Enhancing women safety using lora technology

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*Abstract*

The safety of women is still a major worldwide concern, underscoring the necessity of creative technology-based solutions to offer protection and comfort. In order to facilitate dependable, long-distance communication in emergency scenarios, this article presents a wearable women's safety gadget that makes use of LoRa (Long Range) technology. The gadget has a panic button that, when hit, instantly sends a distress signal to local authorities and authorised contacts over a LoRaWAN network. The device's low power consumption design guarantees a long battery life, which is necessary for continuous use in a variety of settings.

The device's embedded motion sensors may identify distress situations by detecting unexpected movements or falls, and its GPS capabilities allows for real-time position monitoring. You may strike a balance by mixing LoRa and cellular, with cellular handling real-time voice where feasible and LoRa being utilised for emergency warnings and non-urgent data transfer. A cloud-based system processes the data, enabling real-time notifications through SMS and mobile apps to deliver prompt reactions. In addition to delivering real-time communication choices in urban settings, this strategy offers a reliable, hybrid solution that is perfect for rural locations.

Keywords :— Internet of Things (IoT), Long Range, Low power consumption, LoRa, LR-WAN, cellular device,Rela time voice transfer.

**I. INTRODUCTION**

A women's safety device that integrates cellular connectivity with LoRa technology offers a cutting-edge solution for enhanced personal security. Combining the benefits of cellular and LoRa, this device is designed to provide reliable, low-power connectivity as well as the ability to provide voice transfer and real-time position tracking in an emergency. For situations where energy conservation is essential, LoRa, which is well-known for its low-power, long-range wireless communication, is ideal since it can deliver location updates over considerable distances without requiring regular battery charges. On the other hand, cellular technology's high-speed data transfer enables real-time voice communication, which is crucial in emergency scenarios. Continuous location tracking and rapid access to emergency contacts or authorities when needed are advantages for users.

When a problem occurs, the app changes the safe locations and their security ratings. It also allows users to identify hazardous areas and help others. A radio signal alerting you to an emergency is delivered when you hit a panic button. Wearable technology is used to track information in real time. They have motion sensors installed, which take pictures and send them to mobile devices. The bell system is also used to alert the proper person in case of an emergency.

The gadget connects to the advanced cell using a well-designed application that acts as an interface between the device and the phone. Information from the light gadget is continually monitored by the program that was initially introduced in the telephone. When abuse occurs, the program instructs the PDA to carry out the necessary actions, such messaging family members. Prompt action is also mentioned, and ships are sent to the closest police headquarters. The program has been altered to use the advanced cell's GPS to track coordinates and screen the development for basic track capabilities.

**II.LITERATURE SURVEY**

Reference [1] LoRa-Powered Women's Safety Device: This wearable safety gadget has a panic button, GPS, and emergency notifications. It communicates over great distances using LoRa. Function is tested in the field for user input, and privacy is protected via data encryption. This approach is scalable and has the potential to improve human safety by interacting with emergency networks.

Reference [2] GPS Smart Buoy with LoRa: This buoy system integrates GPS and LoRa technologies to provide dependable connectivity for real-time aquatic tracking. Usability for maritime research, environmental monitoring, and disaster response is improved by environmental impact assessments, cloud integration, and testing under various settings, all of which help to capture important ecological data.

Reference[3] High-Efficiency Solar Tracker: A smart solar tracker may use machine learning for seasonal adaptation, adjusting to sunlight for optimal energy output. It provides sustainable energy solutions and is tested for efficiency in comparison to static panels. Scalability is highlighted in its cost-benefit analysis, which maximizes solar accessibility under a variety of environmental circumstances.

Reference[4] LoRa technology is used in the mine safety monitoring system to provide real-time communication under dangerous conditions. Wearable technology allows employees to keep an eye on environmental conditions and vital signs; the data is sent to a central dashboard so managers can monitor worker safety. Emergency response skills are greatly improved by this approach. However, for the gadget to be implemented successfully and work at its best in the field, it is essential to guarantee its durability under challenging circumstances and to give staff members enough training.

