IOT BASED SMART FOOTWEAR FOR WOMEN & CHILDEREN SECURITY

Nandini G R[1], Anusha S Y[2], Deepika T R[3], Ganesh V[4], Sufiya Muskan[5]

[1]*Assistant Professor, Electronics & Communication, SJM Institute Of Technology, Karnataka,India*

[2] *Bachelor Of Engineering, Electronics & Communication, SJM Institute Of Technology, Karnataka,India*

[3] *Bachelor Of Engineering, Electronics & Communication, SJM Institute Of Technology, Karnataka,India*

[4]*Bachelor Of Engineering, Electronics & Communication, SJM Institute Of Technology, Karnataka,India*

[5]*Bachelor Of Engineering, Electronics & Communication, SJM Institute Of Technology, Karnataka,India*

ABSTRACT

Many people who have an improper gait pattern, when engaged in rigorous running, jumping, climbing steps etc. develop a strain over plantar areas and the heels of the foot that may worsen over age, due to the impact made by the foot on the ground. As most gait analyses systems are often bulky and cost prohibitive in usage, the paper focuses on developing a prototype of Smart Shoe a device easy to use for the detecting improper gaits in real-time. Foot position during swing and stance phase is monitored by two accelerometers and the pressure points are monitored by the five pressure sensors embedded in the shoe. The observation in 5 normal subjects, made to walk on a treadmill, wearing the prototype, and the walking pattern data recorded and an interpretation done under the guidance of a physiotherapist, has been discussed. The data recorded is in graphical form for efficient analysis shows individual's walking pattern, swing of foot and load/impact on different parts of the foot, as the subject walks.

Keyword : - *Automatic Fall Detection,Real-Time Location Tracking,Emergency SMS Alert System*

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1. INTRODUCTION

In recent years, the need for personal safety devices has significantly increased, especially for individuals who are more prone to accidents or unsafe situations — such as elderly people, women, disabled individuals, and those working in isolated or high-risk environments. Quick and accurate communication during emergencies can be the difference between life and death. Traditional methods of seeking help, such as calling or shouting, may not always be feasible in critical moments. This highlights the urgent requirement for smart, automatic safety solutions. The Fall Alert System is a wearable safety device designed to detect emergencies like falls or distress situations and respond instantly by sending the user's live location via SMS to a trusted contact. By using a combination of sensor technology, GPS tracking, and GSM communication, the system ensures that help can be summoned even if the person is unconscious or unable to use a phone.

2. LITERATURE SURVEY

A review of existing literature on fall detection and emergency communication systems reveals several insights and challenges that inform the design of this project. Many fall detection systems, such as those discussed by Nguyen et al. (2016) and Karunatilaka et al. (2018), rely on accelerometers and gyroscopes to detect falls but often struggle with issues of false positives and negatives. These systems typically require user interaction or complex setups, highlighting the need for an automatic and reliable fall detection solution. The integration of GPS technology, as explored by Le et al. (2017) and Rashid et al. (2019), allows for real-time location tracking, but challenges remain with GPS accuracy in indoor environments or regions with poor signal strength. Furthermore, GSM-based communication systems, as shown in research by Singh and Agarwal (2015) and Sharma et al. (2016), are effective for emergency alerts but are often limited by battery life and the necessity for manual activation. Additionally, many existing systems are expensive and require smartphone integration, which reduces their effectiveness when the user cannot access their phone during an emergency, as noted by Ratan et al. (2018) and Fitzgerald et al. (2020). Emerging technologies, such as edge computing and machine learning algorithms, as highlighted by Patel et al. (2021) and Kim et al. (2022), offer promising directions for improving system performance and reducing reliance on external connectivity. These findings emphasize the need for an affordable, self-contained, and efficient fall alert system that is independent of smartphones and offers reliable detection, accurate location tracking, and instant communication with emergency contacts, which this project aims to address.

