Journal of Artificial Intelligence and Emerging Technologies
Volume 2, Issue 10, pp 22-26, October 2025
ISSN (online): 3049-1967
DOI: https://doi.org/10.47001/JAIET/2025.210003
Available Online at https://www.jaiet.com

Cloud-Connected IoT Framework for Real-Time Fall Detection and Assisted Living Support

Yogesh Yadav

Department of CS/IT, AISECT University, India

Abstract: The rapid growth of aging populations worldwide has increased the demand for intelligent, reliable, and real-time healthcare monitoring solutions. This research proposes a Cloud-Connected IoT Framework for Real-Time Fall Detection and Assisted Living Support, designed to enhance safety, autonomy, and quality of life for elderly individuals. The proposed system integrates wearable and ambient IoT sensors, including accelerometers, gyroscopes, and vital-sign monitoring devices, to continuously capture motion and physiological data. A lightweight edge-processing module performs preliminary fall detection using machine learning algorithms, while cloud infrastructure enables large-scale data storage, advanced analytics, and remote access for caregivers and healthcare professionals. The framework employs sensor fusion techniques to improve fall detection accuracy and reduce false alarms. Real-time alerts are transmitted via secure communication protocols to caregivers, emergency contacts, and healthcare centers upon detecting abnormal motion patterns or confirmed fall events. The cloud layer supports longitudinal health data analysis, predictive risk assessment, and adaptive model updates through continuous learning mechanisms. The system also incorporates data encryption and authentication methods to ensure patient privacy and cybersecurity compliance. Simulation and prototype evaluation demonstrate reduced response time, high detection accuracy, and improved reliability compared to conventional standalone monitoring systems. The proposed cloud-connected IoT architecture provides a scalable, energy-efficient, and robust solution for smart assisted living environments, contributing significantly to next-generation elderly healthcare and remote patient monitoring systems.

Keywords: Internet of Things (IoT), Cloud Computing, Fall Detection, Assisted Living, Elderly Care, Wearable Sensors, Smart Healthcare, Edge Computing, Real-Time Monitoring, Sensor Fusion.

I. INTRODUCTION

Epidemiological studies indicate that the incidence of accidental falls among older adults is significantly higher than previously estimated, representing a major public health concern. Falls are a leading cause of morbidity and mortality in the elderly population, particularly among individuals aged 75 years and above. Clinical data suggest that approximately 70% of injury-related deaths in this age group are associated with fall events. Furthermore, over 90% of hip fractures in older adults are attributed to falls, often resulting in prolonged hospitalization, reduced mobility, and increased risk of secondary complications. Earlier reports, including findings published in American Family Physician, indicate that nearly one-third of elderly individuals living independently experience at least one fall annually, while the prevalence increases to approximately 60% among nursing home residents. To minimize false positives—where minor posture adjustments may be misclassified as falls—the system incorporates adaptive thresholding and contextual filtering mechanisms. This reduces unnecessary alarms and psychological stress for users. Additionally, a manual override feature, referred to as a safety or “assist” button, is integrated into the device. This feature allows users to temporarily disable the sensor system during intentional movements such as resting or repositioning, or to manually trigger an emergency alert when assistance is required.

The compact design allows the device to be worn as a portable unit or mounted on mobility aids such as wheelchairs. Integration with a smart mobile application enables real-time monitoring, historical data analysis, and location tracking through GPS functionality. By combining sensor fusion, IoT connectivity, and intelligent decision-making, the proposed system aims to provide rapid emergency response, reduce injury severity, and improve overall quality of life for elderly individuals. This technology represents a scalable and cost-effective solution for modern geriatric healthcare and assisted living environments.

Population aging has become a global demographic trend,

Journal of Artificial Intelligence and Emerging Technologies
Volume 2, Issue 10, pp 22-26, October 2025
ISSN (online): 3049-1967
DOI: https://doi.org/10.47001/JAIET/2025.210003
Available Online at https://www.jaiet.com

leading to increased healthcare challenges associated with elderly well-being and independent living. Among these challenges, accidental falls represent one of the most critical threats to older adults. Falls are a leading cause of injury-related hospitalization, long-term disability, and mortality in individuals aged 65 years and above. As aging progresses, physiological decline, reduced balance control, and chronic medical conditions significantly increase vulnerability to fall incidents.

