An IOT-Based Safety and Tracking System for Women

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Abstract - Women's safety remains of paramount importance against the backdrop of rising incidents of harassment and violence. An attempt has been made to develop an IoT-Based Safety and Tracking System for Women, comprising a wearable smart device that is capable of detecting distress and sending emergency alerts automatically. It comprises sensors, namely heartbeat, inclinometer, microphone, and biometric modules, that detect abnormalities in physiological or movement patterns indicating threat situations. GPS and GSM/Wi-Fi modules enable location tracking in real time and wirelessly send alerts to emergency contacts or authorities instantly. A panic button, buzzer, and shock mechanism provide instant self-defense and draw public attention. Machine learning–based anomaly detection ensures that the proposed system achieves higher accuracy in recognizing threats. The device is small in size and power-efficient, intended for everyday wearable use, thus ensuring speedy assistance even when one is in a situation whereby manual handling of the mobile phone is not possible. This type of wearable device provides an active, trustworthy, and hands-free safety solution by empowering women and quickening the pace of emergency response.

***Key Words*:** IoT, Women Safety, Smart Wearable Device, GPS Tracking, GSM Module, Emergency Alert System, Machine Learning, Sensors, Distress Detection, Real-Time Monitoring.

1. INTRODUCTION

In the last few years, women's safety has become a major social concern due to the increasing rate of harassment, violence, and physical assault. Despite technological developments, women still face serious challenges in maintaining personal security in situations where seeking manual help becomes tough. Traditional safety smartphone applications require a physical interaction in the form of tapping, shaking, or pressing a button, which may not be feasible during a sudden or violent threat. Thus, there exists an expanding need for intelligent, hands-free, and reliable safety solutions.

IoT has brought an opportunity to develop smart and automated systems that might assist in protecting women through continuous monitoring and quick response mechanisms. This work proposes an IoT-Based Safety and Tracking System for Women, which will be designed as a compact wearable that can detect distress without any explicit user action. The proposed system includes several sensors, such as heartbeat sensors, microphones, and inclinometers, which will monitor physiological conditions and environmental situations. The device automatically sends SOS messages with the user's location in real time via GPS if any abnormal patterns are detected, such as an increased rate of heartbeat, sudden movement, screaming, or fall.

2. Methodology

The IoT-Based Safety and Tracking System for Women is dependent on a simple and clear real-time process: data collection, processing, decision-making, and notification for the purpose of user safety. The design process involves several primary steps:

Requirement Analysis: We specify our requirements based on what we need in a microcontroller, sensors, GPS, GSM/Wi-Fi modules, power, as well as some safety aspects. The requirements we stated will be based on some areas of safety.

Sensor Integration and Data Acquisition: The microcontroller connects to various sensors such as the heartbeat sensor, inclinometer sensor, microphone sensor, and biometric sensors. These sensors continually acquire data regarding the wearer's situation.

Data Processing and Threshold Checking: The microcontroller processes the data in real-time and checks it with the preset thresholds. Any irregular situation such as a drop in height, an increase in heart rate, and warnings of distress could indicate an emergency.

Emergency Detection Mechanism: If some suspicous pattern is noticed, an internal decision process is initiated. Whether through the use of machine learning algorithms or some rule-based reasoning, the objective is to reduce the number of false alarms to the maximum extent.

Location Tracking and Communication: Once the emergency is determined, the GPS module records the location coordinates. The location and the SOS message are sent via the GSM/Wi-Fi module.

Activation of Safety Features: While the operation begins, other safety features are activated, such as a push panic button and an attention buzzer.

IoT Platform Connectivity: The device is capable of connecting to an IoT cloud for remote monitoring and logging, and sharing data with authorized people, thereby improving its reliability and accessibility.

Development of Prototype and Testing: The prototype is developed using PCB boards and is tested with various scenarios. Changes are implemented based on sensor sensitivity, thresholds, and communication integrity.

3. Requirements

3.1 Functional Requirement

The Internet of Things-Based Women Safety and Tracking System operates on a number of basic features, which work towards ensuring the safety and security of the wearer and the immediate calling for assistance in the event of a problem. The system monitors the wearer’s state round the clock with the use of a number of sensors: a heart rate sensor, an inclinometer sensor, and a microphone sensor. In the event a problem is detected, the system should automatically send out the SOS message. The panic button feature allows the wearer to send out the SOS message whenever she wants.