3. Methodology

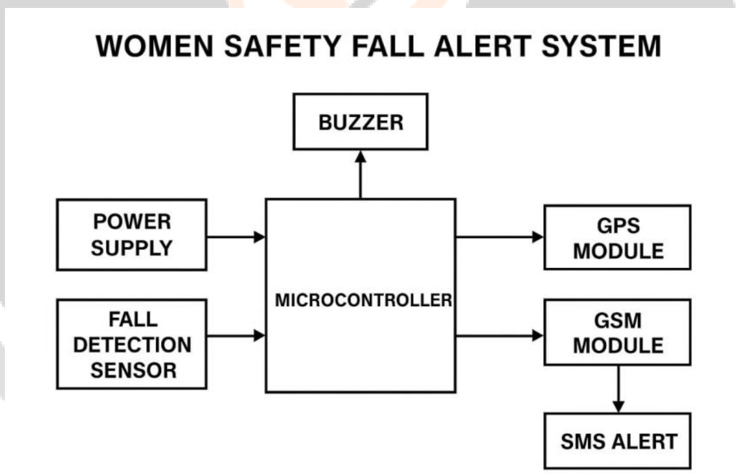

Fig 3.1 Block Diagram

Step-by-Step Process Flow:

This flow outlines the sequence of operations from when the system is powered on to when a fall is detected or the panic button is pressed, and an alert is sent to emergency contacts.

1. System Power-On and Initialization

- **Power On**:
  - The system is powered on via the battery.
  - The microcontroller (Arduino Nano) initializes and begins executing the code stored in its memory.
- **Module Initialization**:
  - The fall detection sensor (GY-271 magnetometer), GPS module (NEO-6M), and GSM module (SIM800L) are initialized.
  - Serial communication starts for debugging purposes, and each module is checked for proper functionality.
- **Display System Status**:
  - The Serial Monitor will show that the system is ready to start monitoring for falls and panic button presses.

2. Continuous Monitoring

- **Fall Detection Monitoring**:
  - The **fall detection sensor** (e.g., magnetometer or accelerometer) continuously checks for sudden changes in movement that might indicate a fall.
  - If no fall is detected, the system continues monitoring.
- **Panic Button Monitoring**:
  - The system also keeps an eye on the panic button for manual activation.
  - If the button is pressed, it triggers an emergency alert, just like a fall detection trigger.
- **GPS Location Tracking**:
  - The GPS module continuously provides the device's current location (latitude and longitude).
  - This location is updated regularly and is ready for use in the alert message when needed.
- **Battery Monitoring**:
  - The system monitors the battery level to ensure it remains powered for the duration of operation.
  - If battery levels are low, a low-battery warning will be displayed on the serial monitor.

3. Triggering of Emergency Alert (Fall or Panic)

- **Fall Detection**:
  - If the fall detection sensor detects a fall (i.e., sudden, unusual movement), it sends a signal to the Arduino.
  - The Arduino immediately processes the data and retrieves the current GPS coordinates.
- **Manual Panic Button Press**:
  - If the panic button is pressed by the user, the system immediately triggers an emergency alert, regardless of the sensor state.
- **Generate Alert**:
  - The Arduino formats the message with the user's GPS location (latitude and longitude), including a Google Maps link for the emergency contact to view the location. Example message: "Fall/Panic Detected! Location: https://maps.google.com/?q=12.971600,77.594600"
- **Send Alert**:
  - The GSM module (SIM800L) is used to send the formatted SMS message with the location data to the pre-saved emergency contact(s) (family, caregivers, or emergency services).

4. Confirmation of Alert

- **SMS Sent Confirmation**:
  - The system waits for a response from the GSM module, confirming that the SMS has been successfully sent.
  - A message confirming the successful transmission is displayed on the Serial Monitor.
- **Failed SMS Attempt**:
  - If the SMS fails to send (e.g., due to poor network coverage or hardware issues), the system retries the message transmission a specified number of times.
  - If all attempts fail, the **Serial Monitor** displays an error message indicating the failure.

5. Continuous Monitoring After Alert

- **Return to Monitoring Mode**:
  - Once the alert is successfully sent (or after a set number of retries), the system returns to continuous monitoring mode.
  - It continues to check for fall detection, panic button presses, and GPS updates.
- **Monitoring for Next Event**:
  - The system is in a loop, always ready to detect another fall or receive a manual panic button press.
  - The GPS continues to update periodically, ensuring that accurate location information is always available.

6. System Shutdown (Optional)

- **Power-Off**:
  - If the user chooses to turn off the device (either manually or through a shutdown process), the system powers down.
  - All modules stop, and the Arduino halts operations.

3.2 Hardware Components:

- **Microcontroller**: **Arduino Nano** (or similar)
  - Acts as the central processing unit of the system.
  - Interfaces with sensors (fall detection, GPS), the GSM module, and the panic button.
  - Controls the flow of information and initiates emergency communication.
- **Fall Detection Sensor**: **GY-271 Magnetometer** (or Accelerometer)
  - Detects sudden movements or changes in orientation that indicate a fall.
  - The sensor measures changes in the magnetic field or acceleration and sends the data to the Arduino for processing.
- **GPS Module**: **NEO-6M GPS Module**
  - Provides the real-time **location** (latitude and longitude) of the user.
  - The data is sent to the Arduino for formatting and use in the emergency message.

