ISSN: 2584-0495 Vol. 3, Issue 11, pp. 1790-1794

International Journal of Microsystems and IoT

ISSN: (Online) Journal homepage: https://www.ijmit.org

AI-Powered Fall Detection Systems: A Solution for Elderly Safety and Well-Being

Prachi Burde, Suhani Bobade, Pranav Brahmankar, Suvarna Duttargi, Divya Sharma

Cite as: Burde, P., Bobade, S., Brahmankar, P., Duttargi, S., & Sharma, D. (2025). AI-Powered Fall Detection Systems: A Solution for Elderly Safety and Well-Being. International Journal of Microsystems and IoT, 3(11), 1790–1794. https://doi.org/10.5281/zenodo.18254847

Published online: 20 November 2025

https://doi.org/10.5281/zenodo.18254847

International Journal of Microsystems and IoT
Vol.3, Issue 11, pp.1790-1794; DOI: https://doi.org/10.5281/zenodo.18254847

AI-Powered Fall Detection Systems: A Solution for Elderly Safety and Well-Being

Prachi Burde, Suhani Bobade, Pranav Brahmankar, Suvarna Duttargi, Divya Sharma
Ajeenkya DY Patil College of Engineering, Pune, Maharashtra, India

ABSTRACT
As the world's population ages, safeguarding the elderly and their health becomes an increasingly important issue. Falls are the most common source of injury for the elderly, and early detection is key to minimizing health hazards and enhancing performance. This work introduces a Fall Detection System integrating motion sensing and location tracking technology to improve geriatric care. With an ESP32 microcontroller, an MPU6050 sensor for motion, and a GPS module, the system tracks movement and detects falls based on analysis of information from the accelerometer and gyroscope of the MPU6050. Upon detection of a fall, the system sends real-time motion immediately to a Blynk app, which alerts caregivers or family members, allowing for an immediate response. Apart from fall detection, the system also records the location of the person using the GPS module, offering real-time latitude and longitude information. This aspect ensures that in the event of a fall, the location of the elderly individual is available, facilitating emergency responders or caregivers to locate them quickly. The Blynk application is a basic and user-friendly system for caregivers to monitor both motion and location data on a smartphone or another device. This dual-purpose system provides a more advanced solution for elderly care, blending fall detection and location tracking to increase safety and peace of mind. The article addresses the design, deployment, and evaluation of the system, and shows how the system can enhance elderly care through prompt fall alert and real-time location data. This technology can serve as an important tool for enabling independence and safety for older adults while providing useful assistance for caregivers and family members.

KEYWORDS
Artificial Intelligence, real-time monitoring, fall detection

I. INTRODUCTION

Falling is a major health hazard for the elderly, typically leading to severe injuries such as fractures, head trauma, or disability in the long term. As age advances, the chances of falling are great due to physical frailty, and it is a life-threatening situation if medical attention is delayed after a fall. Studies show that nearly 30% of people over 65 years and 50% of people over 81 years fall every year, and many are hospitalized [1]. Fear of falling can lead to immobility, isolation, and even depression [5]. Traditional fall detection methods, such as fixed sensors or cameras, are either expensive, obtrusive, or inapplicable in real-world scenarios. Sensor-based wearable systems offer a viable alternative, being portable, inexpensive, and more effective in detecting falls both indoors and outdoors [7]. These devices record motion-related data—such as acceleration, rotation, and direction of movement—to differentiate between normal activities and actual falls [8]. However, improving accuracy with less computational load on wearable sensors remains challenging.

With the integration of Artificial Intelligence (AI) in wearable sensor technology, fall detection systems can become more efficient and responsive. AI algorithms can learn movement patterns, detect falls in real time, and alert caregivers or medical professionals immediately, reducing the risks of delayed response. As a result, AI-enabled wearable fall detection systems can improve elderly care, safety, and reduce healthcare costs.