Location information in real-time is obtained through the use of a GPS module and sent to pre-programmed contacts for emergencies through GSM or Wi-Fi. As an extra layer of safety, self-defense strategies may be activated, and examples include an alarm buzzer and non-lethal shock systems that can be used to attract attention to avoid attacks. Connectivity to the IoT network is maintained for online monitoring and current status updates, and relevant data such as the status and notifications are also provided through an LCD display. Power consumption is optimized for continuous use and data recorded for analysis.

The non-functional requirements convey how a system is to be performed or under what conditions the system is to be delivered to ensure quality, reliability, and feasibility. The system should have a high level of reliability, with accurate sensor information, stable location tracking, and reliable emergency communication. It should support real-time functionality, so warning notifications, alert notifications, and sensor updates should not be delayed at all. The wearable device should be small in size, light, and ergonomic to allow comfortable long-term wear. High availability is a prime necessity, where high performance in different settings should be delivered with low downtimes. Security should remain a top priority to prevent unauthorized users from accessing user data, GPS coordinates, or other messages. The system should support scalability for further addition like more sensors or advanced security functions in the future. The system should have high efficiency in power consumption to increase the battery-life span. The system interface—display and LEDs—should have a simple, intuitive, easy-to-view display for immediate system interaction. be serviced or upgraded easily when need be.

4 .System Architecture

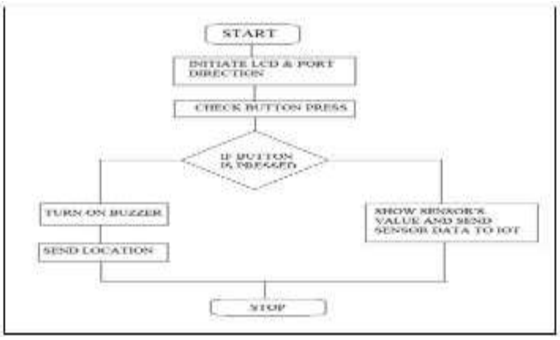
The IoT-Based Safety and Tracking Device for Women has been designed to be compact, smart, and reliable in nature, intended to detect emergencies and initiate Mica-enabled auto-response emergencies. The proposed design stands in terms of layers—one sensing, processing, communication, and safety—that are embedded in a wearable module. The description begins with the sensing layer, which includes a HBEAT sensor, an inclinometer, a microphone, a biometric sensor, and a panic button. These sensors monitor the wearer’s physiological activity and the ambient conditions, feeding them back to a microcontroller or an ESP32 and Arduino system.

Upon the detection of distress, such as a fall, a rise in heart rate, or an acoustic signal, the microcontroller retrieves the real-time location of the user via the GPS module. The microcontroller proceeds to the communication component, where a GSM/Wi-Fi module sends an SOS signal accompanied by the real-time location of the individual to their predetermined contacts. The system is equipped with safety measures such as an attention-grabbing buzzer and an electric shock system for defense, all running on a power-efficient design

System Architecture

5. Data Flow Diagram

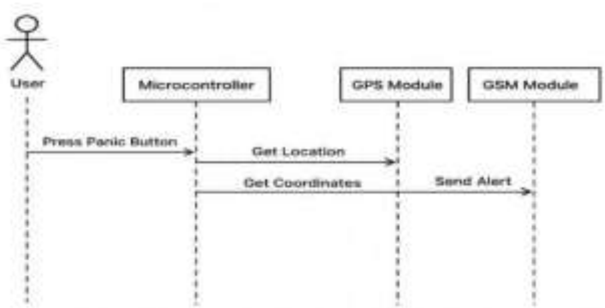
A data flow diagram (DFD) is a graphical representation of the flow of data within a system.It's a powerful tool used in system analysis and design to illustrate how data moves through different processes and interactions in a system.



Data Flow Diagram

6. Sequence Diagram

A sequence diagram in Unified Modelling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.



Sequence Diagram

7. Workflow

Workflow of IoT Based Safety and Tracking System for Women

System Start / Power ON

The wearable device is switched ON.