- **Communication Module**: **SIM800L GSM Module**
  - Sends **SMS messages** with location data to predefined emergency contacts (family, caregivers, emergency services).
  - Operates via a cellular network for reliable communication.
- **Panic Button**: Physical push-button
  - Allows the user to manually trigger an emergency alert if they feel unsafe or require assistance.
  - Acts as a backup to the automatic fall detection system.
- **Power Supply**: **Rechargeable battery**
  - Powers the entire system, ensuring portability.
  - Includes a charging circuit to recharge the battery when necessary.

3.3 Software Requirements:

- **Arduino Code**:
  - The core program running on the Arduino Nano is responsible for:
    - **Monitoring** the fall detection sensor and panic button.
    - **Reading** data from the GPS module for location tracking.
    - **Sending** the location and alert messages via the GSM module when a fall or emergency is detected.
    - **Power management** to optimize battery usage and ensure long operational time.
- **Serial Monitor**:
  - Used for debugging and monitoring the system during the development process.
  - Displays sensor readings, system status, and any errors or failures.
- **SMS Logic**:
  - The Arduino code formats and sends a **text message** to emergency contacts, including a Google Maps link with the user's current location.

3.3 ACTIVITY DIAGRAM

3.3.1 SCHEMATIC DIAGRAM

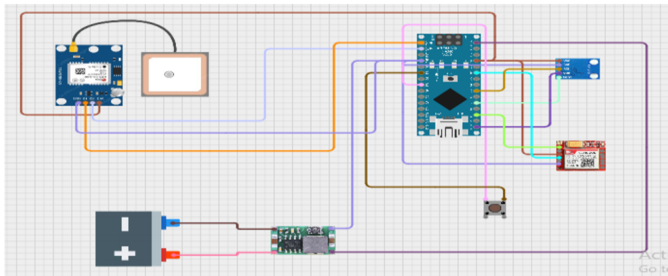

Fig 3.3.1 Schematic diagram

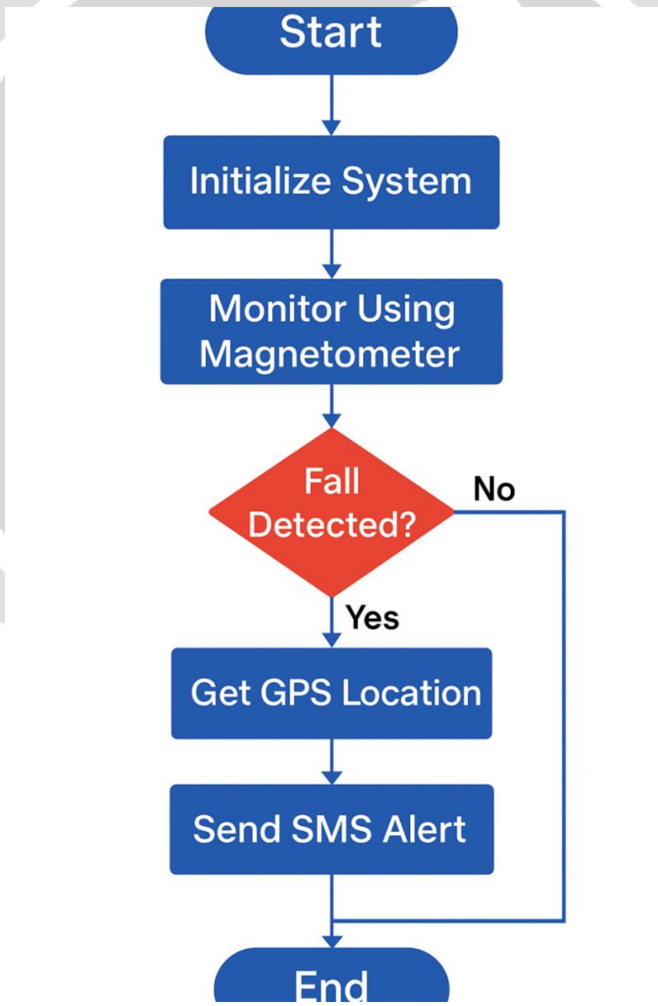

Fig 3.3.2 Activity diagram

6. REFERENCES

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