Reference[5] In order to evaluate physical activity in public health, this study recruits a varied participant base and tracks data for three months using trustworthy activity trackers. Statistical techniques are used to examine data, guaranteeing quality control. Compared to self-reports, trackers improve the quality of the data, although participant compliance is essential. Scalable and economical, privacy concerns necessitate strong safeguards. Targeted health treatments that target inactive groups and individuals at risk for chronic illnesses can be informed by insights from activity patterns.

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**III.PROBLEM STATEMENT**

Using Lora technology, a wearable gadget that improves women's safety is being developed. It has alerting systems for information that is sent to emergency responders and location tracking technology that makes it possible to track a victim's location, enabling quicker and more accurate response times. It also provides assistance so that emergency responders can get to the victim's location quickly and provide timely and effective assistance.

Important Elements to Have:

wearable devices with built-in panic buttons allow women to quickly and discreetly alert authorities or trusted contacts in emergencies. LoRa-enabled GPS trackers can monitor location in real-time, providing valuable information to emergency responders and family members. SOS signals send distress signals through LoRa networks, even in areas with limited cellular coverage, ensuring communication during critical situations and handles real-time voice transfering when possible.

Problems to Be Solved:

LoRa technology can be used to address a number of issues with women's safety systems. In an emergency, smartphone apps may take a long time, but panic buttons need to be accessible quickly. Bypassing cell networks, LoRa allows several wearable devices to broadcast instant SOS notifications. LoRa technology allows for dependable position tracking even in rural locations, where GPS trackers may struggle in areas with inadequate internet or weak connections. LoRa devices' low power consumption prolongs battery life and guarantees availability in an emergency. Furthermore, the solution is affordable and available in both urban and rural areas thanks to LoRa networks' extensive coverage.

**IV.EXISTING METHODS:**

All the necessary features, including GPS tracking, emergency contact information, directions to safe locations, etc., are included in the mobile apps. Additionally, when an issue arises, the app updates the safe places and their safety levels. Additionally, it enables users to assist others and spot dangerous locations. When you press a panic button, a radio signal is sent to notify you of an emergency. Real-time information tracking is done via wearable technology. They are equipped with motion sensors that capture the image and sync it with mobile devices. In an emergency, the bell system is also utilised to notify the appropriate individual.

Through a carefully thought-out application that serves as an interface between the device and the phone, the device communicates with the sophisticated cell. The program that was first introduced in the telephone continuously monitors the information of the bright device. In cases of abuse, the application directs the PDA to perform the related tasks, such sending messages to family members. Additionally, it mentions prompt activity and ships off to the nearest police headquarters. The application has been modified to follow coordinates and screen the development for basic track capability using the advanced cell's GPS.

**V. PROPOSED SYSTEM**

1.Device Design Enhancements:

LoRa Module:

Frequency Configuration: Select the appropriate ISM band for your intended region to maximise coverage and compatibility. Security Layer: Use a standard like AES-128 to encrypt data sent via LoRa in order to prevent unauthorised access to location data. Signal Range Optimisation: Consider using an external or high-gain antenna to extend your reach. This is especially useful in urban or remote areas where signal obstructions could exist.

Cellular Module (4G/5G):

Bandwidth management: Provide a way to dynamically adjust the data rate in an emergency, prioritising voice transmission, to ensure reliable communication. Protocol for Saving Power: Reduce standby power consumption by using low-power modes (e.g., eDRX or PSM).

Microcontroller:

Multi-Mode Operation: By incorporating energy-saving techniques like deep sleep and hibernation, this device can automatically transition between modes based on battery levels. Event-Based Interrupt Handling: In reaction to an emergency signal or a power level threshold, the microcontroller should immediately begin wake-up operations to ensure responsiveness.

GPS Module:

Include an accelerometer to track movement or impact; if sudden changes are noticed, Emergency Mode may be triggered. Fast repair Assist: Use A-GPS or a similar technique to extend GPS lock periods; this is especially helpful inside or in congested areas.

