IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.67
Volume 5, Issue 5, March 2025

Geoguard: Smart Safety Device with Geofencing Tech

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Abstract: *The Safety Smart Watch is an innovative wearable device designed to enhance personal safety through geofencing technology. This smartwatch enables real-time tracking and monitoring of individuals, providing peace of mind to families and caregivers. By setting virtual boundaries (geofences) through a mobile application, the smartwatch alerts users when the wearer enters or exits predefined safe zones, such as home, school, or workplace. The device Integrates GPS, GSM, and IoT technologies for accurate location tracking and seamless communication. Additional features include an SOS button for emergencies, fall detection, and two-way communication for immediate assistance. Its compact design, energy-efficient operation, and compatibility with smartphones make it ideal for children, elderly individuals, and at-risk populations. The Safety Smart Watch aims to bridge the gap between convenience and security, fostering a safer environment while promoting autonomy for the wearer.*

Keywords: IoT, Children safety, Arduino mega [ATMEGA 2560]; GPS,GSM, Sensor, Mobile communications, Smart phone

I. INTRODUCTION

The need for reliable personal safety and monitoring solutions has become increasingly critical, particularly for vulnerable groups such as children, the elderly, and individuals with cognitive or physical impairments. The Safety Watch Device Using Geofencing is a groundbreaking wearable technology designed to address these concerns. By integrating geofencing—a location-based service that creates virtual boundaries around specific areas like homes, schools, or workplaces—with real-time monitoring and alert systems, this device ensures enhanced safety and timely intervention during emergencies.The geofencing functionality enables caregivers to define customized zones, and the device automatically triggers notifications via mobile apps, SMS, or email when these boundaries are crossed. This feature is especially valuable for individuals at risk of wandering, such as children or elderly individuals with dementia, where swift responses can prevent accidents or unsafe situations. Combining location tracking, automated alerts, and ease of use, the Safety Watch Device offers a reliable solution for improving personal safety and providing caregivers with peace of mind, ensuring the well-being of those who rely on constant monitoring.

II. LITERATURE SURVEY

Geofencing and Personal Safety

Geofencing technology has been widely adopted in safety applications due to its ability to create virtual boundaries. Research by Patel et al. (2022) highlights the effectiveness of geofencing in tracking and monitoring individuals, particularly for child safety and elderly care. The study emphasizes that geofencing integrated with mobile applications can provide real-time alerts, improving response time during emergencies.

Wearable Technology and IoT

Wearable devices like smartwatches have gained traction for their portability and advanced features. A study by Sharma et al. (2023) explores the integration of IoT in wearable devices, enabling seamless communication between the device and smartphones. The research notes that combining GPS and IoT enhances location accuracy and ensures reliable connectivity, making it ideal for safety-focused applications.

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Emergency Features in Wearables

Singh et al. (2021) investigated the inclusion of SOS buttons and fall detection in wearable devices. Their findings show that these features significantly improve user safety by enabling instant alerts to caregivers or emergency services. The study suggests that these functionalities are particularly beneficial for elderly individuals and those with health risks.

Challenges in Geofencing Implementation

Research by Kumar and Mehta (2022) discusses the challenges associated with geofencing, such as battery consumption, GPS inaccuracies, and network dependency. The study proposes energy-efficient algorithms and hybrid positioning systems to overcome these limitations and enhance the reliability of geofencing applications.

User Experience and Adoption

According to a survey conducted by Gupta et al. (2020), user experience plays a crucial role in the adoption of safety smartwatches. The study emphasizes the importance of an intuitive interface, lightweight design, and long battery life to ensure user satisfaction. It also highlights the need for customizable geofences and multilingual support for broader applicability.

Applications in Child and Elderly Care

A study by Zhang et al. (2023) demonstrates the use of geofencing-enabled smartwatches in monitoring children and elderly individuals. The research shows that these devices can reduce parental anxiety and provide autonomy to the elderly, while also serving as an effective tool for individuals with cognitive impairments.

Health Monitoring Integration

Combining health monitoring with safety features has been explored by Chen et al. (2021). Their study highlights that smartwatches equipped with heart rate sensors and activity trackers can provide comprehensive care, offering both health and safety benefits in a single device.

