

Smart Assistive System for Alzheimer's Patients using IOT and Machine learning

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Abstract

Alzheimer's disease creates significant safety risks for patients and heavy emotional burdens for caregivers due to memory loss, wandering, and the risk of sudden falls. This study proposes an innovative assistive system that combines a smart wearable armband with AI-driven facial recognition to enhance patient autonomy and security. The armband uses integrated sensors to monitor vital signs like heart rate and body temperature, while GPS and motion tracking provide real-time location data and automatic fall detection. Simultaneously, the facial recognition system uses advanced machine learning to help patients identify familiar faces, reducing confusion and promoting social confidence. By streaming this data to a cloud-based dashboard, the system allows caregivers to intervene immediately during emergencies, offering a scalable and cost-effective solution that bridges the gap between traditional caregiving and modern intelligent healthcare.

Keyword: Alzheimer, armband, accelerometer, physiological sensors.

1. Introduction

Alzheimer's disease is a progressive neurodegenerative disorder that primarily affects memory, cognition, and behaviour. Patients with Alzheimer's often experience disorientation, wandering, and difficulty recognizing familiar faces, leading to significant safety concerns. As the disease advances, individuals lose their ability to perform daily activities, increasing their dependence on caregivers. The burden on caregivers and family members is immense, requiring constant monitoring of the patient's health and location. Existing solutions lack a comprehensive system that integrates real time health monitoring, fall detection, location tracking, and facial recognition. This project aims to bridge this gap by developing an integrated assistive system to enhance patient safety, independence, and caregiver support. The Smart Assistive System for Alzheimer's Patients is designed to provide real-time health monitoring, fall detection, GPS tracking, and facial recognition to assist both patients and caregivers. The Smart Assistive System for Alzheimer's Patients integrates IoT, AI, and wearable technology to provide real-time health monitoring,

facial recognition, and emergency alert notifications. The system includes a smart wearable armband equipped with various sensors to track heart rate, ECG, temperature, fall detection, and GPS location. Additionally, a facial recognition system helps patients identify known individuals, with audio and visual assistance for improved interaction. Data collected from sensors is processed in real-time using ESP8266, and stored in Google Firebase or AWS IoT Cloud. Caregivers can monitor patient health status via a web dashboard or mobile app, receiving alerts for critical conditions like falls, abnormal vitals, or wandering behaviour. This innovative system enhances patient safety, provides caregivers with remote monitoring capabilities, and improves the quality of life for Alzheimer's patients.

2. Related Work

The field of smart assistive systems for Alzheimer's patients has witnessed significant progress over the past decade, especially between

2020 and 2025. Innovations in Internet of Things (IoT) devices and machine learning have enabled real-time monitoring, personalized care, and intelligent support for individuals living with Alzheimer's disease. These technologies facilitate critical functions such as patient tracking, medication reminders, behavior monitoring, and emergency assistance, all with the goal of enhancing patient independence and alleviating the burden on caregivers. In this section, recent research advances are reviewed, providing crucial context and technical foundation for the design and motivation of the present project on Smart Assistive Systems for Alzheimer's Patients using IoT and Machine Learning P Yashwanth Ram, B.A Sabarish (2022).compared face recognition techniques, analyzing how dimensionality reduction methods like PCA affect machine learning model performance and accuracy. The study highlights that reducing data dimensions optimizes computational efficiency, balancing model complexity for practical, real-world application.[1]

Aseel Thamer Ebrahim, Marwa Mawfaq Mohamed sheet, Entisar Younis Abd Al-Jabbar, Warqaa H. Alkhalel, Zaid Husham Al-Sawaff (2023).This study presents an IoT-based framework, using a NodeMCU-based portable prototype with GPS and Wi-Fi, for real-time monitoring of Alzheimer's and elderly patients to enhance safety and care management. The system enables remote tracking of patient movement and medication, facilitating immediate alerts in critical situations.[2]

