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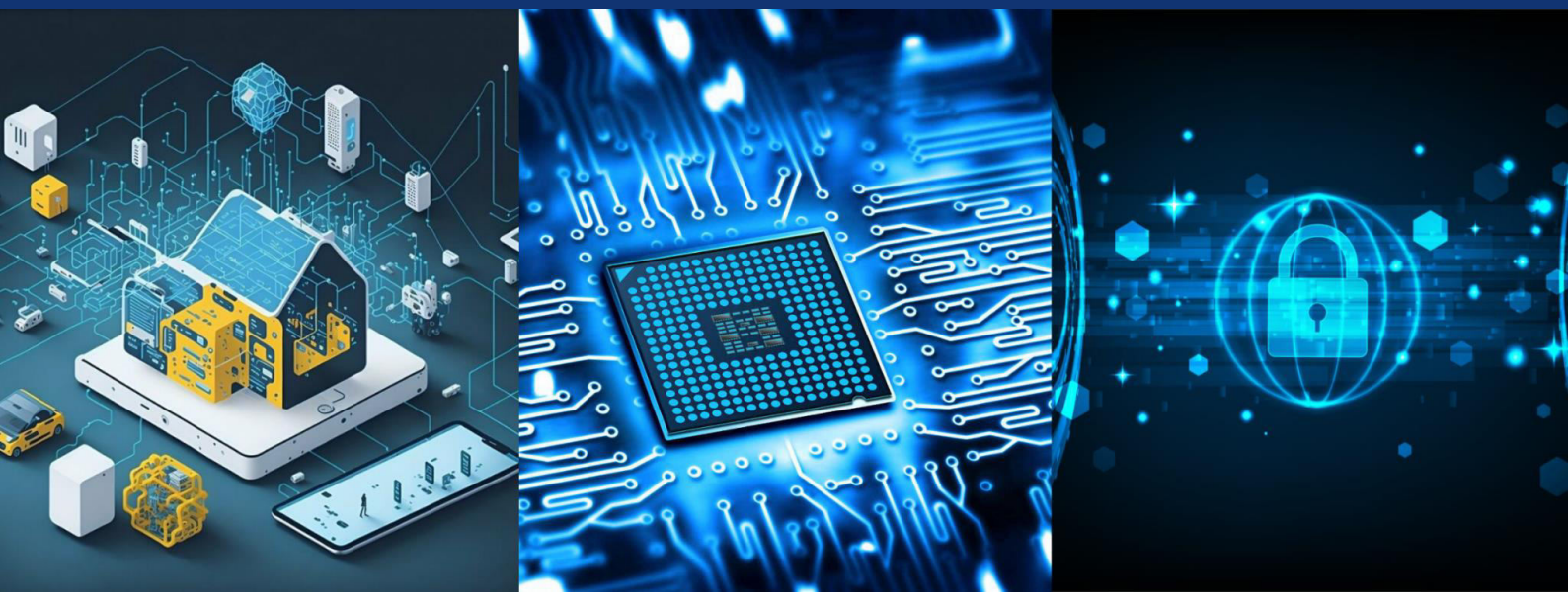