II. LITERATURE REVIEW

Vasoye (2023) [1] identifies the need for the creation of affordable, wearable, and efficient AI-based fall detection systems. Such technologies present a viable way of improving older people's care through enhanced real-time monitoring capacity. Ramachandran et al. (2020) [2] emphasize that the growing elderly population has increased the demand for nursing care, making fall detection systems (FDS) more relevant. Their study identifies machine learning (ML) as a significant tool in improving FDS for elderly healthcare.

Ren et al. (2019) [3] discuss fall risks in older persons, comparing different technological developments in preventing falls. Their study classifies fall detection studies into four categories and discusses current challenges in the area. Vasoye (2023) [1] identifies the need for the creation of affordable, wearable, and efficient AI-based fall detection systems. Such technologies present a viable way of improving older people's care through enhanced real-time monitoring capacity. Ramachandran et al. (2020) [2] emphasize that the growing elderly population has increased the demand for nursing care, making fall detection systems (FDS) more relevant. Their study identifies machine learning (ML) as a significant tool in improving FDS for elderly healthcare. Ren et al. (2019) [3] discuss fall risks in older persons, comparing different technological developments in preventing falls. Their study classifies fall detection studies into four categories and discusses current challenges in the area. Yu et al. (2022) [4] introduce a hierarchical CNN model for the detection of falls using sensor information. Their paper provides suggestions for universal model design principles and demonstrates experiment validation on two datasets.

Kamble et al. (2022) [5] propose an IoT-based smart fall detection system with the use of sensors for measuring speed, posture, and stability. Their system is meant to reduce additional health hazards by effectively detecting falls. Chen et al. (2005) [6] outline a project that is designed to allow elderly people to live independently. Their method uses small particles of sensors that are Wi-Fi connected, which sense falls and determine the location of the person using a MEMS accelerometer and RF signal strength. Birku (2021) [7] describes current fall detection technologies like webcams and smartwatch emergency beacons. The research presents limitations, among which is the limitation of these technologies to indoor settings and vulnerability to false alarms. Saleh et al. (2021) [8] emphasize that numerous fall detection gadgets are based on machine learning algorithms. Nevertheless, they note that the quality of training data in most cases fails to accurately replicate real-world patterns of activity and affect the efficacy of the system. Chaudhari et al. (2021) [9] emphasize fall detection as a preventive strategy, providing an in-depth review of the topic. Their research covers different approaches and technologies employed to prevent falls among the elderly

III. METHODOLOGY

The system starts with initializing the MPU6050 sensor that contains an accelerometer and a gyroscope to measure motion and changes in orientation. At the same time, the ESP32 microcontroller makes the connection to WiFi and communicates with the Blynk IoT platform for transmitting real-time data. After initialization, the system goes into the state of continuous monitoring in which the MPU6050 gathers gyroscope and acceleration data in real time, monitoring motion parameters like AccelX, AccelY, AccelZ, GyroX, GyroY, and GyroZ. These readings are processed to look out for any abnormal or abrupt movement.

The essence of the functionality of the system is its mechanism for detecting a fall. A fall is detected when there's a sudden and high change in acceleration

followed by a long-lasting low acceleration status, which can signal an impact and stillness. If both are present, the system establishes a fall incident and goes on to create an alert. After detection, the ESP32 forwards the captured sensor data to the Blynk IoT platform using WiFi, hence facilitating real-time communication.

For notification of caregivers or users, the system sends an emergency alert via the Blynk app for instant intervention. The system regularly updates the motion status on an LCD display or mobile dashboard to ensure openness and prompt response.