K. Jaspin, E. Ajitha, J. Dafni Rose, K. Sherin (2023). Using the Caffe Model for an Intelligent Traffic Light Control System: An Approach Using Deep Learning. This research focuses on using Internet of Things (IoT) technology for monitoring Alzheimer's and elderly patients, aiming to improve their health and safety. The authors present a framework that utilizes IoT devices to gather real-time data and monitor patient conditions. The paper highlights the role of IoT in providing remote care and alerts in critical situations. It emphasizes the benefits of such a system for elderly care management.[3]

S. Swapna Kumar, Vismaya N Sasi, Vaanisha Murali (2024). This research discusses an IoT and machine learning-based support system for Alzheimer's patients, focusing on improving care and management. The system integrates various sensors and ML algorithms to monitor patient behavior, health metrics, and provide alerts in case of emergencies. It aims to assist caregivers by automating patient observation. The paper highlights how technology can aid in the quality of life for patients and their families. [4]

Arunachalam, R., Sunitha, G., Shukla, S. K., Pandey, S. N., Urooj, S., & Rawat, S. (2023). A smart Alzheimer's patient monitoring system with IoT-assisted technology through enhanced deep learning approach. Knowledge and Information Systems,

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Ibrahim Mamun, M., Rahman, A., Mridha, M. F., & Hamid, M. A. (2021). Alzihelp: an alzheimer disease detection and assistive system inside smart home focusing 5g using iot and machine learning approaches. In Recent Trends in Communication and Intelligent Systems: Proceedings of ICRTCIS 2020 (pp. 105-113).Singapore: Springer Singapore .[6]

Salvi et al. (2025) conducted a comprehensive systematic review of IoT solutions tailored for different stages of Alzheimer's disease. Their study emphasizes the use of wearable biosensors and AI-powered cognitive analytics to achieve continuous, non-invasive monitoring of behavioral, physiological, and cognitive changes. The authors highlight how IoT frameworks successfully integrate location tracking and fall detection systems to significantly enhance patient safety and support severe-stage care management.[7]

A recent study on wearable sensor-based monitoring presented an IoT architecture utilizing an ESP32 microcontroller to track real-time health parameters such as heart rate, SpO2, body temperature, and movement patterns for Alzheimer's patients. By transmitting multi-sensor data to a cloud platform, the system allows caregivers to remotely access live updates without constant human intervention. Furthermore, the integration of machine learning enables the system to analyze the data and predict potential health anomalies, promoting proactive healthcare.[8]

Choudhari et al. (2025) developed "FallNex," a real-time fall detection system that synergizes IoT hardware with machine learning. The system employs a Multi-Layer Perceptron (MLP) model to analyze motion data collected from wearable sensors to predict falls. To minimize false alarms, it incorporates an OpenCV-based visual monitoring module to verify significant activity at the moment of a suspected fall. The hardware seamlessly communicates with a mobile application to deliver instant alerts and provide post-fall guidance via an integrated chatbot.[9]

A 2026 study explored an integrated AI and IoT-based framework specifically designed to monitor Alzheimer's patients continuously. The proposed system utilizes a smart armband equipped with GPS, accelerometers, and heart rate sensors for real-time tracking. In parallel, it implements a facial recognition system employing the CAFFE model and Local Binary Patterns Histograms (LBPH) to help patients identify familiar faces in their environment, thereby fostering social engagement and enhancing the patient's sense of security.[10]

Meshram et al. (2026) introduced an affordable, smart assistive system targeting dementia care and caregiver support. Leveraging cross-platform frameworks like Flutter and cloud backend services like Firebase, their architecture provides practical features including memory recall exercises, real-time alerts, and medication reminders. Notably, the system integrates an assistive, context-aware chatbot that demonstrated an 85% success rate in responding to user queries, significantly reducing the daily stress and burden on caregivers.[11]