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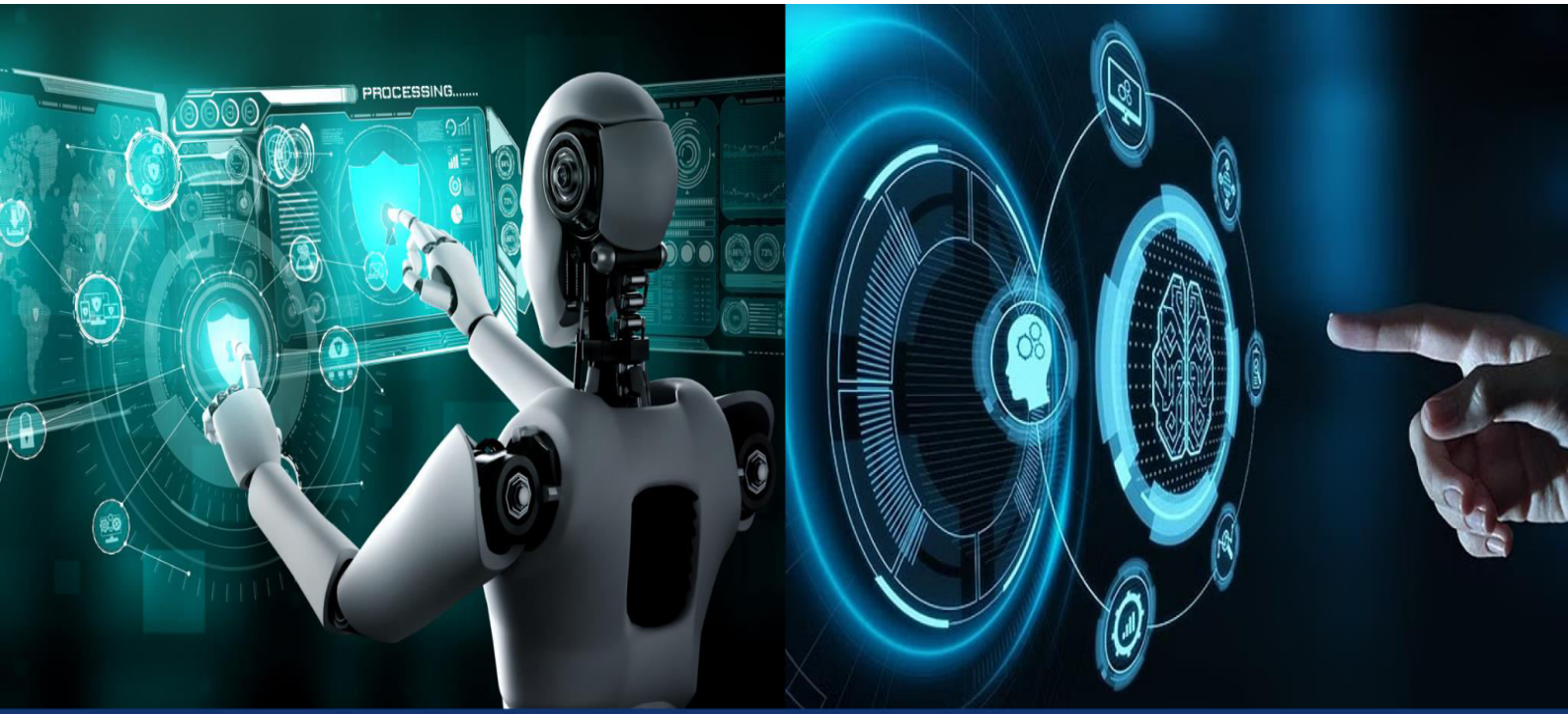

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Human Fall Detection and Prevention System

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ABSTRACT: Falls among elderly individuals are a major cause of injuries and serious health complications. To address this issue, the proposed human fall detection and prevention system integrates real-time monitoring, intelligent processing, an alert mechanism, and a mechanical stabilization feature.

The system utilizes an MPU6050 sensor, which combines an accelerometer and a gyroscope, to continuously monitor human body motion. The initial stage involves analysing the pre-fall condition, followed by confirmation of a fall event. Once a pre-fall condition is detected and verified, a four-arm-based mechanical structure is automatically deployed to prevent the fall. At the same time, an SMS alert is sent to predefined emergency contacts through an Android application.

By integrating detection, prevention, and communication into a single system, the proposed solution enhances safety and reduces emergency response time. The system is efficient, portable, and well-suited for real-time healthcare monitoring applications.

KEYWORDS: Fall Prevention, ESP32 Microcontroller, MPU6050 Sensor, Android Alert System, IoT Healthcare, and Human Fall Detection.

I. INTRODUCTION

The rapid growth of the global aging population has increased the need for advanced healthcare technologies, making elderly safety a major concern. Falls among elderly individuals often lead to serious injuries and increased mortality rates, creating a strong demand for reliable fall detection and prevention systems in healthcare applications.

Recent developments in wearable devices, smart monitoring systems, and assistive technologies have enabled continuous monitoring of human activities. These systems mainly rely on sensor-based approaches to detect abnormal body movements and provide timely assistance.

The proposed system introduces a human fall detection and prevention solution that integrates sensing, processing, mechanical support, and communication. The MPU6050 sensor, which combines an accelerometer and gyroscope, is used to monitor body motion and detect pre-fall conditions. The ESP32 microcontroller processes this data in real time and identifies abnormal patterns. Once a pre-fall condition is detected, servo motors and DC gear motors activate a mechanical support structure to stabilize the user and reduce the risk of injury. At the same time, an SMS alert is sent to predefined emergency contacts through an Android application.