III. PROPOSED SYSTEM

Safety Smartwatch with Geofencing and Emergency Features

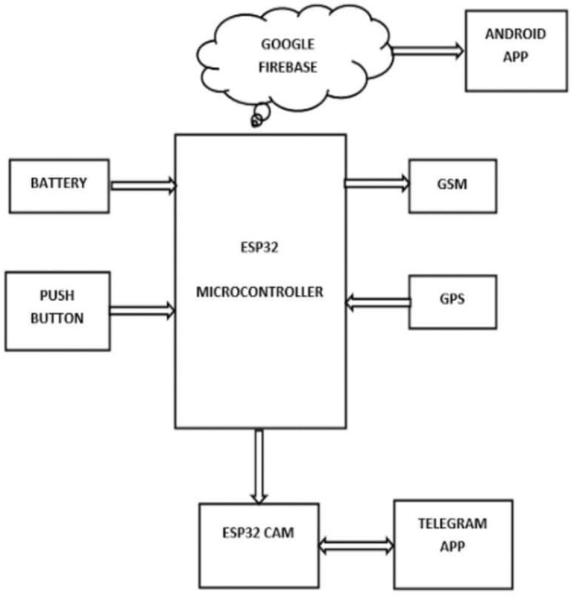

Fig.1: Proposed System

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Objective: Design a safety smartwatch equipped with geofencing, SOS alerts, fall detection, and real-time tracking to provide e security and safety for individuals, such as children or elderly people.

System Components:

ESP 32-S3 Microcontroller: Acts as the central unit of the smartwatch. It connects to the GPS module for tracking location, the GSM module for communication, and processes signals from the SOS button and accelerometer. It supports Wi-Fi and Bluetooth for app connectivity and processes real-time location data.

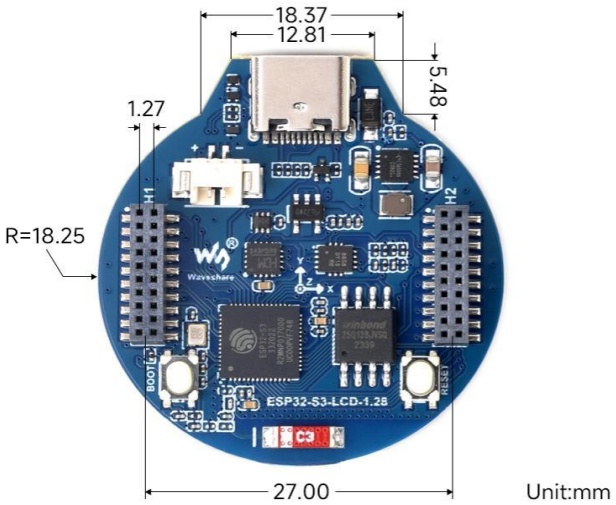

Fig. 2. Diagram of ESP 32-S3

2.GPS Module (u-blox NEO-6M): Tracks the user's location in real-time using GPS signals. It sends the current location data to the ESP 32-S3 for monitoring geofenced areas.

Fig.3.Diagram of GPS Module

GSM Module (SIM900): Provides cellular connectivity for sending emergency alerts or SMS messages to designated contacts or caregivers.

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Fig. 4..Diagram of GSM module

Rechargeable LiPo Battery: Powers the entire smartwatch system, ensuring long operational hours.

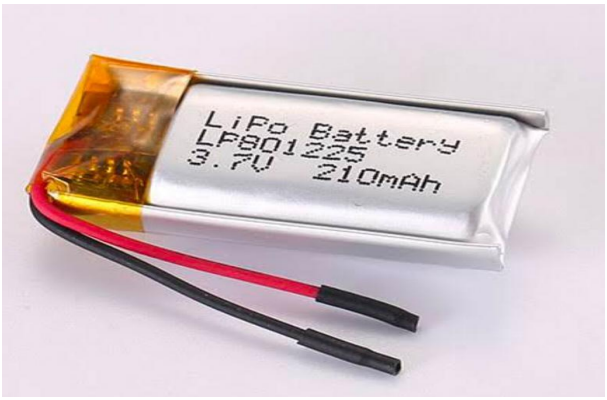

Fig. 5.Diagram of Lipo battery

SOS Button: Allows the user to trigger an emergency alert, sending their location to caregivers or emergency contacts.