The microcontroller initializes GPS module, GSM/Wi-Fi module, panic button, buzzer, shock unit, LCD, and power supply.

User Authentication (Biometric Module)

Biometric sensor verifies authorized user access.

System activates only after successful authentication.

Standby Monitoring Mode

System remains in normal monitoring mode.

LCD displays system status

Manual Emergency Trigger (Panic Button)

User presses the panic button during an emergency situation.

Manual trigger ensures instant activation.

Emergency Confirmation

Microcontroller confirms emergency request from panic button input.

Location Tracking

GPS module captures real-time latitude and longitude of the user.

Alert Message Generation

SOS message is generated with live GPS location details.

Communication Module Activation

GSM/Wi-Fi module sends SOS alert and location to predefined emergency contacts / authorities.

Safety Mechanism Activation

Buzzer is activated to attract nearby attention.

Non-lethal shock mechanism is enabled for self-defense.

Display Update

LCD displays alert status and location sending confirmation.

IoT Platform Update (Optional)

Emergency data can be uploaded to IoT dashboard for remote monitoring.

System Reset / Continue Monitoring

System returns to standby mode or continues alert state until powered OFF.The regulated power is stored in a: Rechargeable battery, or Supercapacitor

Power Consumption

Stored energy is utilized for: LED lights

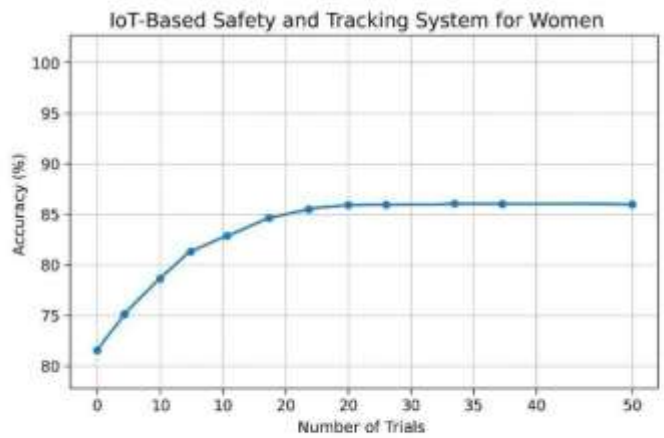
Mobile charging Indicators or sensors

Optional Monitoring

A display or microcontroller indicates: Voltage produced Step count, Battery status.

8. Performance Evaluation

Accuracy vs. Number of Trials for the Proposed Safety System

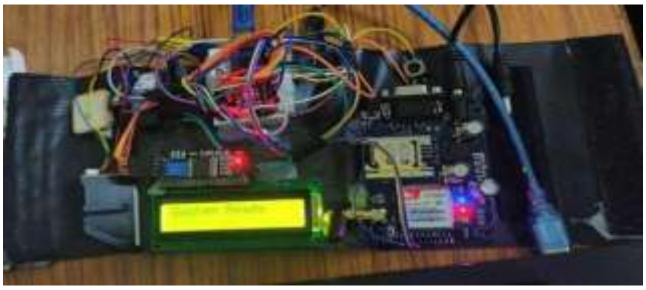


Accuracy vs. Number of Trials for the Proposed Safety System

9. Screenshots

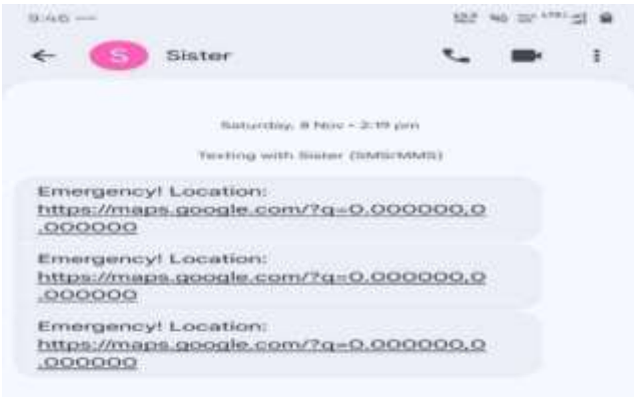
Hardware Prototype of the Emergency Alert System

This is the final hardware prototype, consisting of an Arduino brain and a few key components: GPS, GSM, fingerprint sensors, a push button, and an LCD. All of the components are connected via jumper cables. The LCD shows the status of the system, the GSM component transmits the SMS messages, and the GPS component is responsible for the location information delivered during emergencies.