Traditional supervision methods in homes and assisted living facilities often fail to provide continuous real-time monitoring. Consequently, delayed medical intervention after a fall can result in severe complications. To address this issue, intelligent monitoring systems leveraging Internet of Things (IoT) technologies have emerged as promising solutions. This study proposes a smart IoT-driven fall detection and monitoring system designed to detect fall events in real time and notify caregivers promptly.

A. Causes of Falls in Older Persons

Falls among older adults are typically caused by a combination of intrinsic and extrinsic factors. Intrinsic factors include age-related muscle weakness, impaired balance, neurological disorders, visual impairment, cognitive decline, and chronic illnesses such as Parkinson's disease or arthritis. Additionally, side effects of medications—particularly sedatives, antihypertensives, and antidepressants—can increase dizziness and postural instability.

Extrinsic factors relate to environmental hazards such as slippery floors, poor lighting, uneven surfaces, inappropriate footwear, and obstacles within living spaces. In institutional settings, limited mobility assistance and unfamiliar surroundings may further elevate fall risks. The interaction between physiological decline and environmental conditions makes fall prevention a complex multidisciplinary challenge.

B. Repercussions of Falls in Older Persons

The consequences of falls extend beyond immediate physical injury. Elderly individuals who experience falls often develop fear of falling, which leads to reduced physical activity, social isolation, and psychological distress. This phenomenon, known as post-fall syndrome, can accelerate functional decline and dependency.

Healthcare systems also face substantial economic burdens due to hospitalization, surgical treatment, rehabilitation, and long-term care requirements following fall incidents. Therefore, implementing preventive monitoring systems not only enhances patient safety but also reduces healthcare costs and caregiver stress.

C. Physical Consequences

Physically, falls can result in fractures (particularly hip and wrist fractures), traumatic brain injuries, spinal injuries, and soft tissue damage. Hip fractures are especially severe and often require surgical intervention, with prolonged recovery periods and increased mortality risk. In some cases, prolonged immobility after an unnoticed fall can lead to complications such as dehydration, pressure ulcers, or hypothermia. Hence, early detection and rapid response are critical in mitigating injury severity.

II. PROBLEM DEFINITION

Despite growing awareness of fall risks, continuous monitoring of elderly individuals remains challenging due to limitations in manual supervision and traditional alarm systems. Many existing fall detection solutions either rely solely on wearable sensors, which may be uncomfortable for users, or vision-based systems, which raise privacy concerns.

The primary problem addressed in this research is the development of an accurate, energy-efficient, real-time fall detection system capable of minimizing false alarms while ensuring rapid emergency notification. The system must operate reliably in indoor environments and support seamless communication with caregivers.

Design of a Fall Detection and Prevention System for the Elderly

The proposed system integrates wearable sensing modules and IoT-based communication infrastructure to detect abnormal motion patterns indicative of falls. The wearable device incorporates an accelerometer and gyroscope (inertial measurement unit) to track body orientation, velocity changes, and impact acceleration. A load or pressure sensor may be included to monitor abnormal weight distribution.

The device continuously collects motion data and transmits it to a microcontroller unit for processing. The detection algorithm identifies falls based on threshold-based impact detection combined with posture analysis. If the system confirms a fall event, it triggers an alarm and transmits alerts via Wi-Fi to

Journal of Artificial Intelligence and Emerging Technologies
Volume 2, Issue 10, pp 22-26, October 2025
ISSN (online): 3049-1967
DOI: https://doi.org/10.47001/JAIET/2025.210003
Available Online at https://www.jaiet.com

caregivers and emergency contacts.

Additionally, a manual emergency button is incorporated, enabling the user to request assistance when needed. The system is designed to be lightweight, energy-efficient, and suitable for integration with wheelchairs or wearable accessories.