By combining sensor technology, embedded processing, mechanical intervention, and communication systems, the proposed solution provides an efficient and real-time approach for improving user safety and reducing emergency response time.

II. RELEVANT LITERATURE

Several research studies have been reviewed to understand advancements in fall detection systems and elderly care technologies. Noury et al. [1] explained the fundamental principles and methodologies of fall detection, focusing on sensor-based healthcare monitoring systems. Bourke and Lyons [2] proposed a threshold-based algorithm using gyroscope data, where angular velocity is analysed to accurately identify fall events. Dai et al. [3] developed a mobile phone-based fall detection system utilizing built-in sensors such as accelerometers, providing a cost-effective solution for real-time monitoring. In addition, recent developments between 2020 and 2024 highlight the increasing use of

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wearable devices, smart monitoring systems, and assistive technologies to improve the safety and independence of elderly individuals [4].

Modern fall detection systems utilize sensors such as accelerometers and gyroscopes to monitor body movement and detect abnormal conditions like sudden impacts or changes in orientation [5], [13]. These technologies have significantly improved detection accuracy and system reliability.

Existing commercial devices provide fall detection and alert features; however, many of these systems depend on external services or manual activation, which may reduce their effectiveness during emergency situations [5]–[8].

Research in this area focuses on developing algorithms to distinguish falls from normal activities. The combination of multiple sensors improves accuracy and minimizes false detections [9], [13]. Additionally, modern systems use efficient microcontrollers and processing architectures to enable real-time monitoring and faster response [11], [12].

Recent approaches also explore mechanical intervention mechanisms to prevent falls, shifting from detection-only systems to proactive safety solutions [14], [15].

III. METHODOLOGY

The proposed system is designed to accurately detect human fall events, activate a safety mechanism to prevent falls, and provide immediate emergency assistance through an SMS alert system. The system continuously observes the user's physical movements using sensors such as an accelerometer and a gyroscope. These sensors collect real-time information related to body motion, orientation, and sudden positional variations. The accelerometer measures linear acceleration along different axes, while the gyroscope measures angular velocity, helping the system analyze posture and movement patterns.

The collected sensor data is sent to a processing unit, such as an ESP32 microcontroller or a mobile application. This unit processes the incoming data to identify unusual patterns that may indicate a fall. A threshold-based detection approach is used, where a sudden increase in acceleration along with a rapid change in body orientation is treated as a possible fall condition. These values are continuously compared with predefined limits to distinguish between normal daily activities such as walking, sitting, or running and actual fall events.

To enhance system reliability, an additional validation step is performed after detecting a possible fall. This step reduces false alarms by verifying whether the user remains inactive or in an abnormal position for a certain duration. The fall event is confirmed only when all predefined conditions are satisfied, ensuring that unnecessary alerts are avoided during normal activities.

Once a fall is confirmed, the system immediately triggers the alert mechanism. An SMS notification is automatically sent to predefined emergency contacts such as family members or caregivers. This is implemented using Android-based SMS services like SmsManager or through a GSM communication module such as SIM800L. The alert message may include important details such as the user's condition and location, enabling quick response and timely assistance.

Additionally, the system can provide immediate feedback to the user through buzzer alerts, vibration, or on-screen notifications. This informs the user that a fall has been detected and an alert has been generated. The combination of sensor-based monitoring and SMS communication ensures that the system remains operational even without internet connectivity, making it reliable for real-world applications.

