Smart Assistant For Alzhimer's Patients

Fasna P.U[1], Haneena Siraj[2], Sana Rafeek[3], Fardhin V.M[4], Suvitha P.S[5]

[1,2,3,4]Student, Department of Electronics and Communication Engineering, IES College of Engineering, Thrissur, Kerala

[5]Assistant Professor, Department of Electronics and Communication Engineering, IES College of Engineering, Thrissur, Kerala

Email_id: fasnaullas@gmail.com, haneenasiraj02@gmail.com, sanarafeek9633@gmail.com, fardhinvm9@gmail.com, suvithaps@iesce.info

Abstract

Alzheimer's disease (AD) presents growing challenges in patient care, safety, and daily functioning. This paper introduces a secure, IoT-based wearable assistant system designed to support individuals with mild to moderate AD. The system integrates facial recognition via a Convolutional Neural Network (CNN) to distinguish between family and non-family members, enhancing memory recall and social interaction. It employs steganography to securely embed identity and relational data within images, ensuring privacy. Additional features include GPS-based location tracking with geofence alerts, voice communication through Google Assistant, and psychological status monitoring via conversational analysis. To further enhance patient safety and autonomy, the system incorporates a Panic Assistant that enables immediate alerts in emergency situations, and a Daily Routine Voice Prompter that delivers scheduled voice reminders for essential activities such as medication, meals, hydration, and hygiene. These additions aim to reduce anxiety, improve adherence to routines, and foster independence. The prototype, implemented on a Raspberry Pi 3 platform, demonstrates high accuracy in facial classification, secure data transmission, and responsive voice interaction, offering a comprehensive and compassionate solution for AD patient assistance.

***Keywords*:** Panic Alert, GPS System, Face Recognition, Daily Routine Voice Prompter.

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1. Introduction

Alzheimer's Disease (AD) is a progressive neurodegenerative disorder that impairs memory, cognition, and daily functioning, affecting millions worldwide. As the global population ages, the prevalence of AD continues to rise, posing significant challenges for caregivers and healthcare systems. Traditional support mechanisms often fall short in providing real-time assistance, safety monitoring, and emotional support for individuals with mild to moderate AD. Recent advances in Artificial Intelligence (AI) and Internet of Things (IoT) technologies offer promising avenues for enhancing patient care. In this paper, we present a comprehensive, secure, IoT-based assistant system designed to support. Individuals with AD. The system integrates facial recognition using Convolutional Neural Networks (CNNs) to help patients identify family members and distinguish unfamiliar individuals. It also employs steganography to securely embed identity and relational data within images, preserving privacy. To further enhance safety and autonomy, we introduce two additional modules: a Panic Assistant, which enables immediate alerts during emergencies, and a Daily Routine Voice Prompter, which delivers scheduled voice reminders for essential activities such as medication intake, meals, hydration, and hygiene. These features aim to reduce anxiety, improve routine adherence, and foster independence. The proposed system also includes GPS-based location tracking with geofence alerts, voice interaction via Google Assistant, and psychological status monitoring through conversational analysis. Implemented on a Raspberry Pi 3 platform, our prototype demonstrates high accuracy in facial classification, secure data transmission, and responsive voice interaction, offering a holistic solution for AD patient assistance.

2. Literature review

The integration of AI, IoT, and smart assistance technologies has been widely studied to support Alzheimer's patients. This section reviews nine key studies relevant to face recognition, voice prompting, monitoring, and emergency support.

Thomas & Lin[1] developed a system integrating NLP and vision models to provide reminders and emotional support. The study highlights multimodal input and improved interaction quality, though it requires expensive hardware and high computational resources.

Ullas et al. [2] proposed a solution merging facial recognition, GPS, and voice assistance. It offers personalized support and scalability, but suffers from lag and limited performance in low-light conditions.

Ahmed & Lee [3] explored emotion detection alongside facial recognition to enhance patient interaction. While it improves emotional engagement, emotion recognition accuracy remains inconsistent.

Sharma & Patel [4] combined IoT and AI to automate alerts and recognize emergencies. The multimodal system enables early detection, but implementation complexity and hardware dependency are major drawbacks.

Tanaka et al.[5] integrated sensors and cloud systems for continuous patient monitoring. Real-time data collection supports cognitive health, though privacy concerns and storage costs pose challenges.