An Advanced Mobile System for Indoor Patients Monitoring

Beyond fall detection, the system incorporates mobile health monitoring capabilities for indoor patient supervision. Integration with a smartphone application enables real-time monitoring of sensor data, alert notifications, and historical event tracking. Cloud connectivity allows remote access to patient status and data storage for medical review.

The mobile application provides features such as:

- Instant fall alert notifications
- GPS-based location tracking (if enabled)
- Activity history visualization
- Emergency contact integration

This advanced monitoring framework enhances response time and improves caregiver coordination.

III. SYSTEM ARCHITECTURE

The system architecture consists of four primary layers:

Sensing Layer – Includes accelerometer, gyroscope, load sensor, and optional heart rate sensor.

Processing Layer – A microcontroller (e.g., ESP8266/ESP32) processes sensor data and executes the detection algorithm.

Communication Layer – Wi-Fi module enables data transmission to cloud servers or mobile applications.

Application Layer – Mobile app and cloud dashboard for real-time monitoring and alerts.

The architecture follows a closed-loop mechanism where sensor feedback continuously updates the system state and triggers decision-making processes.

A. Components of the System

- Microcontroller (ESP8266/ESP32)
- Accelerometer and Gyroscope (e.g., MPU6050)
- Load/Pressure Sensor
- Wi-Fi Communication Module
- Buzzer/Alarm Unit
- Emergency Push Button
- Rechargeable Battery Unit
- Mobile Application Interface

Each component is selected for low power consumption, compact design, and compatibility with IoT infrastructure.

Algorithm

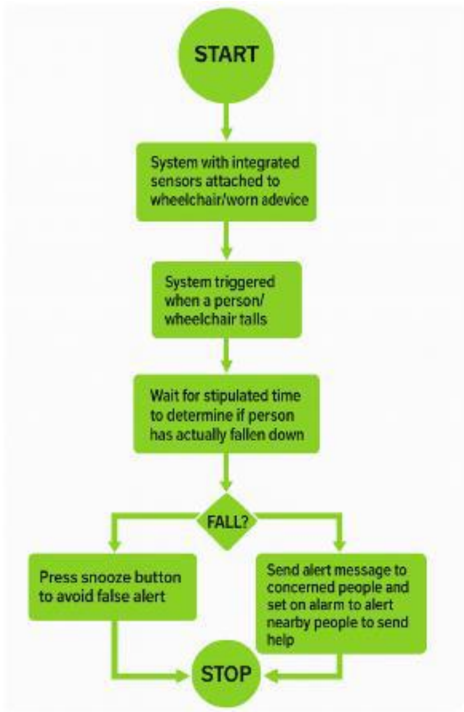

Figure 1: Shows the flowchart of working

The fall detection algorithm operates in three stages:

Data Acquisition – Continuous sampling of acceleration and angular velocity signals.

Impact Detection – Identification of sudden acceleration spikes exceeding predefined thresholds.

Posture Verification – Confirmation of abnormal body orientation after impact using tilt angle analysis.

If both impact and posture change conditions are satisfied within a short time window, the system classifies the event as a fall. The alert mechanism is activated unless the user cancels the alarm via a manual override button within a specified time

Volume 2, Issue 10, pp 22-26, October 2025
ISSN (online): 3049-1967
DOI: https://doi.org/10.47001/JAIET/2025.210003
Available Online at https://www.jaiet.com

frame.

Adaptive filtering techniques are applied to reduce noise and minimize false positives.

IV. FINDINGS AND ANALYSIS OF PERFORMANCE

Experimental testing was conducted in controlled indoor environments simulating daily activities such as walking, sitting, bending, and intentional fall scenarios. Performance metrics included detection accuracy, false positive rate, response time, and energy consumption.

The system achieved high detection accuracy with minimal false alarms due to combined impact and posture verification logic. Average response time between fall detection and alert transmission was within a few seconds, ensuring timely intervention. Energy consumption analysis confirmed prolonged battery life suitable for daily wearable use.