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3.1. Block Diagram

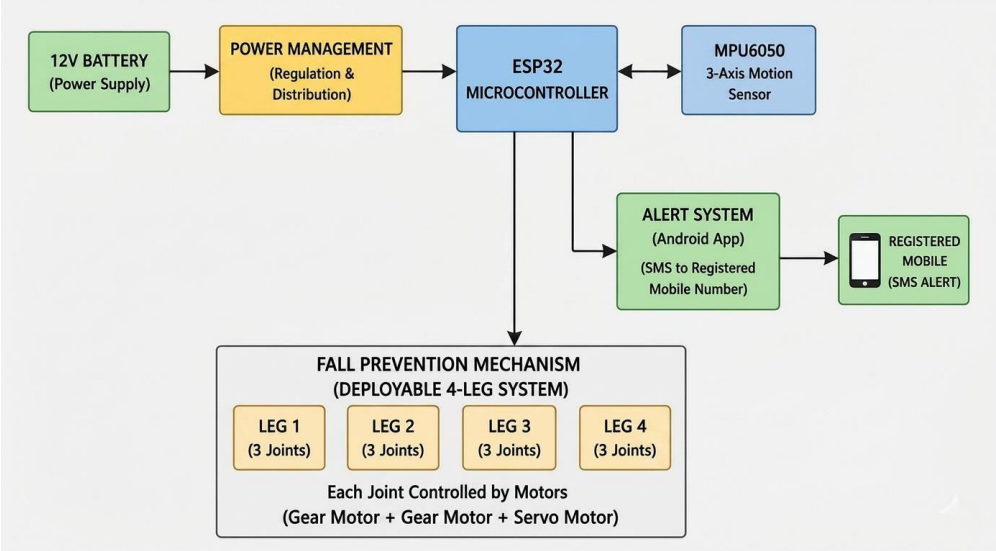


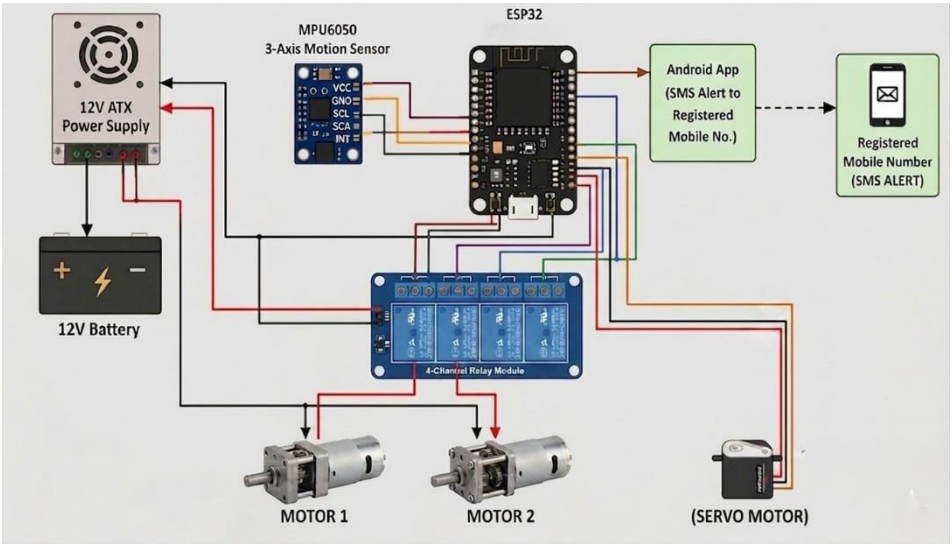
Fig. 3.1: Block Diagram of Proposed Human Fall Detection and Prevention

3.1.1 PROPOSED SYSTEM

The proposed Human Fall Detection and Prevention System is designed to detect falls, generate alerts, and provide immediate assistance. The system operates using a 12V battery as the primary power source to supply energy to all system components. The ESP32 microcontroller functions as the main processing unit, where all sensor data is received and analyzed.

To capture real-time body motion, the MPU6050 sensor is used in the system. It is a 3-axis accelerometer and gyroscope sensor that detects movement and changes in body orientation. When a fall is detected, the system automatically sends an SMS alert to the registered mobile number through an Android application.

In addition to detection and alerting, the system includes a movable four-legged mechanical structure for fall prevention. Each leg consists of joints controlled by servo motors and gear motors, enabling automatic deployment. This mechanism provides physical support and stability to the user during a fall event.