A comprehensive survey evaluated various smart solutions for detecting and managing dementia in elderly populations. The study emphasized the critical role of combining wearable IoT sensors with machine learning algorithms to continuously monitor the Activities of Daily Living (ADL) of patients. Their findings indicate that continuous, non-intrusive monitoring is essential for tracking cognitive diminution and providing actionable, real-time data to caregivers, thereby lowering the socio-economic burden of the disease.[12]

Research focused specifically on the mobility challenges of Alzheimer's patients highlights the difficulty of accurate fall detection due to disease-induced gait instability. A 2024 study proposed using an unsupervised domain adaptation approach in machine learning to address these domain shifts and minimize false positives. By adapting the models to the specific, erratic movement patterns of AD patients, the system achieved a highly scalable and reliable method to reduce injury risks in practical, real-world environments[13]

Exploring the cognitive assistance aspect, a 2026 study introduced the "Memory Vault," a dual cognitive reinforcement system for dementia care. The architecture successfully integrated an AI-assisted face recognition module to help patients visually identify known persons. By linking the facial recognition engine with a retrospective memory retrieval framework, the system provided critical assistance to patients, directly supporting the feasibility of using local AI processing to trigger memory recall and task management.[14]

Nandini et al. (2024) developed a wearable smart watch embedded with a machine learning-based fall detection system. Their research demonstrated the efficacy of analyzing localized telemetry data to accurately and instantly detect fall events. The system's ability to autonomously trigger alerts to emergency contacts upon recognizing a critical threshold validated the life-saving potential of combining edge-based ML prediction with cloud-based IoT communication protocols.[15]

Further advancing wearable fall detection, an IoT-based study focused on recognizing specific "walk-fall-still" patterns using continuous accelerometry. By analyzing acceleration statistics locally on the wearable device within one-second intervals, the system significantly reduced latency and optimized energy usage. This research reinforces the architectural choice of processing critical motion data directly at the sensor node to eliminate false alarms before transmitting cloud-based emergency signals.[16]

Investigating the user experience of cognitive aids, a 2026 mixed-methods study assessed the deployment of smart visual wearables for older adults with cognitive impairment. The research highlighted that successful assistive technologies must prioritize intuitive, hands-free interactions—such as automated visual cues and simple voice commands. This underscores the necessity of designing assistive systems that reduce the cognitive load on the patient while providing essential memory and social support.[17]

To optimize fall detection on low-power devices, a recent 2026 study introduced the FIBiLS (Fall detecting using IMU sensor data and BiLSTM model) deep learning architecture. By combining a 1-D Convolutional Neural Network (CNN) with a Bidirectional Long Short-Term Memory (BiLSTM) model, the researchers successfully classified complex fall events using wearable inertial measurement unit (IMU) sensors. Implementing this framework on an edge-computing microcontroller demonstrated a highly accurate approach that minimizes cloud-transmission latency for real-time, mobile-compatible fall detection.[18]

Investigating the specific biomechanical challenges of neurodegenerative diseases, a 2026 systematic review analyzed the evolution of wearable sensor technologies used for fall detection. The researchers noted that Alzheimer's patients often exhibit decreased balance and highly specific gait instability, necessitating continuous, unobtrusive monitoring. The study highlights that recent advances in energy-efficient, miniaturized embedded devices with on-device processing can facilitate timely alerts and effectively mitigate adverse physical outcomes like prolonged "long-lies" after a fall.[19]

Addressing cognitive decline, an innovative 2026 framework titled "AI-Driven Memory Implants with IoT Monitoring" presented a non-invasive, wearable cognitive support system. The system employs an IoT-enabled camera and environmental recognition algorithms that automatically activate upon detecting memory retrieval attempts. By continuously monitoring the patient's state and providing

immediate contextual guidance through an audio interface, the system transforms passive monitoring into active, intelligent care during moments of severe confusion.[20]