Chen & Gupta[6] designed a voice-prompt system for medication and routine reminders. It improves daily management and is easy to use, but personalization is limited and schedules must be set manually.

Raj & Bhat [7] introduced a wearable IoT device for real-time health and activity tracking. It is portable and provides alerts, but battery limitations and connectivity issues reduce reliability.

Joseph et al.[8] applied CNN-based models to detect behavioral changes and assist caregivers. The framework achieves high accuracy and supports personalized care, but requires large datasets and incurs high training costs.

Kumar et al.[10] investigated deep learning for patient identification and caregiver recognition. The system reduces caregiver workload and provides accurate detection, though performance drops in poor lighting and costs remain high.

3. Objectives

The main objective of this research is to design a secure, wearable IoT-based assistant system that improves the safety, independence, and emotional well-being of people with mild to moderate Alzheimer's Disease. The system combines several intelligent features to address memory loss, confusion, and daily routine challenges. It uses facial recognition to help patients identify familiar people and reduce disorientation, while secure image transmission ensures private communication with caregivers. Voice-based interaction through Google Assistant provides natural communication, answers to patient queries, and psychological support. GPS tracking with geofence alerts helps caregivers monitor patient movement and prevent wandering, and a panic assistant allows patients to send emergency alerts during distress. A daily routine voice prompter delivers reminders for medicines, meals, hydration, hygiene, and sleep, encouraging routine adherence. To protect sensitive data, encrypted protocols are employed, while the wearable device itself is designed to be lightweight, comfortable, and easy to use. Edge computing enables real-time processing directly on the device, reducing delays, and the system architecture is built to be scalable and adaptable for future upgrades and integration with additional sensors.

4. Methodology

The methodology adopted for the development of the Smart Assistant for Alzheimer's Patients is structured into several stages, ensuring that both technical feasibility and patient usability are prioritized. The approach integrates hardware, software, and security modules into a unified wearable IoT-based system.

4.1 System Design and Architecture

The system is designed as a collar-based wearable device incorporating multiple modules: facial recognition, voice prompting, GPS tracking, panic assistance, and secure data transmission. Each module is interconnected through a Raspberry Pi 3 platform, enabling real-time processing and communication.

4.2 Facial Recognition Module

A Convolutional Neural Network (CNN) is trained to identify family members and distinguish unfamiliar individuals. This supports memory recall and reduces confusion. Edge computing principles are applied to process recognition locally on the device, minimizing latency.

4.3 Block Diagram

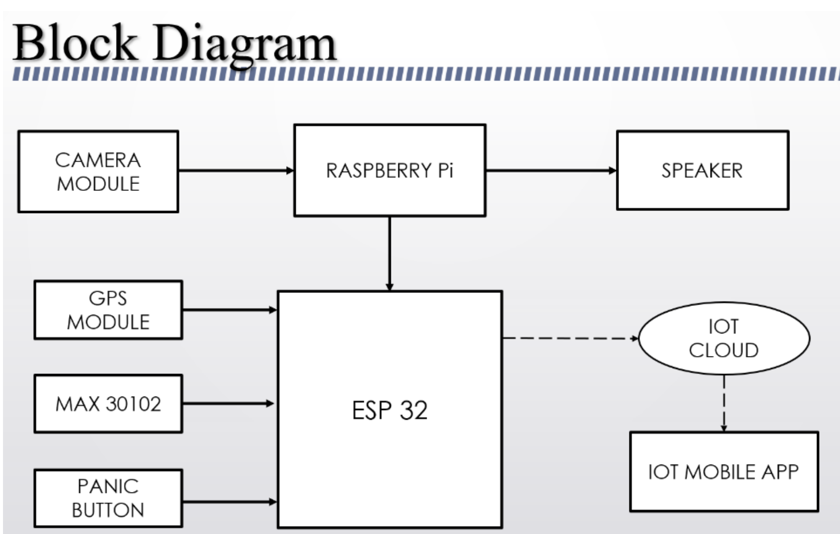

Figure 1: Block diagram: Smart assistant for Alzhimer's patient

4.4 Secure Data Transmission

Steganography techniques are used to embed identity and relational data within images, ensuring privacy. Additionally, Secure/Multipurpose Internet Mail Extensions (S/MIME) and encrypted email protocols are employed to protect sensitive patient information during communication.