Power Source:

Solar Recharging: Use Maximum Power Point Tracking (MPPT) to maximise energy extraction from solar cells, especially in situations with fluctuating light levels. Battery Status Monitoring: Real-time battery monitoring can start power-saving procedures as needed.

2.Operational Modes with Enhanced Features:

Normal Mode:

Adaptive LoRa transmission is the process of programming LoRa broadcasts to alter their frequency in response to user movement or predetermined periods (e.g., lower frequency at night to save power).Cellular Module Standby Optimisation: Make sure the cellular module has a "sniff" mode so it can periodically search for strong signals. When needed, this will enable a fast transition to emergency mode.

Emergency Mode:

Activation via Multi-Trigger System: Enables activation through a number of methods, such as button pushes, voice commands, and impact detection using an accelerometer. Real-time audio transmission: Make sure the audio is clear and has little latency for efficient distress communication.

3.Data Flow and Integration:

Location Sharing via LoRa:

Enhanced Location Packet: Standard LoRa location packets can include crucial signals like a "last known position" tag, battery health, or environmental data. Nearby Device Alerting: Configure the device to search for other LoRa-capable devices and provide location data even without a gateway in order to create a distributed safety net.

Voice Communication over Cellular:

Emergency Priority Protocol: This function, if activated by the carrier, automatically improves call quality in an emergency by raising the device's connection priority inside the cellular network. Record emergency calls automatically, save audio samples locally, or transfer them to the cloud for use in post-event or legal research.

Fallback Mechanism:

LoRa Mesh Network Formation: Establish a temporary mesh network in areas with other comparable devices to relay emergency signals and extend the warning radius in real time.

4.Backend and Alert System:

Cloud Monitoring and Analytics:

Data Analysis and Prediction: Use cloud analytics to search for patterns in location data, battery life, or environmental indicators that could point to an emergency. Emergency Escalation Triggers: Cloud monitoring can identify when emergency signals are sent regularly and escalate notifications to authorities if certain thresholds are met.

Alert to Contacts:

Notify users when they enter or exit a pre-established geofenced region, such as a safe zone, using geofence-based alerts. Multi-Contact Alerting: Prioritise primary contacts for urgent alerts, followed by secondary contacts and local authorities, to ensure that information continues to flow even in the case that primary contacts are not accessible.

**VI.IMPLEMENTATION**

Hardware Configuration:

To get location information, connect the GPS module to the microcontroller.Incorporate the LoRa module to send GPS information.To enable voice calls and SMS notifications, connect the microcontroller to the GSM module.Configure the panic button and connect it to initiate the GSM call/SMS as well as the LoRa broadcast.

Programming:

Write code to monitor the panic button's state and track position continually.After activation, set up the LoRa module to transmit data.Configure the GSM module to send an SMS or make a call when the button is pushed.

To handle network problems or unsuccessful transmission attempts, use error handling.

Testing

Examine the device under real-world circumstances to see whether location tracking using LoRa is dependable.Make that SMS and GSM-based calls function consistently, even in places with poor network coverage.

Check battery life under various use situations.

**VII.SYSTEM ARCHITECTURE**

A. Components of the Device

A microcontroller, such as an Arduino or ESP32, is the main control unit that handles data processing, module communication, and emergency response.GPS Module: Constantly gathers the latitude and longitude coordinates of the gadget.LoRa Module: Manages long-distance data transfer, transmitting position information to a base station or central monitoring system.Two functions are supported by the GSM module:

Voice Call: When the panic button is hit, an emergency voice call is placed to a pre-specified contact.

SMS Alert: Notifies a designated emergency contact by SMS of the user's position.

Panic Button: Starts emergency procedures, such as SMS notifications, phone calls, and LoRa transmissions.

Battery and Power Management: Optimizes energy use and guarantees dependable power to the device.

B. Communication and Data Flow

GPS Tracking of Location: Location data is continually gathered by the GPS module. The microcontroller prepares this data for transmission by processing it.

