, login, https requests) so that you can send emails or push notifications or process the data after it is written.It's easy to start a project with Firebase or add a Firebase to your project.

It allows real-time database connection, which means multiple users can see the changes in the data when the data gets created or edited. Firebase is a backend platform used to build Web, Android and IOS based applications. It furnish with actual time database, specific APIs, more than one authentication types, web website hosting platform and plenty greater. Firebase frees builders to recognition crafting amazing consumer experiences. They don't want to manipulate servers. You don't want to jot down APIs.. Firebase can electricity your app's backend, along with statistics garage, consumer authentication, static web website hosting and greater. Focus on developing first rate consumer experiences. Firebase will deal with the rest. Build cross platform local cell and internet apps with our Android, IOS and JavaScript SDK's.

A Realtime Database emulator is a part of the Local Emulator Suite, which permits your app to have interaction together along with your emulated database content material and config, in addition to optionally your emulated task resources (functions, different databases, and safety guidelines). Using the Realtime Database emulator includes only some steps: Adding a line of code in your app's check config to connect with the emulator. From the foundation of your neighborhood task directory, running firebase emulators: start. Making calls out of your app's prototype code the use of a Realtime Database platform SDK as usual, or the use of the Realtime Database REST API.

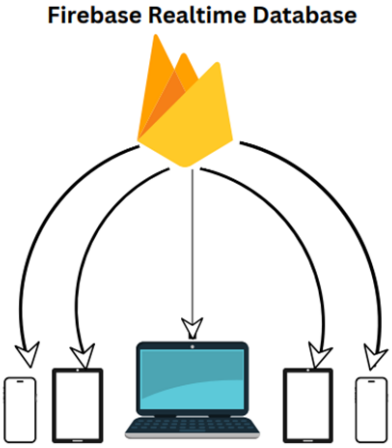


Fig 2. Firebase

4.2 HARDWARE

Components & Their Functionality:

- **Arduino Nano (Microcontroller)**
  - Acts as the main control unit.
  - Communicates with the GSM module and GPS module.
  - Reads input from push buttons.
- **SIM800L GSM Module**
  - Enables mobile network communication.
  - Can send/receive SMS, make calls, or use GPRS.
  - A microphone is connected to enable voice communication.
- **Neo-6M GPS Module**
  - Provides location coordinates (latitude and longitude).
  - Sends GPS data to Arduino via UART (TX, RX).
- **Push Buttons (With Pull-down Resistors)**
  - Likely used for sending emergency alerts or triggering specific functions.

- **LiPo Battery & Charging Module**
  - Powers the entire circuit.
  - A switch is used to control power

5. METHODOLOGY

5.1 Internal working :

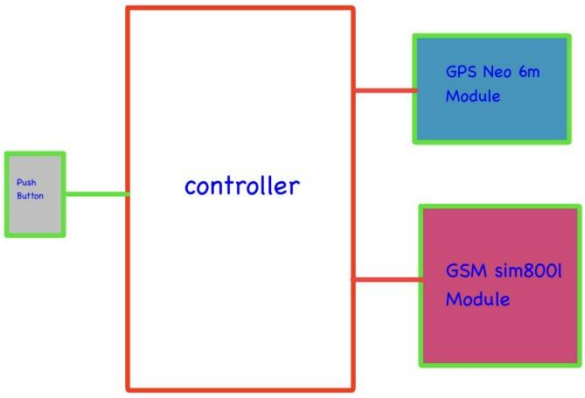
The proposed system is powered by an Arduino Nano microcontroller and is designed to perform two primary functions: **emergency communication** and **real-time tracking**. The key hardware components include a **GPS Neo-6M module**, **SIM800L GSM module**, **microphone**, **Li-Po battery**, and a **battery charging module**, ensuring the device is portable, reliable, and sustainable.

a) Working Principle:

- **GPS Module Functionality:** Upon system activation, the GPS module begins acquiring **real-time latitude and longitude coordinates** from multiple satellites. The Arduino

Fig 3. Workflow

- microcontroller continuously receives the streamed location data and processes it by filtering out irrelevant or noisy signals to maintain accuracy.
- **Emergency Detection and Communication:** The system operates in **low-power sleep mode** until the **SOS push button** is pressed, indicating an emergency situation. Once triggered:
  - The Arduino signals the SIM800L



GSM module.
  - The GSM module sends an **SMS** containing the current GPS coordinates to a **pre-configured emergency contact number**.
  - An **alert message** can also be dispatched to inform the contact of the emergency event.
- **Audio Recording:** Simultaneously, the integrated **microphone** begins recording ambient background audio, which is stored locally or transmitted for future reference. These audio recordings can serve as critical evidence for investigations and legal processes.
- **Power Management:** The entire system is powered by a **Li-Po battery**, enabling prolonged operation without reliance on external power sources. The inclusion of a **charging module** ensures that the battery can be recharged efficiently, making the system **sustainable and long-lasting**.

b) Advantages of the Proposed Method:

- **Portability:** Compact and lightweight design facilitates easy wearability.
- **Reliability:** Real-time GPS tracking and GSM-based communication enhance response times.
- **Sustainability:** Rechargeable battery system reduces dependency on disposable power sources.
- **Multifunctionality:** Simultaneous location tracking, alert messaging, and audio recording offer comprehensive safety coverage.

c) Applications:

The Emergency Response System can be widely applied for:

- **Personal safety** for women, children, and elderly individuals.
- **Vehicle tracking** and monitoring during travel or expeditions.
- **Adventure sports safety**, providing real-time tracking and emergency alert capabilities.

