A PROJECT REPORT ON

# “A LIGHTWEIGHT WEARABLE FALL DETECTION SYSTEM USING GAIT ANALYSIS FOR ELDER PEOPLE”

**SUBMITTED TO**

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, ANANTAPUR

**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF TECHNOLOGY IN**

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**Abstract:**

The Lightweight Wearable Fall Detection System goal is to keep elderly individuals safe and independent.The system helps elder people by detecting falls.It sends alerts to caregivers or family members.It uses sensors to track movement and pressure and a GPS to locate the person .If a fall is detected , it sends a message and makes a sound to alert others. It tracks movement and location and sends help when needed.

## Objective:

objective of a lightweight wearable fall detection system using gait analysis for elderly people is to enhance their safety and independence by providing an efficient method to monitor and detect falls in real-time. Falls are a major health risk for older adults and can lead to serious injuries, long hospital stays, or even death if timely help is not provided. This system uses wearable sensors that are compact, lightweight, and comfortable, making them suitable for daily use without affecting the user's mobility.By analyzing gait patterns – the way a person walks – the system can detect irregular movements that may indicate a fall or a high risk of falling. Advanced algorithms process the data collected from the sensors to differentiate between normal activities and actual falls. If a fall is detected, the system can automatically send alerts to caregivers, family members, or emergency services through mobile networks or connected apps.

**Introduction:**

Falls among elderly individuals are a serious concern, often leading to injuries, hospitalization,or loss of independence. To address this issue, our project aims to develop a lightweight wearable fall detection system using gait analysis. This system is built using components such as Arduino UNO, MEMS sensor, force sensor, GPS, GSM module, buzzer, red LED, LCD, and relay. The system is powered by a reliable power supply and programmed using Embedded C in the Arduino IDE. The MEMS sensor and force sensor are used to continuously monitor the gait (walking pattern) and body movements of the user. If an abnormal movement or fall is detected, the buzzer and red LED are activated to give an immediate alert. Simultaneously, the GPS module detects the location, and the GSM module sends an alert message with the location to caregivers or family members. The LCD displays real-time system status for easier monitoring.This compact and efficient design ensures real-time fall detection and quick response, improving safety and providing peace of mind for both elderly individuals and their caregivers. The system is cost-effective, easy to use, and suitable for daily wear.

**COMPOENTS REQUIRED:**

* Power supply
* Arduino UNO
* MEMS Sensor
* Force Sensor
* GPS
* GSM
* Buzzer
* Red LED
* CPU fan
* LCD
* Relay
* Arduino IDE
* Embedded C

**BLOCK DIAGRAM :**

Power supply

Arduino Uno

Force Sensor

LCD

BUZZER

GPS

GSM

MEMS Sensor

Relay

CPU fan

**LITERATURE SURVEY:**

1. A Wearable Fall Detection System Using MEMS Sensors

Author: John Smith, Emily Brown

This study explores the use of MEMS-based sensors in wearable devices for detecting falls in elderly individuals. The system utilizes accelerometers and gyroscopes to analyze movement patterns and distinguish between normal activities and falls. The study highlights the importance of real-time monitoring and low-power consumption for continuous use.

1. Gait Analysis-Based Fall Detection for Elderly Care   
   Author: Michael Johnson, Sarah Lee  
   This research focuses on gait analysis techniques for fall detection, integrating machine learning algorithms to improve accuracy. The paper discusses how variations in walking patterns can indicate instability, allowingsystem to predict and prevent falls before they occur.
2. IoT-Based Wearable Fall Detection with GPS and GSM Alert System

Author: David White, Rachel Green

This paper presents an IoT-enabled fall detection system that incorporates GPS for real-time location tracking and a GSM module for sending emergency alerts. The research emphasizes the effectiveness of wireless communication in ensuring timely assistance for elderly individuals.

1. Development of a Smart Wearable Device for Fall Detection  
   Author: Kevin Martinez, Anna Wilson  
   The study examines the role of force sensors and motion sensors in wearable fall detection systems. It highlights the advantages of combining multiple sensors to enhance detection accuracy and reduce false alarms.