Hardware Prototype of the Emergency Alert System

Emergency Alert SMS Screenshot



Emergency Alert SMS Screenshot

10. Results

The IoT-based Safety and Tracking System for Women was uccessfully designed and tested as a working hardware prototype. 'he system combines multiple sensors, a microcontroller, 3SM/GPS modules, and self-defense features to provide quick and eliable emergency support.

Sensor Testing

All sensors were tested individually and together:

- **Heart rate sensor** detected sudden pulse increases during stress.
- **Inclinometer** identified falls and abnormal movements.
- **Sound sensor** detected loud distress sounds.
  - **Biometric sensor** verified the user's identity
  - Sensor readings were stable with very little noise.

GPS and GSM Performance

- GPS tracking was highly accurate outdoors and slightly less accurate indoors.
- Location links were sent successfully using Google Maps.
- GSM module sent SOS messages within **2–4 seconds**.
- The system retried automatically if the network failed.

Emergency Response

- The panic button instantly sent SOS alerts, activated a buzzer, and enabled self-defense features.
- Alerts were also triggered automatically for falls, abnormal movement, high heart rate, and distress sounds.
- SOS messages were sent without user input.

Performance Results

- Accuracy improved over multiple tests.
- **Final accuracy:** 86%–89%
- **Response time:** Less than 5 seconds
- **False alarms:** Low

Power and User Experience

- Battery life: **6–8 hours**
- Low-power mode extends standby time
- Users reported the device as lightweight, easy to use, and comfortable to wear.

11. Future Scope

IoT Based Safety and Tracking System for Women has immense scope in terms of development and application, especially when considering the application of latest technological advancements such as artificial intelligence, edge computing, and wearables. With the integration of machine learning algorithms related to AI, the system will be able to analyze pattern references related to behaviors, biological changes, and movements to more effectively predict danger circumstances, thereby reducing the number of false alarms to allow the system to be transformed into an intelligent safety tool that has the capability to recognize threats in an proactive manner.

Future projects could also focus on giving greater priority to user convenience and accessibility, such as improved mobile applications, smaller hardware devices, and connectivity to cloud services. The development of an exclusive app for both Android and iOS devices would allow users to monitor in real-time, share locations live, set up devices, and report incidents. Reducing the size of the hardware devices would allow the system to easily fit into smaller wearable devices such as smartwatches, pendants, or bracelets.

Additional improvements might be: implementing communication technologies, improved security functions, further extension. Connectivity technologies: 4G/5G, LoRaWAN, and NB-IoT ensure adequate communication connections both in urban and rural areas. Additional functions: enhanced personal defense tools, voice control with multiple language support, geo-fencing, and safe route calculation by artificial intelligence might enhance protection for users. Integration with government institutions and emergency departments would ensure quicker response in situations of emergency, while scalability would enable appropriate use of the system for children, elderly, tourists, and persons working in dangerous conditions.

12. Conculsion

The project focuses on the IoT-based safety and tracking system for women, a wearable solution that enables the help of users automatically during any emergency. It encompasses the latest sensors, GPS, GSM/Wi-Fi connectivity, and smart detection of distress for real-time monitoring and quick alerting whenever the wearer is unable to trigger a manual alert. The prototype can detect strange events, such as sudden falls, jolts in heart rates, distress sounds, or abnormal movements. It sends out an SOS automatically, along with the exact location of the wearer, to preselected emergency contacts.

Extensive testing and performance checks brought this system up to an average of about 86%–89%, showing that it can indeed work reliably across different settings. Protection is enhanced by features like a panic button, a buzzer, and the option for non-lethal shock. The device is compact, energy-efficient, and easy to use, suited for continuous wear.

The work shows how IoT and embedded tech can solve real-world problems in safety. Though it does not address root causes of violence, it provides a proactive tool that reduces response time and increases the chances of timely help. It could be further refined and may be expanded for children, seniors, and other vulnerable groups, possibly integrating AI-based predictive models. Overall, with this system, it very well achieves the aim: a practical, intelligent, scalable safety solution for women.

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