Start

↓

Initialize MPU6050 & Wi-Fi

↓

Read Accelerometer & Gyroscope Data

↓

Calculate Acceleration & Angular Velocity

↓

Check Fall Condition (Acceleration > 2.5g & Gyro > 200°/s)

├── Yes → Wait & Check Immobility

├── No → Continue Monitoring

├── Yes → Send Alert (Buzzer, IoT Notification)

↓

Repeat Monitoring

IV. RESULT AND ANALYSIS

The *ESP32* is a Wi-Fi and Bluetooth-enabled powerful microcontroller used to develop an *AI-powered fall detection system* for aged care. In your setup, it communicates with the *MPU6050* sensor (gyroscope and accelerometer) to read movement in real time. The ESP32 interprets this data and forwards it to the *Blynk* platform so that caregivers can see the status of the elderly remotely. With motion detection thresholds, the system notifies in the event of a fall. The ESP32 provides a secure, cloud-connected solution that enhances elderly safety through real-time monitoring and simple alerts. ESP32 board is shown in Fig3. MPU6050 is shown in Fig.4. Overview of Fall Detection System is shown in Fig.1.

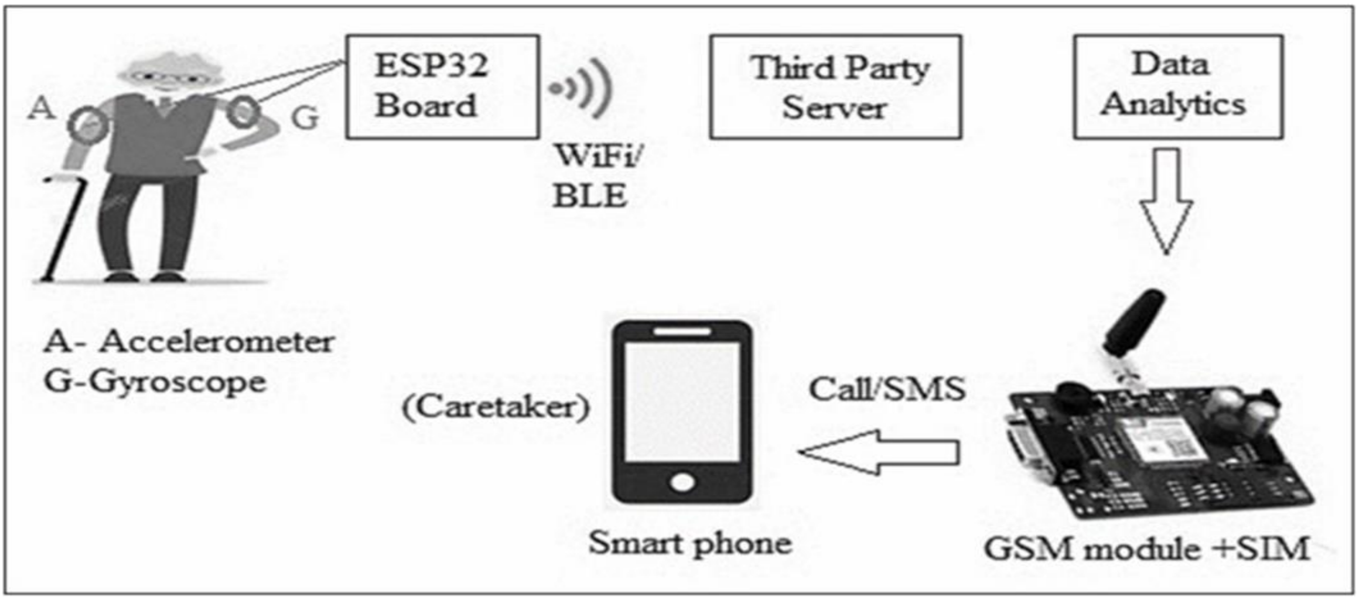

Fig.1 Overview of the FD-architecture

Fig.2. ESP32 Board

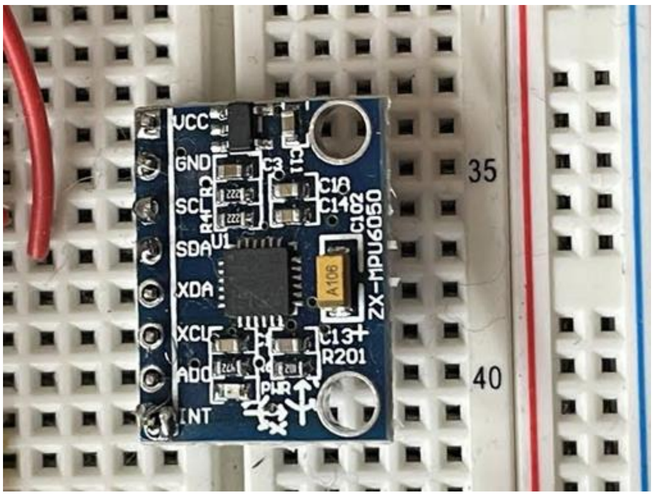

Fig.3. MPU6050

The *MPU6050* sensor module consists of a *3-axis accelerometer* and *3-axis gyroscope* that are perfectly suited for **AI-based fall detection systems. It monitors movement and identifies irregular motion patterns, including falls, by monitoring acceleration and rotation. When combined with a microcontroller such as the **ESP32**, it provides real-time fall detection and notifications, which improve elderly safety and welfare through rapid response to emergencies.

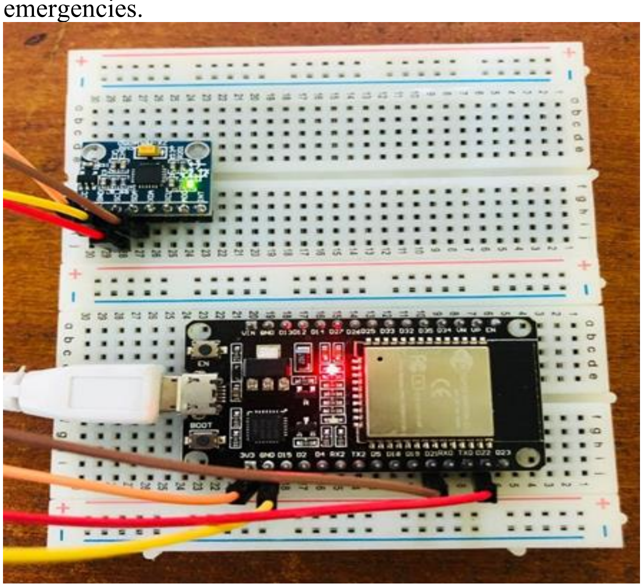