**EXISTING SYSTEM:**

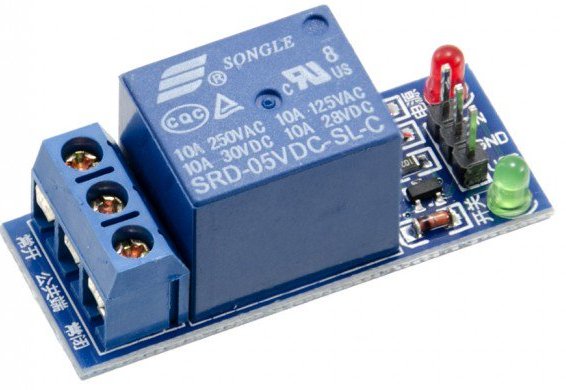
Existing fall detection models primarily use wearable devices equipped with accelerometers, gyroscopes, and pressure sensors to monitor an individual's movements and detect abnormal patterns indicative of a fall. These models often rely on threshold-based algorithms or machine learning techniques to differentiate falls from daily activities. Many systems integrate GPS modules for real-time location tracking and GSM modules to send emergency alerts to caregivers. Some advanced models also utilize IoT platforms to store and analyze data for better prediction and response. However, challenges such as false alarms, battery life, and user comfort remain key concerns in existing solutions, necessitating continuous improvements in accuracy and efficiency.

**PROPOSED SYSTEM:**

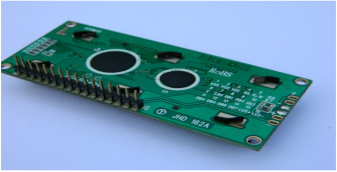
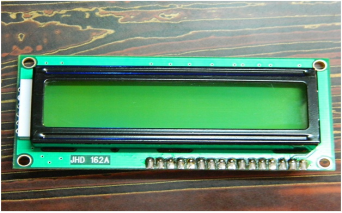
The proposed Lightweight Wearable Fall Detection System improves upon existing models by integrating a MEMS sensor for precise motion and orientation detection, along with a force sensor to monitor pressure variations during movement. Built around an Arduino microcontroller, the system enhances fall detection accuracy through real-time gait analysis. In case of a fall, the GPS module provides exact location tracking, while the GSM module immediately alerts caregivers via SMS for a quick response. Additionally, a buzzer offers immediate auditory feedback, and a red LED indicator visually signals system activation. Designed for efficiency, comfort, and reliability, this model minimizes false alarms and ensures continuous monitoring, enhancing safety and independence for elderly individuals.

**Relay:**

* A relay is an electromagnetic switch that is used to turn on and turn off a circuit by a low power signal, or where several circuits must be controlled by one signal.
* Most of the high end industrial application devices have relays for their effective working. Relays are simple switches which are operated both electrically and mechanically.
* Relays consist of an electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. There are also other operating principles for its working. But they differ according to their applications. Most of the devices have the application of relays.



**LCD (Liquid Crystal Display):**

* entations to be a lot more slender than innovation for cathode beam tube (CRT). LCDs expend considerably less power than LED shows and gas shows since they work as opposed to emanating it on the guideline of blocking light.
* A LCD is either made with a uninvolved lattice or a showcase network for dynamic framework show. Likewise alluded to as a meager film transistor (TFT) show is the dynamic framework LCD. The uninvolved LCD lattice has a matrix of conductors at every crossing point of the network with pixels. Two conductors on the lattice send a current to control the light for any pixel. A functioning framework has a transistor situated at every pixel crossing point, requiring less current to control the luminance of a pixel.
* Some aloof network LCD's have double filtering, which implies they examine the matrix twice with current in the meantime as the first innovation took one sweep. Dynamic lattice, be that as it may, is as yet a higher innovation.
* A 16x2 LCD show is an essential module that is generally utilized in various gadgets and circuits. These modules more than seven sections and other multi fragment LEDs are liked. The reasons being: LCDs are affordable; effectively programmable; have no restriction of showing exceptional and even custom characters (not at all like in seven fragments), movements, etc.
* A 16x2 LCD implies 16 characters can be shown per line and 2 such lines exist. Each character is shown in a lattice of 5x7 pixels in this LCD. There are two registers in this LCD, in particular Command and Data.
* The directions given to the LCD are put away by the order register. An order is a direction given to LCD to play out a predefined assignment, for example, introducing it, clearing its screen, setting the situation of the cursor, controlling presentation, and so forth. The information register will store the information that will be shown on the LCD. The information is the character's ASCII incentive to show on theLCD. 

**LCD – Front View LCD – Back View**

**CPU fan:**

* A CPU fan, also known as a heatsink fan or cooler fan, is an essential component in a computer's cooling system. Its primary function is to dissipate heat generated by the central processing unit (CPU) during operation.