Using LoRa Communication to Track Location: The LoRa module receives the GPS data from the microcontroller . Over long distances, LoRa sends this data to a base station or gateway. A cloud server or a monitoring app that shows real-time position tracking receives the data from the LoRa base station at the receiving end.

C. GSM-Based Emergency Voice and SMS Transmission

Panic Button Activation: The microcontroller uses the GSM module to send an SMS and make a voice call when the panic button is pressed.

Voice Call: The user can communicate personally or just make an automated call to alert others to an emergency by having the GSM module ring a pre-established emergency contact.

SMS Alert: A designated contact receives an SMS from the device containing the user's current GPS coordinates. Location information is included in the SMS for prompt help.

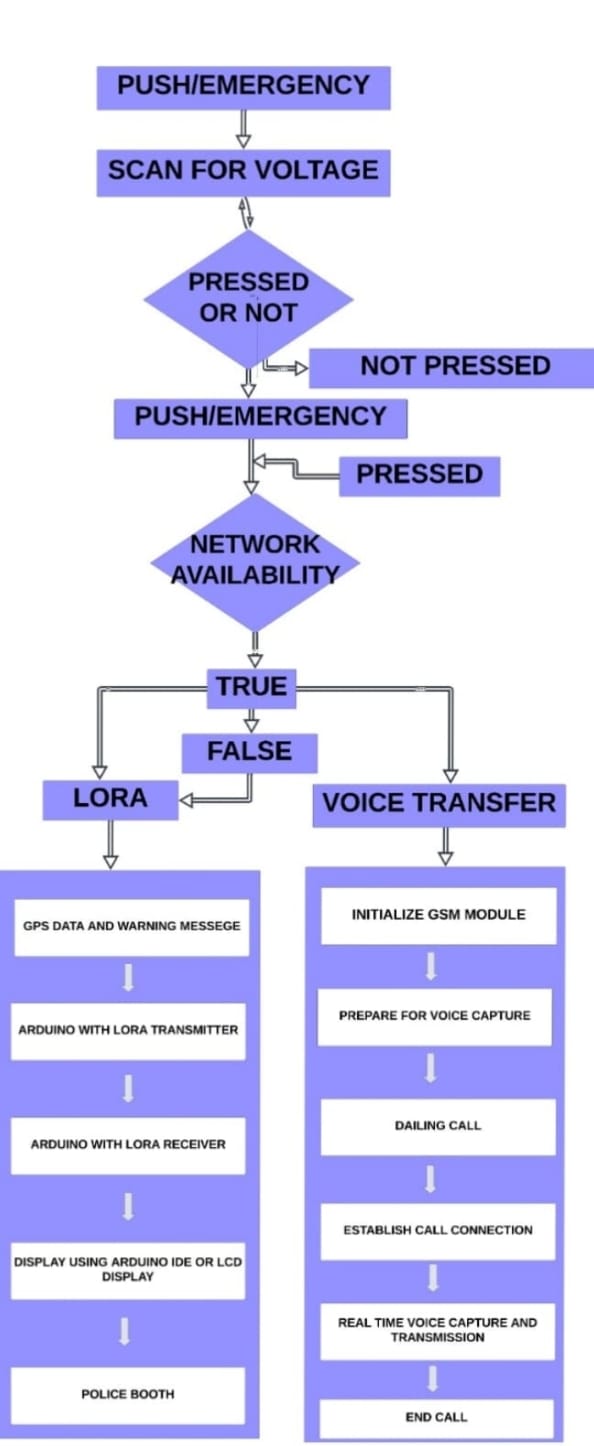
D. Monitoring System (Cloud Server/LoRa Base Station)

Location data sent by LoRa is received by the LoRa Base Station/Gateway and sent to a cloud server.Central Monitoring Application or Cloud Server: saves the incoming GPS data and processes it shows location changes in real time on a monitoring interface (such as a mobile app or website). When the panic button is pressed, notifications or alarms are sent out.

E. Emergency Response and User Interface

A mobile app will shows the user's current position enables family members or law enforcement to keep an eye on their safety.

alarm Notifications: The monitoring system has the ability to instantly notify law enforcement or registered contacts in the event that the device generates an alarm.

