Fall Detection System

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November 1, 2023

1 Introduction

Falls pose a significant risk to the elderly, especially those suffering from neurodegenerative or motor neuron diseases such as Parkinson's disease. These individuals often experience reduced mobility and balance, making them more vulnerable to falls that can result in severe injuries and complications. To address this critical issue, the development of an advanced Fall Detection and Protection System is necessary. This system will not only detect falls but also provide timely assistance, ensuring the safety and well-being of the affected individuals. The project will build upon existing research and technology, incorporating a wide range of sensors and innovative techniques to achieve higher accuracy and reliability in fall detection.

Many implementations (context aware based and wearable based) have been implemented to develop a fall detection algorithm and system with varied accuracies. While some used inertial sensors, others used audio sensors, floor image sensors or cameras to detect; usage of sensors in smartphone for the same. Some efforts have also been made to provide protection during a fall. This has been done using airbag systems.

2 Approach

- Using NodeMCU ESP32
  - WEARABLE DEVICE (NodeMCU ESP32):
    - Hardware: The wearable device utilizes a NodeMCU ESP32 equipped with built-in accelerometers and GPS capabilities.
    - Functionality: It continuously collects and logs accelerometer data and GPS coordinates from the wearer's movements.
    - Data Transmission: This data is transmitted to a remote server via a Wi-Fi connection for further analysis.
  - MULTI-THREADED SERVER:
    - Deployment: The server is hosted remotely and operates using multithreading to efficiently manage multiple concurrent connections.
    - Data Reception: It receives data sent by the wearable device over the Wi-Fi connection.
    - Primary Function: The server acts as the central processing unit for fall detection using a custom Machine Learning model.
  - MACHINE LEARNING MODEL:
    - Model Design: A Machine Learning model is designed specifically to analyze the accelerometer data and distinguish between regular movements and fall events.

        * Real-Time Analysis: The model continuously processes the incoming data to detect falls.
        * Notification Trigger: Upon detecting a fall event, the model triggers the notification process.
    - NOTIFICATION TO THE FALLEN PERSON'S PHONE:
        * Event Handling: When a fall is detected, the server initiates a notification process.
        * Notification Method: It sends an internet-based notification to the fallen person's phone to alert them of the fall event.
    - RELAYING INFORMATION TO THE CARETAKER'S PHONE:
        * Role of Fallen Person's Phone: The fallen person's phone serves as an intermediary.
        * Data Sharing: It relays information about the fall, including GPS coordinates, to the designated caretaker's phone.
        * Timely Communication: This step ensures that the caretaker is promptly informed, enabling them to provide assistance or coordinate help efficiently.

- Using Smartphone and in-built sensors
    - Smartphone: Utilizes the smartphone's in-built sensors.
    - Wifi Module: For connectivity and data transfer.
    - GSM Module: As a backup for cellular communication.
    - Software: Utilizes smartphone apps and software for fall detection and notification.
    - Machine Learning: The smartphone apps employ machine learning algorithms for fall detection.

Optional Airbag Protection System: If possible, an airbag system can be added.

3 Components

- Approach-1:
    - NodeMCU ESP32
    - Accelerometer
    - Gyroscope
    - Smartphone
    - GSM Module
- Approach-2:
    - Smartphone
    - Wifi module
    - GSM module

4 References

- "An IoT-based Device Type Invariant Fall Detection System" by Sheikh Nooruddin, Md. Milson Islam, and Falguni Ahmed Sharna.