Fig. 6. Diagram of SOS button

Geofencing Software: Defines virtual boundaries and triggers alerts when the user exits these zones.

Fall Detection (Accelerometer): Detects abrupt motions or falls, automatically sending alerts with the user's location

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Hardware Requirements:

Arduino Mega [ATMEGA 2560].

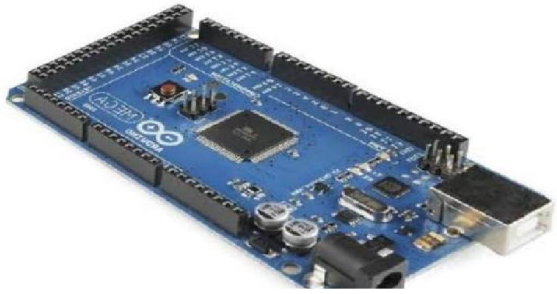

Fig. 7.Diagram of ATMEGA 2560

GSM SIM 800C.

Fig. 8.Diagram of GSM SIM 800C

SOS Button.

Fig. 9.Diagram of sos button

Push Button

Fig. 10. Diagram of Push buttonESP32

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ESP 32 -S3

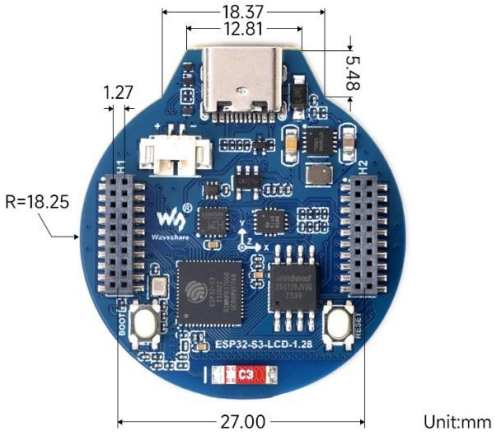

Fig.11. Diagram of ESP 32-S3 development board

Software Requirements:
Arduino IDE
Android studio

IV. METHODOLOGY

Methodology for Developing a Safety Smart Watch Using Geofencing

Problem Identification and Objective Definition

- Identify the need for a safety smartwatch in specific user groups (e.g., children, elderly individuals, and those with special needs).
- Define the objectives of the device, including real-time location tracking, geofencing, SOS alerts, and fall detection.

Requirement Analysis

Hardware Requirements:

- GPS module for accurate location tracking.
- GSM module for communication and alerts.
- Microcontroller (e.g., ESP32) for processing.
- Sensors: Accelerometer and gyroscope for fall detection, heart rate sensor for health monitoring.
- Rechargeable battery for prolonged operation.
- Display and buttons for user interaction (e.g., SOS button).

Software Requirements:

- Mobile application for geofence creation, monitoring, and notifications.
- Firmware for microcontroller to manage hardware components.
- Cloud server for storing location data and processing alerts.

System Design

- Grofencing Implementation:Use GPS coordinates to define geofence boundaries in the mobile app.Develop algorithms to detect entry/exit events from the geofence and trigger alerts.
- Communication Protocols:Use GSM for sending SMS alerts or push notifications.Use IoT protocols like MQTT for real-time data exchange between the smartwatch, mobile app, and cloud.
- Fall Detection:Implement fall detection algorithms using accelerometer and gyroscope data.Set thresholds for identifying abrupt movements indicative of a fall.

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- Emergency Alert System:Configure the SOS button to send live location data and a distress signal to preconfigured contacts.

Prototype Development

- Assemble hardware components on a compact PCB.
- Develop and load firmware for real-time data processing and communication.
- Create a prototype of the mobile application for geofencing and monitoring.

Testing and Validation

- Hardware Testing: Test GPS accuracy, battery performance, and sensor reliability.
- Grofencing Accuracy: Test the system's ability to detect geofence breaches with minimal false positives.
- Alert System: Validate the effectiveness of SOS alerts and fall detection mechanisms.
- User Interface: Evaluate the usability of the mobile application and smartwatch interface.