Fig. 4 Experimental Setup

The fall detection system using AI uses *Blynk, ESP32, and an MPU6050 sensor* to monitor elderly people in real-time. The *MPU6050 accelerometer and gyroscope* sense sudden movement changes, which could be a fall. The ESP32 interprets this data and sends acceleration and gyroscope values to *Blynk's virtual pins (V0-V5)*, where they are made available on the Blynk app or web dashboard.

With the *Blynk IoT platform, caregivers can **remotely see live sensor data, including acceleration on the X, Y, and Z axes, and gyroscope readings. The dashboard offers a simple visualization of movement patterns, allowing for rapid review of possible falls. If an abnormal movement occurs, **Blynk can send instant alerts*, including push notifications, emails, or SMS, to enable timely intervention. ESP32 experimental setup is shown in Fig.4.

The system operates continuously, updating sensor values every *100 milliseconds, which allows for real-time monitoring and accurate readings. By using predefined acceleration levels, the system is able to **discriminate between routine activity and an actual fall*, minimizing false alarms.

This *smart fall detection system increases safety for the elderly* through offering *constant monitoring, instant alerts, and remote access*. Caregivers can react in time to emergencies, enhancing general well-being and minimizing hazards for the elderly who live alone. Additional future developments may involve **machine learning-based algorithms** for enhanced fall detection accuracy. Through incorporating *Blynk with IoT and AI, this system provides a **low-cost, scalable, and life-saving solution** for elderly care*. Which is shown in Fig.5.