4.5 Voice Interaction and Routine Prompter

Google Assistant is integrated to provide natural voice-based communication. A Daily Routine Voice Prompter delivers scheduled reminders for medication, meals, hydration, hygiene, and sleep. Conversational analysis is also used to monitor psychological status and emotional well-being.

4.6 Location Tracking and Geofence Alerts

GPS modules track patient movement in real time. Geofence alerts are triggered when patients move beyond predefined safe zones, ensuring caregiver awareness and timely intervention.

4.7 Panic Assistant

A panic alert system is embedded into the wearable, allowing patients to send immediate emergency notifications to caregivers or medical personnel during distress or disorientation.

4.8 Flow Chart

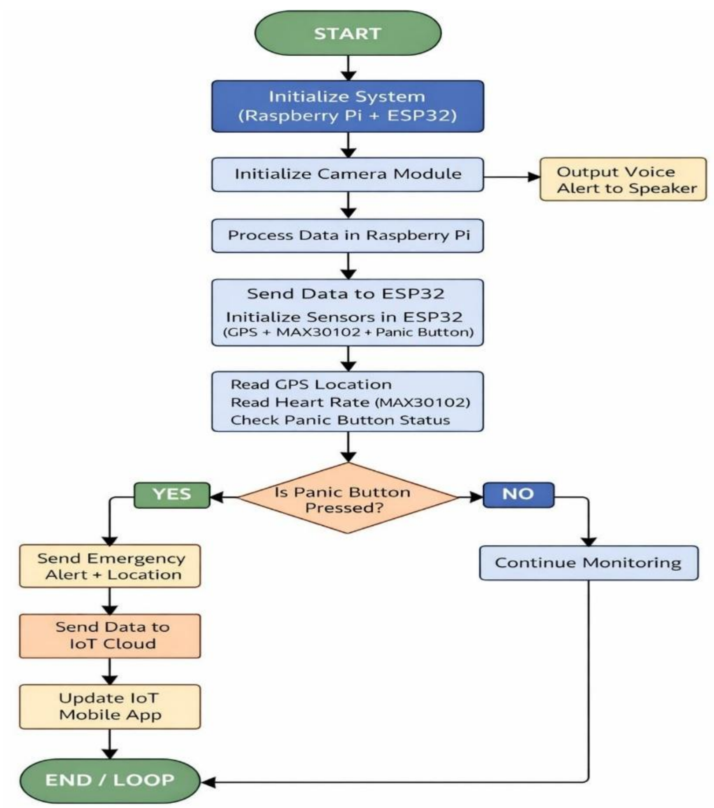

Figure 2: Flow chart of smart assistant

5. System Design

The design of the IoT-Based Alzheimer's Assistant System focuses on integrating multiple assistive technologies into a cohesive, user-friendly platform. The system is engineered to support Alzheimer's patients in their daily routines while ensuring safety, autonomy, and caregiver connectivity. This chapter describes the architectural layout, functional modules, and data flow involved in the system.

5.1 Facial Recognition Module: This module uses a camera and deep learning model to identify familiar individuals. When a known face is detected, the system displays the person's name and relationship to the patient on a screen. This helps reduce confusion and anxiety in social interactions.

5.2 Voice Prompt Module: A speaker and text-to-speech engine deliver scheduled reminders for daily tasks such as taking medication, eating meals, and maintaining hygiene. Prompts are customizable and can be updated remotely by caregivers.

5.3 Panic Assistance Module: A physical panic button allows patients to request immediate help. When pressed, the system sends an alert to registered caregivers via SMS or app notification, including the patient's current location.

5.4 GPS Tracking Module: This module continuously monitors the patient's location. If the patient wanders outside a predefined safe zone, the system automatically sends an alert to caregivers with real-time GPS coordinates.

5.5 Secure Data Transmission Module: All collected data—including facial recognition logs, voice prompt history, and location updates—is encrypted and transmitted to a secure cloud backend. This ensures data integrity and privacy.

5.6 Raspberry pi: The Raspberry Pi is a small, low-cost, single-board computer designed to perform many of the functions of a traditional computer. In this system, it acts as the central processing unit that connects and controls different modules such as the camera for facial recognition, GPS for location tracking, sensors for monitoring, and speakers for voice prompts. Its compact size, affordability, and ability to run real-time applications make it ideal for wearable IoT-based projects like the Alzheimer's assistant, where portability, efficiency, and integration of multiple features are essential.

