

Research Paper

CENTRALIZED SOLUTION FOR ALZHEIMER'S DETECTION AND CLASSIFICATION

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Abstract- Alzheimer's disease is a progressive neurological disorder that significantly impacts memory, cognitive abilities, daily activities, and overall quality of life, while also increasing the responsibilities placed on caregivers. Despite the availability of various diagnostic and support technologies, many existing solutions operate independently, making patient monitoring and care management fragmented and less effective. This paper proposes a centralized Alzheimer's care platform that combines artificial intelligence-based MRI analysis with intelligent object tracking and caregiver support features within a unified environment. The system employs deep learning techniques to analyze MRI scans and assist in identifying different stages associated with cognitive decline, providing an additional tool for early awareness and monitoring. To support day-to-day living, a computer vision module continuously observes object interactions, recognizes hand movements, records item locations, and generates visual activity summaries that help users and caregivers locate frequently misplaced belongings. The platform further incorporates an accessible web interface, secure data management mechanisms, caregiver monitoring dashboards, and a personalized recommendation component that delivers useful insights based on observed behavioral patterns. Comprehensive functional evaluation confirms the effectiveness of the MRI processing workflow, item tracking operations, activity visualization generation, and caregiver notification mechanisms. Rather than serving as a replacement for professional medical assessment, the proposed framework is designed as a supportive assistance system that enhances patient care, improves caregiver awareness, and promotes better management of daily challenges associated with Alzheimer's disease. The integration of diagnostic support, behavioral monitoring, and intelligent recommendations within a single platform demonstrates the potential of combining artificial intelligence and assistive technologies to improve the quality of life of individuals affected by cognitive disorders. Future enhancements may include clinical-scale validation, multimodal healthcare data integration, privacy-focused deployment strategies, advanced predictive analytics, and extensive usability studies involving patients, caregivers, and healthcare professionals.

Keywords- Alzheimer's Disease, Artificial Intelligence, MRI Analysis, Deep Learning, Computer Vision, Object Tracking, Caregiver Analytics, Assistive Healthcare, Heatmap Visualization, Smart Healthcare Systems.

I. INTRODUCTION

Alzheimer's disease is one of the most prevalent and challenging neurodegenerative disorders affecting the global population. It is characterized by the gradual deterioration of cognitive functions, including memory, reasoning, decision-making, communication abilities, and problem-solving skills. As the disease progresses, individuals often experience increasing difficulty in performing routine daily activities, managing personal responsibilities, recognizing familiar people, and maintaining independence.

The impact of Alzheimer's disease extends beyond patients themselves, affecting families, caregivers, healthcare providers, and healthcare infrastructures. With increasing life expectancy and a rapidly aging population, the number of individuals living with dementia-related conditions continues

to rise, making Alzheimer's disease a major public health concern worldwide.

The management of Alzheimer's disease is particularly complex because it requires continuous monitoring, early assessment, long-term care planning, and daily support.

Traditional healthcare approaches primarily focus on clinical evaluations, neurological examinations, cognitive assessments, and neuroimaging techniques such as Magnetic Resonance

Imaging (MRI). While these methods assist healthcare professionals in identifying signs of cognitive decline, they often operate independently from systems designed to support patients in their everyday lives. Consequently, there is frequently a disconnect between medical assessment and practical daily assistance, resulting in fragmented care experiences for patients and caregivers.

In addition to clinical challenges, individuals with Alzheimer's disease often struggle with everyday tasks such as locating personal belongings, remembering object placements, following routines, and maintaining awareness of their surroundings. These difficulties can increase frustration, anxiety, and dependence on caregivers. Family members and professional caregivers spend considerable time assisting patients with routine activities, monitoring behavioral changes, and ensuring personal safety. As the condition advances, the caregiving burden becomes increasingly demanding, often leading to emotional stress, physical exhaustion, and financial challenges. Therefore, there is a growing need for intelligent technologies that can simultaneously support both patients and caregivers while improving the overall quality of care.

