A Lightweight Wearable Fall Detection System using Gait Analysis for Elderly

Abstract

The Lightweight Wearable Fall Detection System for the elderly utilizes gait analysis to detect falls and ensure timely assistance. Built around an Arduino microcontroller, the system processes data from multiple sensors, including a MEMS sensor for motion and orientation detection, and a force sensor to monitor pressure changes during movement, allowing for precise fall detection. In the event of a fall, the system triggers a GPS module to provide real-time location data, and the GSM module sends an alert to caregivers or family members via SMS. A buzzer offers immediate audible feedback to the wearer, while a red LED indicator displays the system's status. This wearable device aims to enhance the safety and independence of elderly individuals by ensuring quick response in emergency situations.

Introduction

Elderly individuals are at a higher risk of falls due to age-related factors such as decreased mobility, impaired balance, and medical conditions. Falls can lead to severe injuries, long-term disabilities, and even fatal consequences if timely assistance is not provided. Traditional fall detection methods suffer from limitations, including delayed response times and false alarms. This project integrates multiple sensors, including MEMS and force sensors, to analyze gait patterns and sudden posture changes. The system automatically sends an alert via GSM and provides real-time location tracking using a GPS module, ensuring a quick response from caregivers or emergency services.

Components

Arduino Uno, MEMS sensor, Force sensor, GPS module, GSM module, LCD Display, Buzzer, LED indicator.

Objective

Accurate Fall Detection: Using MEMS sensors and force sensors for movement monitoring.

Real-time Location Tracking: GPS integration ensures quick emergency response.

Wearable, Lightweight, and Comfortable Design: Ensuring user comfort and ease of use.

Methods

Data Acquisition: Sensors continuously collect movement and orientation data from the user.

Fall Detection Decision: The system determines if a fall has occurred based on predefined motion parameters.

Emergency Response Activation: If a fall is detected, an alert is triggered via the GSM module, and location details are sent through GPS.

Caregiver Notification & Response: Caregivers receive an SMS alert with the user's location and take necessary actions.

System Reset & Continuous Monitoring: After an alert is sent, the system resets and continues monitoring for future falls.
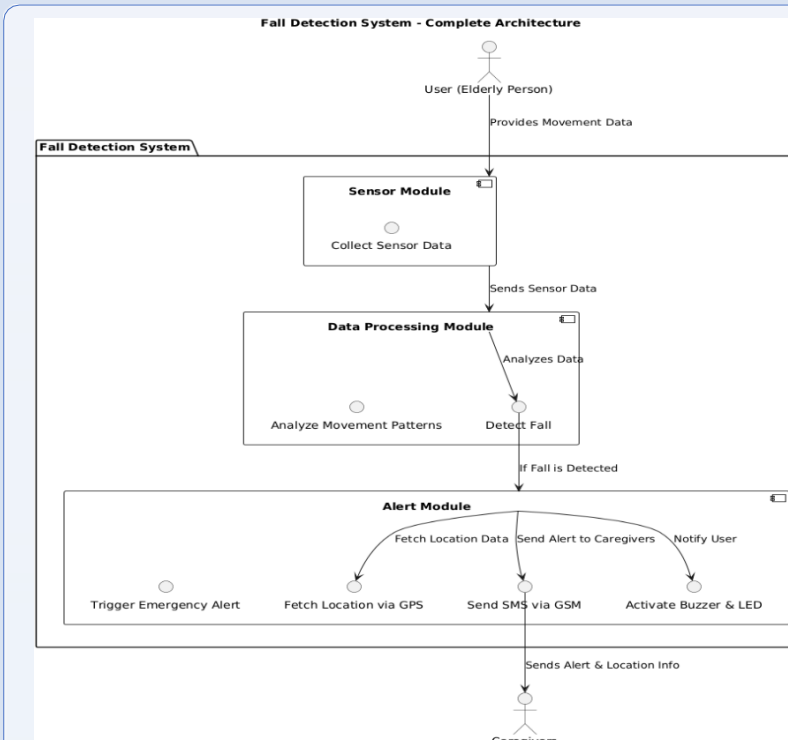
Results

Displaying sensor values on the LCD.

Sending SMS alerts with GPS location upon fall detection.

References

"Fall detection system for elderly people using IoT and Big Data" Diana Yacchirema, Jara SuaR rez de Puga, Carlos Palau, Manuel Esteve, 2018.

"Fall detection monitoring system with position detection for elderly at indoor environments under supervision,"Dias PVGF, Costa EDM, Tcheou MP, Lovisolo L, 2016 8th IEEE LATINCOM ; 2016:16.

Conclusion

The proposed system enhances elderly safety by providing real-time fall detection, location tracking, and emergency alerts. It is a cost-effective, reliable, and user-friendly solution for fall prevention. The use of multi-sensor technology ensures precise motion analysis, reducing false alarms and ensuring accurate detection. By integrating GSM and GPS communication, the system provides an efficient emergency response mechanism. The device's lightweight design enhances usability, making it ideal for continuous wear. Future enhancements, such as AI-based detection algorithms, cloud connectivity, and mobile app integration, could further improve its effectiveness and adoption in healthcare applications.

Future Scope

- **Machine Learning Integration**: Improving accuracy through AI-based activity recognition.
- **Cloud-based Monitoring**: Remote access for caregivers and healthcare providers.
- **Mobile App Support**: Providing real-time data and alerts via a smartphone application.

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