5.7Hardware and Software Components

- Hardware: Raspberry Pi, camera module, GPS sensor, panic button, speaker, Wi-Fi module.
- Software: Python, OpenCV (for facial recognition), Google Text-to-Speech API, Firebase or AWS (for cloud storage), encryption libraries.

6. Existing System

Current Alzheimer's support systems are largely fragmented, focusing on individual features such as facial recognition, GPS tracking, or voice-based reminders. While these technologies provide partial assistance, they often operate in isolation and fail to deliver a unified, comprehensive solution. For example, facial recognition modules may help patients identify familiar people, but they do not integrate with emergency alert systems or routine management tools. Similarly, GPS-based tracking devices can monitor patient movement, yet they lack secure communication protocols and emotional support features. Voice-prompt applications exist to remind patients of daily tasks, but they are limited in personalization and adaptability. Moreover, most existing systems struggle with usability, data privacy, and scalability. Patients often find them difficult to operate, caregivers face challenges in monitoring multiple devices, and sensitive patient data is exposed to risks due to weak security measures. These limitations result in gaps in safety monitoring, routine adherence, and emotional well-being, making current solutions insufficient for holistic Alzheimer's care.

7. Proposed System

The proposed system addresses these shortcomings by introducing a secure, wearable IoT-based assistant that integrates multiple intelligent modules into a single device. Built on a collar-type wearable platform, the system combines CNN-based facial recognition to aid memory recall, steganography for secure image transmission, GPS tracking with geofence alerts for safety, and Google Assistant for natural voice-based interaction. It further incorporates a Panic Assistant that enables patients to send immediate emergency alerts, and a Daily Routine Voice

Prompter that delivers scheduled reminders for medication, meals, hydration, hygiene, and sleep. Unlike existing systems, this solution emphasizes data security through encrypted protocols such as S/MIME, ensuring confidentiality and integrity of patient information. Edge computing principles are applied to process facial recognition and other tasks locally on the device, reducing latency and improving responsiveness. The design is lightweight, comfortable, and user-friendly, making it suitable for everyday use by Alzheimer's patients. Additionally, the modular architecture supports scalability and adaptability, allowing future integration of sensors or advanced AI modules. By unifying safety, routine management, emotional support, and secure communication, the proposed system offers a holistic, intelligent, and compassionate solution that enhances patient autonomy, caregiver confidence, and overall quality of life.

8. Conclusion

In conclusion, the Smart Assistant for Alzheimer's Patients represents a comprehensive and innovative approach to addressing the challenges faced by individuals with mild to moderate Alzheimer's Disease. By integrating facial recognition, secure data transmission, GPS tracking, voice interaction, panic assistance, and routine prompting into a single wearable IoT-based system, the project bridges critical gaps left by existing fragmented solutions. The design emphasizes patient safety, autonomy, and emotional well-being while ensuring secure communication and real-time responsiveness through edge computing. Its lightweight, user-friendly architecture makes it practical for everyday use, while its scalability allows for future enhancements and integration with advanced technologies. Overall, this system demonstrates how AI and IoT can be combined to create compassionate, intelligent, and secure assistive technologies that improve quality of life for patients and provide confidence and support for caregivers.

Alzheimer's Disease (AD) is a progressive neurodegenerative disorder that impairs memory, cognition, and daily functioning, affecting millions worldwide. As the global population ages, the prevalence of AD continues to rise, posing significant challenges for caregivers and healthcare systems. Traditional support mechanisms often fall short in providing real-time assistance, safety monitoring, and emotional support for individuals with mild to moderate AD. Recent advances in Artificial Intelligence (AI) and Internet of Things (IoT) technologies offer promising avenues for enhancing patient care. Studies have shown that digital technologies can support reminders, monitoring, and tracking but face usability barriers and adoption challenges [1-3]. GPS alarms and indoor positioning systems have been explored to prevent wandering, though accuracy and privacy remain concerns [4-7]. Integrated frameworks combining sensors, alerts, and AI-driven monitoring demonstrate strong potential for holistic support [8]. Wearables with fall detection and panic buttons have also proven effective in elderly care, though usability challenges persist [9-10]. Innovations such as AI-powered smart glasses highlight how facial recognition and voice interaction can reduce confusion and provide real-time assistance [11-12].

9. References

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