Emergency Contact: Can take the necessary action after receiving the voice call or SMS alert. 

##### **VIII.RESULTS AND TESTING**

**1. LoRa Module Testing (Location Tracking & Distress Signaling)**

Goal: To provide dependable position updates and the sending of distress signals, especially in regions with poor cellular coverage .

Test Configuration: Set up two LoRa devices: a receiver in a distant place and one on the wearable.

Determine the distance at which the device consistently sends location data in order to do range testing.

By sending out an emergency signal and noting if the LoRa module notifies the backend system of this, you may replicate a crisis situation.

Anticipated Outcomes: In "Normal" mode, the LoRa module ought to send precise position data on a regular basis.

When in "Emergency" mode, the receiver should immediately hear the distress signal.

Excellent signal quality at distances that are characteristic of the target area, such as inside rural or urban borders.

Metrics of Performance: Signal Range: Although structures may limit range, LoRa normally operates within 1–10 km in open spaces.

Signal Delay: In "Normal" mode, the location is updated in 1-2 seconds; distress signals are given priority right away.

**2. GSM Module Testing (Voice Transmission & Backup Communication)**

The goal is to verify real-time connection and voice clarity for emergency communication.

Test Configuration: Make a test call from the device to a pre-specified number, such as the control room or a contact's phone. Test under various network circumstances, especially in places where cellphone service is poor.

Check to see if the system switches back to LoRa in the event that cellular connectivity is lost. Anticipated Outcomes: Uninterrupted, clear audio transmission under typical network circumstances. little loss in communication quality or latency in signal-weaker locations. If GSM is not available, the device should immediately switch to LoRa for the distress signal.

Metrics of Performance:

Voice Quality: The voice should be clear and lag-free.

Response Time: After pushing the emergency button, the phone connection should start in two to five seconds.

**3. GPS Module Testing (Accuracy of Location Data)**

Goal: To guarantee that the GPS module delivers accurate and up-to-date location information.

Test Configuration: Test the GPS in both open and semi-enclosed spaces, such as beneath trees or close to buildings.

To ensure accuracy, compare the GPS data sent over GSM and LoRa to established coordinates.

Anticipated Outcomes: Accurate localisation in open areas within a 5–10 m radius. regular, on-time backend server updates in both emergency and normal modes.

Metrics of Performance:

Accuracy: Placed within a reasonable radius.

Update Frequency: Continuous updates every few seconds in emergency mode; occasional updates in regular mode.

**4. Power Management Testing (Battery Efficiency)**

Goal: Verify that the gadget runs effectively on a small amount of electricity over extended periods of time.

Configure the gadget for testing by fully charging it and timing its discharge in normal mode (intermittent updates).

Use emergency mode to measure power drain (continuous updates and GSM calls). If your gadget is being charged using solar power or another method, check the recharge times.

Anticipated Outcomes: The device ought to function normally for a few days. Even with a larger power drain, the device should be able to endure prolonged Emergency mode activities.Low-frequency communication and standby should be powered adequately by solar recharging.

Metrics of Performance:

Battery Life: In Normal mode, aim for at least two to three days on a full charge.

Charging Efficiency: It should be possible to recharge manually or with solar power in one to three hours.

**5. Backend System Testing (Alerts, Monitoring, and Fallback Mechanisms)**

Goal: To guarantee that data updated regularly in the backend and that notifications are received by the appropriate contacts.

Test Configuration: Create both distress and non-distress signals, then see how the backend responds.

By intentionally turning down cellular connectivity and making sure that location data and LoRa-based warnings persist, you may test backup solutions.

Anticipated Outcomes: Notifications of alerts are sent instantly to specified recipients. dependable location updates via the monitoring system that may be used as a backup in case GSM fails.

Metrics of Performance:

Timing of Alert: Contacts receive notification seconds after a distress trigger.

System Redundancy: When GSM disconnects, the backup LoRa system immediately comes up.