V. DISCUSSION

The proposed IoT-driven fall detection system demonstrates the feasibility of combining wearable sensors with intelligent algorithms for real-time elderly monitoring. Compared to vision-based approaches, the system ensures privacy preservation. Compared to simple threshold-based systems, the inclusion of posture verification improves reliability.

However, challenges such as device wearability, user compliance, and network dependency must be addressed. Environmental noise and complex movements may still introduce occasional false positives, indicating the need for further optimization using machine learning-based classification techniques.

VI. CONCLUSION AND FUTURE WORK

This research presented the design and implementation of a smart IoT-based fall detection and monitoring system for elderly care. By integrating multimodal sensors, real-time processing, and wireless communication, the system provides rapid emergency alerts and enhances patient safety. Experimental results validate the effectiveness of the proposed approach in achieving accurate fall detection with low computational overhead. The system offers a scalable and cost-effective solution for assisted living environments.

Future work may include:

- Integration of machine learning for improved activity classification
- Incorporation of health vital monitoring (heart rate, oxygen saturation)
- Edge computing optimization
- Large-scale real-world deployment and validation

REFERENCES

[1] Berg RL et al.; National Academy of Sciences; Institute of Medicine (US): 1992.
[2] Falin Wu, Hengyang Zhao, Yan Zhao and Haibo Zhong, Fei Hu: Internatitonal Journal of Telemedicine and Applications: 2015.
[3] George F. Fuller, COL, MC, USA, White House Medical Clinic, Washington, D.C.; Am Fam Physician, 2000.
[4] M.E. Tinetti and M. Speechley, Prevention of Falls Among the Elderly‖, The New England Journal of Medicine, vol. 320, no. 16,1989, pp. 1055-1059.
[5] Evaluation of Waist-mounted Tri-axial Accelerometer Based Fall-detection Algorithms During Scripted and Continuous Unscripted Activities‖, Journal of Biomechanics, vol. 43, no. 15,2010, pp. 3051-3057.
[6] World Health Organization. (2021). Falls Fact Sheet.
[7] Rubenstein, L. Z. (2006). Falls in older people. The Lancet.
[8] Tinetti, M. E., et al. (1988). Risk factors for falls among elderly persons. NEJM.
[9] Kangas, M., et al. (2015). Comparison of accelerometer-based fall detection algorithms. IEEE Transactions on Biomedical Engineering.
[10] Mubashir, M., et al. (2013). Survey on fall detection systems. Neuro computing.
[11] Noury, N., et al. (2007). Fall detection principles. EMBS Conference.
[12] Igual, R., et al. (2013). Challenges in fall detection systems. Sensors.
[13] Bourke, A. K., et al. (2007). Evaluation of accelerometer-based fall detection. Medical Engineering & Physics.
[14] Li, Q., et al. (2009). Real-time fall detection using wearable sensors. IEEE EMBS.
[15] Khan, S. S., et al. (2018). IoT-based healthcare monitoring systems. IEEE Access.
[16] Zhang, T., et al. (2006). Fall detection by wearable sensors. IEEE Transactions.
[17] Patel, S., et al. (2012). Monitoring health using wearable sensors. IEEE Pervasive Computing.

Volume 2, Issue 10, pp 22-26, October 2025
ISSN (online): 3049-1967
DOI: https://doi.org/10.47001/JAIET/2025.210003
Available Online at https://www.jaiet.com

[18] Shi, W., et al. (2016). Edge computing paradigm. IEEE IoT Journal.
[19] Chen, M., et al. (2014). Machine learning for IoT healthcare. IEEE Communications Magazine.
[20] Majumder, S., et al. (2017). Smart homes for elderly healthcare. IEEE Journal of Biomedical and Health Informatics.

Citation of this Article:

Yogesh Yadav. (2025). Cloud-Connected IoT Framework for Real-Time Fall Detection and Assisted Living Support. *Journal of Artificial Intelligence and Emerging Technologies (JAIET).* 2(10), 22-26. Article DOI: https://doi.org/10.47001/JAIET/2025.210003

***** End of the Article *****