A 2025 study proposed an intelligent decision-making system (IDMS) utilizing deep learning and IoT-enabled wearable devices for the continuous monitoring and categorization of Alzheimer's disease. The research emphasizes the use of deep learning techniques applied to digital signal processing to analyze high-dimensional composite data from patients. By leveraging advanced neuronal synchrony measurements and wireless sensor networks, the framework achieves precise diagnostics and real-time monitoring, ultimately aiming to halt disease progression and improve the patient's quality of life.[21]

3. Methodology

The methodology of this project centers on the design and implementation of a Smart Assistive System for Alzheimer's Patients using IoT and Machine Learning. The approach is modular, comprising data acquisition through wearable IoT sensors, real-time monitoring and analysis via cloud-based machine learning models, and automated alert generation for caregivers. The system utilizes consumer-grade wearable devices embedded with GPS, accelerometer, and physiological sensors coupled with facial recognition algorithms powered by machine learning. This architecture is designed to be scalable, cost-effective, and efficient, leveraging open-source frameworks and cloud computing to provide timely and accurate support for patient safety, cognitive assistance, and caregiver facilitation in both clinical and home environments based on machine learning

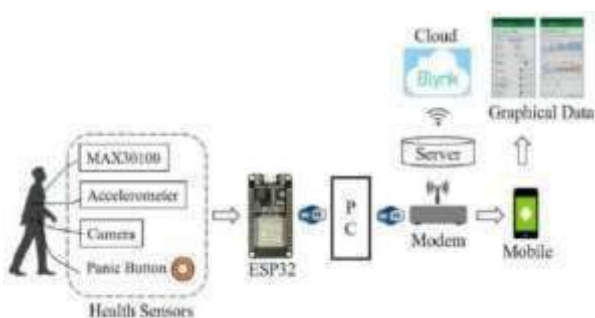


Figure 1: Block diagram of a hardware system

Workflow Steps

Step Sensor Initialization At system startup, wearable IoT sensors—such as GPS, accelerometer, heart rate, and temperature sensors—are activated

and configured to stream continuous data. The

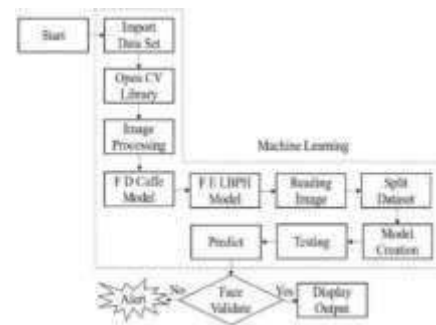


Figure 2: flow chart

devices establish secure connections to the data processing unit or cloud platform.

Step 2: Data Acquisition and Preprocessing

Data from multiple sensors are collected in real time and preprocessed to filter noise, normalize values, and synchronize timestamps. This step ensures quality input for further analysis, removing artifacts or irrelevant fluctuations.

Step 3: Activity and Health Monitoring Machine learning models analyze the preprocessed sensor data to detect and classify patient activities (e.g., walking, sitting, falling). Physiological parameters are monitored for anomalies such as irregular heart rates or signs of distress.

Step 4: Facial Recognition and Context Awareness

Using IoT-connected cameras, the system applies facial recognition algorithms to identify caregivers, family members, or strangers in the vicinity, assisting the patient's social interaction and alerting caregivers if unknown individuals are detected.

Step 5: Event Detection and Alert Generation

When unusual patterns or emergencies (e.g., falls, wandering beyond safe zones, missed medications) are detected, the system automatically triggers alerts. Notifications are sent securely to caregivers' devices with contextual information about the event.

Step 6: Communication and Data Logging All sensor readings, events, and alerts are logged into cloud storage. Communication protocols (e.g., MQTT, HTTP) ensure timely, reliable transmission between the patient's wearable devices, cloud servers, and caregiver applications.

Step 7: User and Caregiver Feedback The user interface—accessible via mobile apps or web dashboards—displays current patient status,

reminders (medication, appointments), and historical data trends. Caregivers receive real-time updates and can respond promptly to alerts, enhancing care quality and decision-making.