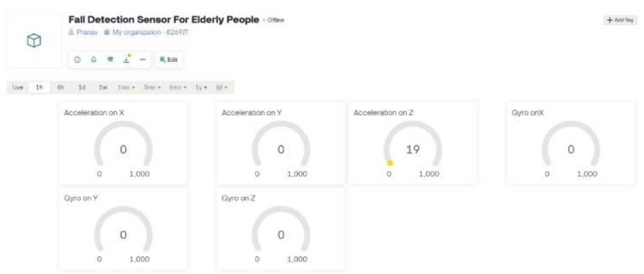

Fig.5 Blynk

This project utilizes AI-based fall detection with an ESP32, MPU6050 sensor, and Blynk IoT platform to track the movement of older adults and identify falls in real-time. The MPU6050 sensor records acceleration (X, Y, Z) and gyroscope (X, Y, Z) data to determine unusual movements, which are relayed to Blynk where they are plotted in a mobile application. When a fall is sensed, the system instantaneously sends out an alert, as indicated in the second image, and a notification on the mobile app, accompanied by a push notification (third image) to caregivers. The ESP32 microcontroller is WiFi-enabled and sends sensor reading to Blynk for continuous monitoring. A threshold for motion detection is set in the MPU6050 sensor for detecting sudden falls. When a person falls, the system will automatically send an alert, which will provide timely help and improve the safety and well-being of older adults. Fall occurrence is shown in Fig.6.

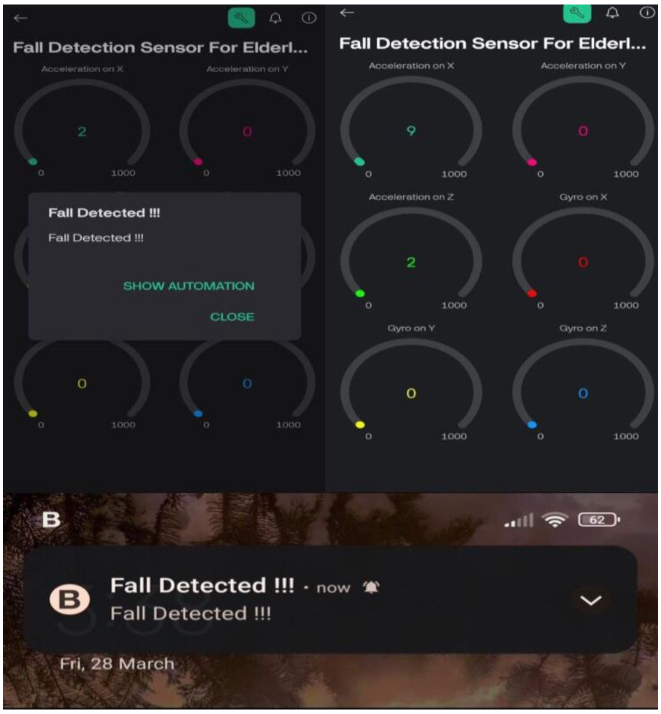

Fig. 6. Fall Detection occurrence

V. ROLES OF AI AND IOT IN HEALTHCARE

The integration of Artificial Intelligence (AI) and the Internet of Things (IoT) is revolutionizing healthcare with enhanced patient monitoring, diagnosis, treatment, and general healthcare provision. In the area of elderly fall prevention, these technologies are instrumental to mitigating risks and upgrading the quality of life in the elderly.

Role of AI and IoT in Fall Prevention for the Elderly:

Wearable Devices: IoT-enabled wearable devices, such as smartwatches and fitness bands, monitor vital signs like heart rate, blood pressure, and oxygen saturation in real time. AI algorithms analyze the data to detect anomalies that can indicate an increased risk of falling.