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3.2. Flow Chart

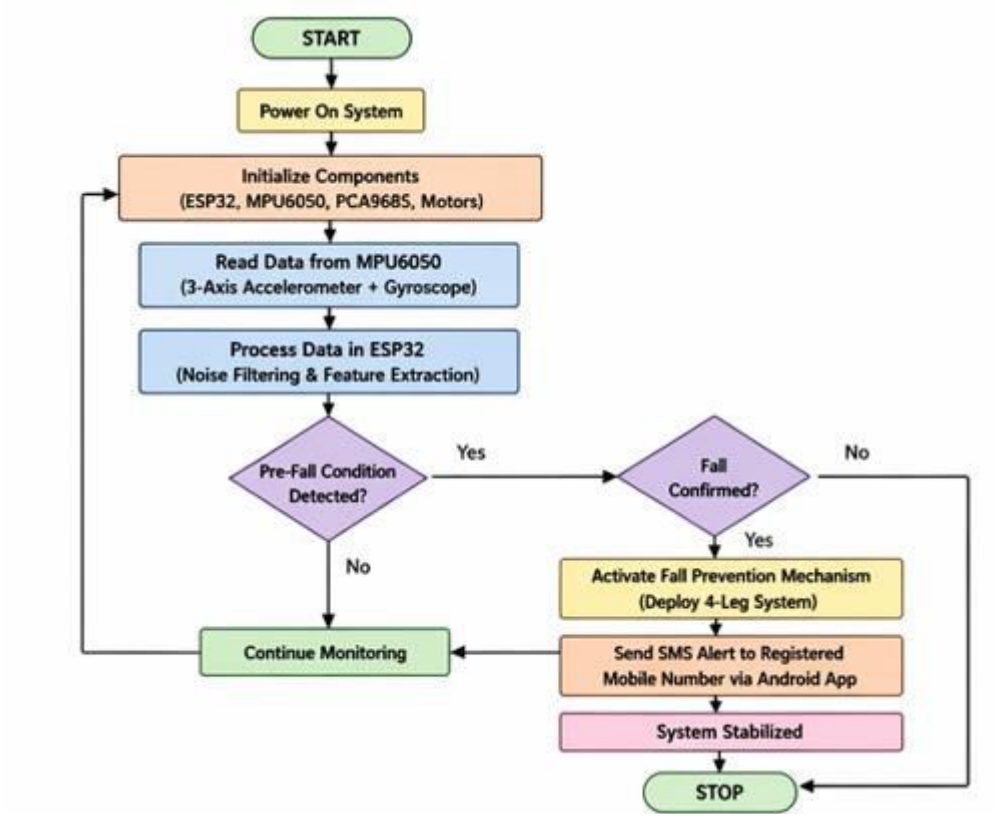

Fig. 3.2: Flow chart of Proposed Human Fall Detection and Prevention System

For proper operation of the proposed Human Fall Detection and Prevention System, all components—including the ESP32 microcontroller, MPU6050 motion sensor, PCA9685 motor driver, and motors—are initially powered on. Once initialized, the MPU6050 sensor, which consists of a 3-axis accelerometer and gyroscope, continuously captures real-time data related to body acceleration and orientation. This data is transmitted to the ESP32 microcontroller, where it is processed by filtering noise and extracting relevant motion parameters.

The processed data is then analysed to identify pre-fall conditions such as sudden loss of balance, directional changes, or abnormal acceleration patterns. If no pre-fall condition is detected, the system continues monitoring the user's movements. However, if a pre-fall condition is identified, further analysis is performed to confirm whether an actual fall is occurring. If the fall is not confirmed, the system resumes normal monitoring.

If a fall event is confirmed, the ESP32 initiates the fall prevention mechanism, where the four supporting legs are activated to stabilize the user. At the same time, an SMS alert is sent to predefined emergency contacts, and an alarm notification is generated through the Android application to inform caregivers or family members.

After executing the prevention and alert processes, the system returns to its normal stable state and continues monitoring. The system either resumes its operation cycle or remains in a stable condition based on the user's status.

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IV. RESULTS

Fig. 4.1: System After Fall Detection

The figure illustrates the real-time operation of the proposed fall detection and alert system. It shows how sensor data is processed to monitor user activity and detect abnormal conditions. When a fall is identified, the system generates an SMS alert and sends it to predefined contacts, ensuring immediate response and assistance.

The developed system effectively assists elderly and vulnerable individuals by reducing the risk of falls. It continuously monitors body movements, detects sudden changes in posture, and provides timely alerts to caregivers in case of a fall event. The system demonstrated good accuracy in identifying fall conditions using sensor data.

The integration of the MPU6050 sensor with the SMS alert mechanism has improved the overall efficiency and performance of the system. It maintains stable operation under different conditions, showing good adaptability and reliability. The results indicate that the proposed system is practical and effective for enhancing user safety and minimizing fall-related risks.