This workflow synthesizes the modular processes of the system, illustrating how IoT sensing, machine learning analysis, and communication integrate to provide continuous, intelligent support to Alzheimer's patients and caregivers. These features highlight the system's comprehensive capabilities designed to improve Alzheimer's patient care through IoT and machine learning innovations.

4. Results and Discussion

Hardware Implementation and Prototyping Powered by a dual-cell 18650 battery pack, the wearable prototype utilizes an ESP32 microcontroller to process real-time data from a MAX30100 sensor (heart rate and SpO2), a temperature/humidity sensor, and an onboard accelerometer for automated fall detection. This critical health and environmental data is displayed locally on an integrated OLED screen for immediate viewing, while the ESP32 simultaneously transmits the information to cloud servers for remote caregiver monitoring and emergency alerts.



Figure 3: Hardware Prototype of the Wearable IoT Sensor Module

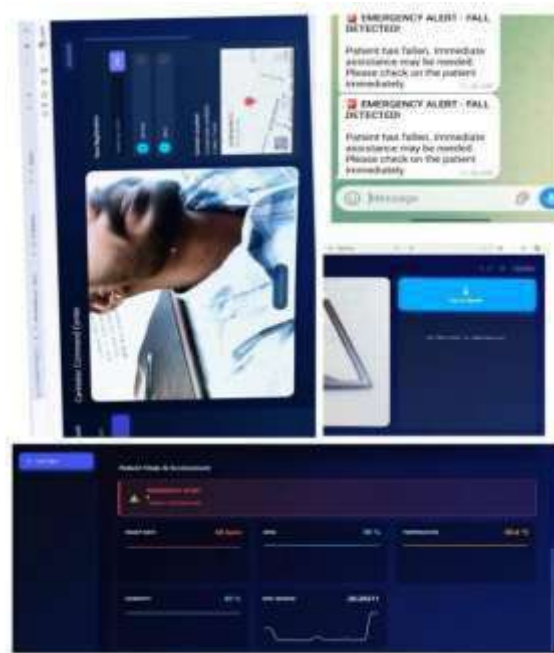


Figure 4 Dashboards

Here is an ultra-concise version that gets straight to the point while maintaining the academic tone successfully enables real-time monitoring and support through dedicated web interfaces:

Patient Interface: Delivers cognitive assistance via live facial recognition of familiar individuals and an interactive voice assistant.

Caregiver Dashboard: Allows remote management of the face database and features live GPS tracking on Google Maps to mitigate wandering.

Health & Fall Monitoring: Continuously logs patient vitals (Heart Rate, SpO2, Temp, Humidity) and analyzes MPU sensor data to instantly detect falls.

Emergency Alerts: Automatically triggers visual dashboard warnings and pushes instant mobile notifications to caregivers via a Telegram bot during critical events.

Applications

The Smart Assistive System is a versatile tool designed to improve life for Alzheimer's patients across various settings, from private homes to clinical research facilities. Its core applications include:

- Real-Time Safety & Health
- Cognitive Aids
- Social & Emotional Support
- Caregiver Efficiency
- Adaptive Accessibility
- Data-Driven Research

5. Conclusion

This project successfully demonstrates the development of an integrated IoT and machine learning framework designed to mitigate the risks associated with Alzheimer's disease. By combining wearable sensors for real-time physiological monitoring with AI-driven facial recognition, the system provides a comprehensive safety net for patients and a reliable tool for caregivers. Key results indicate that the system effectively detects critical events, such as falls and wandering, while the use of affordable, consumer-grade hardware ensures the solution is scalable and accessible for home-based care.

Beyond its technical performance, the system addresses the social and emotional challenges of dementia by fostering familiarity through automated facial identification. This dual approach—focusing on both physical safety and cognitive support—represents a shift toward more human-centered healthcare technology. Ultimately, this research provides a robust foundation for future personalized medicine, proving that intelligent, connected systems can significantly enhance the quality of life, independence, and dignity for elderly patient

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