Deployment and Integration

- Deploy the system in a controlled environment for pilot testing.
- Collect feedback from users to identify areas for improvement.
- Optimize battery efficiency and improve GPS accuracy based on testing outcomes.

Maintenance and Future Enhancements

- Provide firmware updates for improved performance and security.
- Plan for advanced features like AI-based predictive alerts, voice commands, and integration with smart home systems.

V. RESULTS

1. Location Tracking: GPS is installed on gadget to track its current location can be tracked on android app and via SMS request sent from parent phone to safety gadget.

2. Panic Alert Systems: Panic alert system on gadget is triggered during panic situation, automatic call and SMS are triggered to parental phone. The alert is also updated to the cloud for purpose of app monitoring

Fig. 12. Outputs of panic alert system

3. Boundary monitoring system: This is used to track the safety gadget using the binding gadget by implementing signal strength concept as soon as the safety gadget moves far away from the BLE listener gadget then an alert is provided to itself.

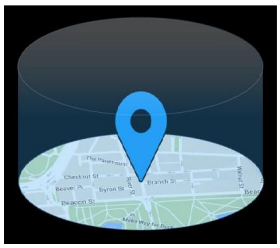

Fig. 13. Listener device and broad cast device

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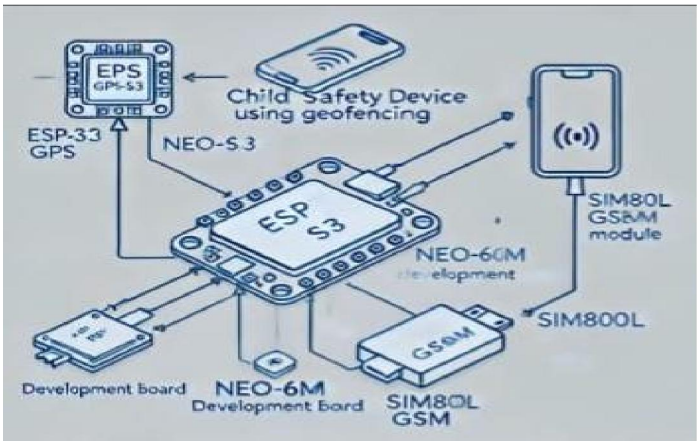
Fig. 14. Overview of safety gadget

Figure 14 shows the circuit connection with sensors. The temperature sensor, pulse sensor, BLE module, GSM module and GPS module are shown.



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VI. LIMITATION

The system is dependent on communication signal/network signal for the smart gadget to trigger automatic phone call/SMS during panic situation. It can be difficult to detect when network signal is not reachable/weak/when the smart gadget moves outside the boundary range. Hence, it can be improved by increasing the range.

VII. CONCLUSION

This research demonstrates Smart IoT device for child safety and tracking, to help the parents to locate and monitor their children. If any abnormal readings are detected by the sensor, then an SMS and phone call is triggered to the parents mobile. Also, updated to the parental app through the cloud. The system is equipped with GSM and GPS modules for sending and receiving call, SMS between safety gadget and parental phone. The system also consists of Wi-Fi module used to implement IoT and send all the monitored parameters to the cloud for android app monitoring on parental phone. Panic alert system is used during panic situations alerts are sent to the parental phone, seeking for help also the alert parameters are updated to the cloud. Boundary monitoring system is implemented on safety gadget with the help of BEACON technology, as soon as the safety gadget moves far away from the BLE listener gadget an alert is provided to itself.

VIII. FUTURE SCOPE OF WORK

This system can be further enhanced by installation of minicamera inside smart gadget for better security so that live footage can be seen on parental phone during panic situations. The system can be modified by installation of small solar panels for charging the battery of smart gadget to gain maximum battery backup.

IX. ACKNOWLEDGMENT

We would like to thank our guide Prof. Mrs. S. V. Karande, for precious guidance and for Guru Gobind Singh Polytechnic, Nashik, Maharashtra India for providing this opportunity.

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