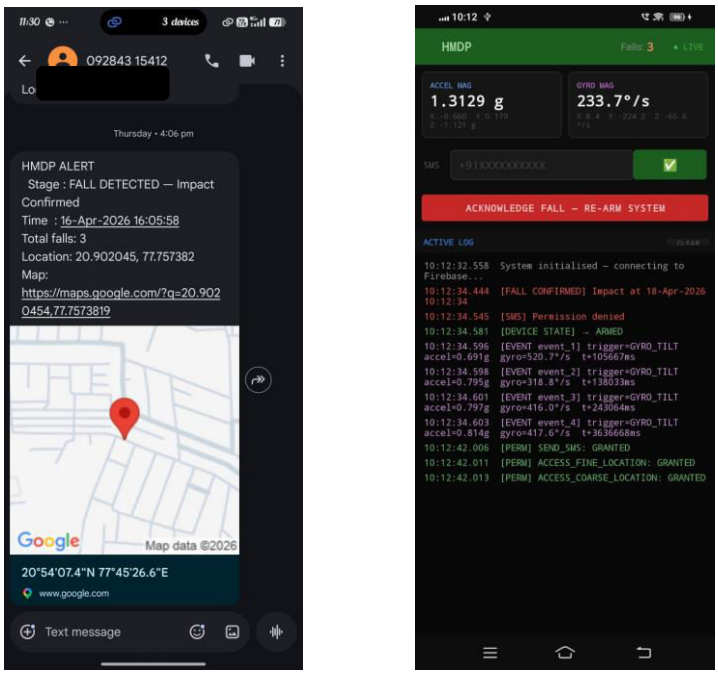

Fig. 4.2: Integrated Fall Detection and Alert System with Real-Time Mobile Monitoring and SMS-Based Location Notification

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The system performs real-time monitoring and SMS alert functionality. It detects fall events using sensor data and sends an alert message along with location details to predefined contacts through a mobile application. This ensures immediate response and improves user safety.

V. CONCLUSION

The proposed Human Fall Detection and Prevention System aims to reduce the risk of injuries caused by accidental falls among elderly individuals and people with mobility issues. The system uses the MPU6050 sensor to continuously monitor body movement, while the ESP32 microcontroller processes the sensor data to detect sudden changes and identify fall conditions.

Once a fall is detected, the microcontroller activates servo motors that deploy a four-arm mechanical support structure attached to the belt. These arms open instantly to provide stability and reduce the impact of the fall, thereby helping to prevent serious injuries.

The proposed system presents a cost-effective and innovative solution by combining embedded systems, sensor technology, and mechanical design. It demonstrates how wearable technology can be utilized to enhance personal safety and support vulnerable individuals. With further improvements and real-world testing, the system has strong potential to be developed into a practical and reliable solution for healthcare applications.

REFERENCES

[1] M. Noury, A. Fleury, P. Rumeau, A. K. Bourke, G. Ó. Laighin, V. Rialle, and J. E. Lundy, “Fall detection – Principles and Methods,” Proc. IEEE Engineering in Medicine and Biology Society, pp. 1663–1666, 2007.
[2] A. K. Bourke and G. M. Lyons, “A threshold-based fall-detection algorithm using a bi-axial gyroscope sensor,” Medical Engineering & Physics, vol. 30, no. 1, pp. 84–90, 2008.
[3] J. Dai, X. Bai, Z. Yang, Z. Shen, and D. Xuan, “Mobile phone-based pervasive fall detection,” Personal and Ubiquitous Computing, vol. 14, no. 7, pp. 633–643, 2010.
[4] https://www.safehome.org/medical-alert-systems/best/long-range/
[5] https://myseniorcarehub.com/blog/top-smartwatches-for-seniors-with-fall-detection-in-2026/
[6] https://www.ageinplacetech.com/archive/202603
[7] https://www.mcknightshomecare.com/assistive-aging-technology-trends-to-watch-in-2026/
[8] https://leadingage.org/3-trends-in-senior-care-technology/
[9] https://newsroom.arm.com/blog/arm-2026-tech-predictions
[10] https://seniorhousingnews.com/2026/01/16/hdg-execs-these-6-trends-could-reshape-senior-living-in-2026/
[11] https://newsroom.arm.com/blog/what-arm-based-innovations-happened-in-february-2026
[12] https://newsroom.arm.com/blog/arm-innovations-from-dec-2025-jan-2026
[13] https://www.frontiersin.org/journals/neurorobotics/articles/10.3389/fnbot.2026.1766109/full
[14] https://www.archivemarketresearch.com/reports/smart-fall-detection-system-773829
[15] https://www.coherentmarketinsights.com/market-insight/fall-detection-systems-market-3213

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