**6. Environmental Testing (Temperature, Water Resistance, etc.)**

Verifying the device's robustness in a range of weather situations is the goal.

Setup for the Test: Put the gadget in controlled settings with different levels of dust, humidity, and temperature.

If the gadget is meant to be used outside, check its water resistance.

Anticipated Outcomes: Consistent performance within the designated environmental parameters.

When exposed to dust or moisture, there is no harm or malfunction.

Metrics of Performance:

Temperature Tolerance: Between -10°C and 45°C, the gadget should operate correctly.

Water Resistance: The equipment should be waterproof or splash-proof, depending on its grade.

**7. Field Testing (Real-World Scenarios)**

The goal is to replicate real-world user experiences.

Test Configuration: Run tests in low-coverage, urban, and rural settings. Use a variety of motions and velocities (e.g., walking vs. riding in a vehicle). Anticipated outcomes include smooth transitions between GSM and LoRa when needed. dependable notifications, precise position, and power control under actual circumstances.

Metrics of Performance:

Signal switching: a dependable and seamless transition between modes.

Accuracy of location and frequency of updates: in line with lab findings.

**IX.DISCUSSION**

This women's safety tracking device's creation and testing demonstrate how well it can bridge important gaps in personal safety technologies, particularly in places with spotty cellular service. The gadget strikes a balance between extensive coverage and dependable, low-power connectivity by combining LoRa and GSM modules, which is essential for both urban and rural environments.

With long-range capabilities that may circumvent cellular networks, the LoRa module works incredibly well for position monitoring and emergency alerts. This is especially useful in places with poor signal quality. Maintaining connectivity in remote areas, which is a common drawback of conventional GSM-only smartphones, requires this functionality. While many wearable safety gadgets lack this crucial capability, the GSM module allows real-time speech transmission, allowing for instantaneous, clear audio communication in an emergency. This dual-modality strategy ensures connectivity and communication without relying on a single network type, enabling efficient operation across a range of circumstances.

The device's ability to function for lengthy periods of time in normal mode and transition to high-frequency warnings during crises is demonstrated by power management testing. This efficiency is especially important for wearables since usability is directly impacted by battery life. The GPS module helps to ensure exact tracking, which is necessary for prompt emergency response, and improves the accuracy of position data. Another layer of security is added by the device's smooth interaction with a backend system, which offers backup methods for ongoing monitoring and automatically transmits notifications to specified contacts.

The device's robustness is further demonstrated by environmental testing, which indicates that it can function in a range of temperatures and with mild water exposure. This resilience increases the device's overall robustness by guaranteeing that it will continue to be dependable and functional for outside activities.  
  
Field testing confirms its usefulness by demonstrating that the gadget can fulfil demands in the real world by smoothly navigating between GSM and LoRa and sustaining consistent performance in a variety of terrains. Future developments, however, may concentrate on extending battery life even further and investigating other environmental safeguards, such improved water resistance, to make it even more adaptable.

In conclusion, this safety gadget is an appealing option for personal safety as it blends connection, robustness, and ease of use. Its well-considered design takes into account a variety of practical requirements, such as emergency voice support and rural coverage, giving customers peace of mind and a dependable tool for preserving personal security in a variety of settings.

**X.CONCLUTION**

A women's safety device that integrates cellular and LoRa technologies offers a dependable, flexible, and low-power solution for location tracking and emergency response. LoRa's long-range, low-power connectivity guarantees location updates and alarm capabilities in areas with spotty cellular coverage. The cellular module provides real-time voice communication in the interim, which is necessary for timely emergency help.

Three common problems with safety devices are addressed by this dual-technology approach: extending battery life, ensuring consistent connectivity across a range of environments, and facilitating quick, real-time communication when required. Because of its intelligent power management and context-based switching, this device can operate in both normal and emergency modes, providing users with peace of mind and prompt access to help when they need it most.

Ultimately, this safety gadget design offers reliable, real-time communication options along with a versatile, progressive approach to women's safety that functions in both urban and rural environments.

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