Ambient Sensors: Sensors installed in living spaces track patterns of movement, picking up on deviations that can signal a fall.

Real-Time Detection: AI examines accelerometer and gyroscope data from wearables to identify sudden movement patterns characteristic of falls, providing real-time alerts to caregivers or emergency services.

Risk Modeling: AI algorithms assess certain risk factors in an individual—such as gait instability or muscle weakness—predicting the risk of falls and enabling preventive interventions.

Data Sharing: IoT devices transmit health information to electronic health records (EHRs) so that healthcare professionals can monitor patients remotely and adjust care plans as needed.

Personalized Interventions: AI analyzes collective data to provide personalized exercise routines or environmental modifications to reduce fall risk.
Enhanced Emergency Response:

Location Tracking: GPS-enabled IoT devices provide the exact location of an individual during falling, facilitating fast emergency response.

Challenges and Considerations:
Data Privacy and Security: The extensive data gathering that is intrinsic to AI and IoT utilization necessitates strict cybersecurity practices to protect sensitive health information.
User Acceptance: It is important to make sure that older persons are willing and comfortable using these technologies for them to be effective. Technical Reliability:
Accuracy and reliability of AI algorithms and IoT devices are important to prevent false alarms or undetected events.

VI. CONCLUSION

The integration of Artificial Intelligence (AI) and the Internet of Things (IoT) in fall prevention in the elderly has seen significant advancement, particularly with wearable sensor-based systems. The first article introduces AI-based fall detection and prevention systems, with machine learning and real-time monitoring enhancing the care of the elderly. It highlights the role of IoT in creating smart environments that actively minimize fall risks. Wearable sensor-based systems for the evaluation of fall risk, focusing specifically on their accuracy, reliability, and potential for early intervention. It highlights the performance of motion sensors, accelerometers, and gyroscopes in detecting gait abnormalities and fall prediction.
AI and IoT improve fall detection and prevention through real-time analytics and predictive modeling. Despite this, there remain challenges to be tackled such as sensor accuracy, user compliance, and data privacy concerns. Future research needs to focus on creating more sophisticated AI algorithms, integrating multimodal sensing, and addressing ethical concerns to allow these technologies to be more efficient and pervasive.

REFERENCES

[1] Harsh Vasoye and hetvi bhattasana, A review of Elderly Fall Detection Systems Using Artificial Inteelligence, may 2023
[2] Anita Ramachandran and Anupama Karuppiah, A Survey on Recent Advances in Wearable Fall Detection Systems,13 Jan 202

[3] Lingmei Ren, Yanjun Peng, Research of Fall Detection and Fall Prevention Technologies: A SystematicReview,2019.
[4] Shou Yu, Yidong Chai, Hsinchun Chen, Randall Brown, Scott Sherman, Jay F. Nunamaker, "Fall Detection with Wearable Sensors: A Hierarchical Attention-based Convolutional Neural Network Approach,
[5] Sayali M. Kamble , Pratiksha R. Kawle, Suwarna S. Mohile, Megha R. Meshram, Prof. Gayatri Padole Mam, Neetu Gyanchandani Mam IOT Based Person/Wheelchair Fall Detection ystem, 5th Feb 2022.
[6] Jay Chen, Karric Kwong, Dennis Chang, Jerry Luk, Ruzena Bajcsy. Wearable Sensors for Reliable Fall DetectionSeptember 1-4, 2005
[7] Yonas Birku, Survey on fall detection systems, 2018
[8] Majd Saleh, Manuel Abbas, Joaquim Prud'Homm, Dominique Somme, Regine Le Bouquin Jeannes , A Reliable Fall Detection System Based on Analyzing the Physical Activities of Older Adults Living in Long-Term Care Facilities, 2021
[9] Mansi Chaudhari, Shreya Pawar, Vaishnavi Kalal, Bharti Sahu, Fall Detection and Alarm System For Elderly,12th Dec 2021