By leveraging real-time GPS tracking combined with quick communication through GSM, the device significantly enhances safety over traditional methods, ensuring timely intervention and support in critical situations.

5.2 Working of Hardware Devices:

The proposed **women's safety bracelet** is engineered to provide immediate assistance during emergencies

through a simple and intuitive interface. Powered by an **Arduino Nano**, the bracelet manages and coordinates the functionality of various integrated hardware modules to ensure quick response and communication.

1) Key Functionalities:

- **Emergency Activation (Single Click):** Upon **single pressing** the push button:
  - The system activates and instantly retrieves the user's **real-time location** using the **GPS Neo-6M module**.
  - A **distress message** containing the GPS coordinates is sent via the **GSM SIM800L module** to a set of **pre-registered emergency contacts**, including the police if configured.
- **Dual Functionality (Double Click):** If the push button is **double-clicked**:
  - In addition to sending the distress message and real-time location, the **audio recording module** is activated.
  - The device begins **recording ambient sounds**, providing crucial audio evidence that may support investigation and prosecution efforts.
- **Emergency Call Activation (Long Press):** When the button is **long-pressed**:
  - The device autonomously initiates a **call to law enforcement authorities**.
  - It simultaneously sends an **emergency SMS** containing the user's location, ensuring multiple channels of communication for quicker response.

2) Hardware Components and Features:

- **GSM SIM800L Module:** Functions similarly to a mobile phone network module, capable of **transmitting both voice and SMS** data, ensuring robust and reliable communication during emergencies.
- **Power Supply:** The device can operate with a **12V DC power supply**, offering flexibility for both mobile and stationary configurations.
- **User Interface:** A **16x2 LCD** screen is integrated to display:
  - **System status**
  - **Real-time data**, such as GPS coordinates and message delivery status.
- **Buzzer Alarm:** An audible **buzzer** provides **instant emergency alerts**, warning nearby individuals and drawing attention in critical situations.
- **Circuit Design:** To minimize size and improve stability, the complete circuitry is constructed on a **zero PCB** (printed circuit board), enabling a **compact and durable** wearable design.

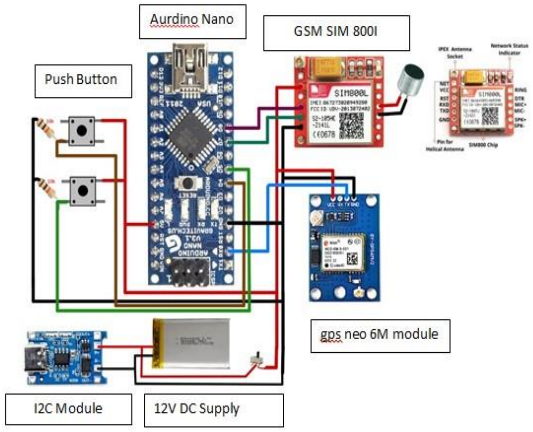


Fig 4. Hardware Components

6. CONCLUSION

This project successfully demonstrates how the integration of various hardware components and communication modules can create an efficient and reliable **tracking and alert system**. By utilizing the **Arduino Nano**, **GSM module (SIM800L)**, **GPS module (Neo-6M)**, and an **I2C-based power management module**, the proposed system ensures **real-time location tracking** and **instant emergency communication**. The inclusion of **push-button controls** enables users to discreetly signal emergencies, making the device highly effective for personal safety and emergency response scenarios.

Major Achievements:

1. **Real-Time Location Tracking:**
   - The Arduino Nano processes accurate **latitude and longitude coordinates** acquired from the GPS module (Neo-6M).
   - These coordinates are transmitted to predefined recipients via the GSM module, ensuring **efficient and real-time tracking** during emergencies.
2. **Stable GSM Communication:**

- The **SIM800L GSM module** supports both **call and SMS functionality**, establishing **reliable communication link** with emergency contacts.
- This ensures that **location-based alerts** are delivered promptly, enabling quicker response actions.

3. **Potential for Additional Sensor Integration:**
   - The system architecture allows for easy incorporation of additional sensors such as **temperature**, **heartbeat**, or **motion sensors**.
   - This extension could broaden the system's applicability to **health monitoring** and **enhanced security** functions.
4. **Mobile Application Integration:**
   - A dedicated **mobile application** has been developed for **tracking** and **managing alerts**, making the system more **user-friendly**, **accessible**, and adaptable to various emergency situations.

The proposed **Raksha Band** represents a significant step toward enhancing personal safety, especially for women, by providing a **compact**, **portable**, and **technologically advanced** solution. Through continuous improvements such as **sensor integration**, **better battery management**, and **mobile app enhancements**, the system can evolve into a comprehensive personal safety platform for a wide range of users, including children, elderly individuals, and travelers.

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