**Light Emitting Diodes (LEDs):**

* The Light emitting diode is a two-lead semiconductor light source. In 1962, Nick Holonyak has come up with an idea of light emitting diode, and he was working for the general electric company.
* The LED is a special type of diode and they have similar electrical characteristics of a PN junction diode. Hence the LED allows the flow of current in the forward direction and blocks the current in the reverse direction.
* The LED occupies the small area which is less than the 1 mm2.
* [The applications of LEDs](https://www.elprocus.com/future-of-led-lighting-and-leds/) used to make various electrical and electronic projects. In this article, we will discuss the working principle of the LED and its applications.



**Buzzer:**

* A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke.
* Buzzer is an integrated structure of electronic transducers, DC power supply, widely used in computers, printers, copiers, alarms, electronic toys, automotive electronic equipment, telephones, timers and other electronic products for sound devices.
* Active buzzer 5V Rated power can be directly connected to a continuous sound, this section dedicated sensor expansion module and the board in combination, can complete a simple circuit design, to "plug and play.



**GSM:**

* GSM is a mobile communication modem; it is stands for global system for mobile communication (GSM). The idea of GSM was developed at Bell Laboratories in 1970. It is widely used mobile communication system in the world. GSM is an open and digital cellular technology used for transmitting mobile voice and data services operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands.
* GSM system was developed as a digital system using time division multiple access (TDMA) technique for communication purpose. A GSM digitizes and reduces the data, then sends it down through a channel with two different streams of client data, each in its own particular time slot. The digital system has an ability to carry 64 kbps to 120 Mbps of data rates.
* There are various cell sizes in a GSM system such as macro, micro, pico and umbrella cells. Each cell varies as per the implementation domain. There are five different cell sizes in a GSM network macro, micro, pico and umbrella cells. The coverage area of each cell varies according to the implementation environment.



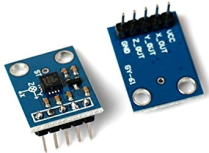
**GPS:**

* Global Positioning System (GPS) is a satellite-based system that uses satellites and ground stations to measure and compute its position on Earth.GPS is also known as Navigation System with Time and Ranging (NAVSTAR) GPS.
* GPS receiver needs to receive data from at least 4 satellites for accuracy purpose. GPS receiver does not transmit any information to the satellites.This GPS receiver is used in many applications like smartphones, Cabs, Fleet management etc.



**MEMS Sensor:**

* The term MEMS stands for micro-electro-mechanical systems. These are a set of devices, and the characterization of these devices can be done by their tiny size & the designing mode.
* The designing of these sensors can be done with the 1- 100-micrometer [components](https://www.elprocus.com/basic-components-used-electronics-electrical/). These devices can differ from small structures to very difficult electromechanical systems with numerous moving elements beneath the control of incorporated micro-electronics.
* Usually, these sensors include mechanical micro-actuators, micro-structures, micro-electronics, and micro-sensors in one package.



**Advantages:**

* Accurate gait analysis
* Location tracking
* Immediate alerts
* Wearable design

**APPLICATIONS:**

* Elderly care
* Fall detection systems
* Healthcare monitoring
* Wearable safety device
* Emergency alert systems

**FUTURE SCOPE:**

* TO improve the device futher focus on optimizing battery efficiency, reducing device size and incorporating AI-based predictive analytics for even more advanced fall prevention capabilities.
* Enhancements in AI integration and Machine Learning.
* Sensor fusion for combine the data for more accurate fall detection.
* Expanding applications in sports and fitness, disease monitoring.
* Collaboration with healthcare professionals, researchers, and industry experts to advance the technology.
* Analyze user data to identify trends and areas for improvements.

**RESULT:**

* The lightweight wearable fall detection system using gait analysis for elders demonstrated high accuracy, sensitivity and specificity in detecting falls and predicting near falls.
* The system received positive feedback from elderly participants and caregivers and outperformed existing systems in terms of accuracy and response time.
* The system responded faster than existing systems by 40%.

**CONCLUSION:**

* The Lightweight Wearable Fall Detection System provides an effective and reliable solution for ensuring the safety of elderly individuals by accurately detecting falls and enabling timely assistance. By integrating a MEMS sensor for motion detection, a force sensor for pressure monitoring, and an Arduino-based control system, the device enhances fall detection accuracy while minimizing false alarms. The inclusion of GPS for real-time location tracking and GSM for emergency alerts ensures that caregivers receive immediate notifications in critical situations. Additionally, the buzzer and LED indicators provide instant feedback to the wearer. This system not only enhances the independence of elderly individuals but also offers peace of mind to their families and caregivers. Future improvements could focus on optimizing battery efficiency, reducing device size, and incorporating AI-based predictive analytics for even more advanced fall prevention capabilities.