Recent advancements in Artificial Intelligence (AI), Deep Learning, and Computer Vision have created new opportunities for developing innovative healthcare support systems. Deep learning models have demonstrated remarkable success in analyzing medical images and identifying disease-related patterns that may not be easily detectable through traditional analysis methods. In the context of Alzheimer's disease, AI-assisted MRI analysis has emerged as a valuable tool for supporting early-stage detection and classification of cognitive impairment. Similarly, computer vision technologies enable real-time object recognition, activity monitoring, gesture detection, and behavioral analysis, making them suitable for assisting patients in their daily environments. These technological developments provide a foundation for creating integrated systems capable of addressing both diagnostic support and daily living assistance within a unified framework. Despite these advances, many currently available solutions remain isolated and task-specific. Diagnostic systems often focus exclusively on medical image analysis, while assistive technologies primarily address reminders, tracking, or monitoring functions. Most platforms do not facilitate meaningful communication between diagnostic information, behavioral data, caregiver observations, and support recommendations. Furthermore, elderly users with cognitive impairments may find complex interfaces difficult to navigate, reducing the effectiveness of otherwise sophisticated technologies. As a result, there is a need for a centralized and user-friendly platform capable of combining multiple support functions while maintaining accessibility, privacy, and ease of use. To address these challenges, this research proposes a Centralised Solution for Alzheimer's Care that integrates AI-assisted MRI-based detection, smart item tracking, caregiver analytics, and personalized recommendation services into a single intelligent platform. The proposed system utilizes deep learning techniques to analyze MRI scans and provide stage-oriented cognitive assessment support. In parallel, a computer vision-based smart item tracking module assists patients in locating frequently misplaced objects by recognizing items, monitoring placement activities, and maintaining location histories. An analytics component transforms collected information into meaningful visualizations and behavioral summaries that help caregivers understand patient habits and

identify emerging concerns. Additionally, a recommendation engine generates personalized suggestions and care-support insights based on detected patterns and system observations.

The primary objective of this platform is to reduce fragmentation in Alzheimer's care by connecting diagnostic support, daily assistance, and caregiver decision-making within a unified environment. The system aims to improve patient independence, enhance caregiver awareness, simplify access to relevant information, and support more informed care planning. While the proposed solution is not intended to replace professional medical diagnosis or clinical decision-making, it serves as a supportive technology that complements existing healthcare services. By combining artificial intelligence, computer vision, data analytics, and assistive technologies, the proposed framework demonstrates a comprehensive approach toward improving the management of Alzheimer's disease and enhancing the quality of life for both patients and caregivers.

II. RELATED WORK

A. Alzheimer's Disease and Digital Care

Dementia is a major public health concern, and Alzheimer's disease accounts for a large proportion of dementia cases [1]. The Alzheimer's Association reports increasing prevalence and high caregiver burden, emphasizing the need for accessible and scalable care-support technologies [2]. Digital tools can assist care, but they must be designed for cognitive accessibility, privacy, and caregiver collaboration.

B. AI in Medical Imaging

Deep learning has become an important method in medical image analysis, especially for classification, segmentation, and detection tasks [3]. Lundervold and Lundervold reviewed deep learning in MRI and highlighted both potential and challenges in medical imaging workflows [4]. Datasets such as OASIS provide neuroimaging and clinical data that support Alzheimer's research and algorithm development [5].

C. Computer Vision for Daily Support

Computer vision can support daily living by recognizing objects, gestures, and activity patterns. Frameworks such as MediaPipe enable real-time perception pipelines for hand and pose processing [8]. Object detection approaches such as YOLO demonstrate how visual systems can detect objects quickly in camera streams [7]. For Alzheimer's care, these techniques must be adapted carefully because false detections can increase caregiver stress.

III. PROPOSED SYSTEM

A. Problem Statement

Existing Alzheimer's care technologies are often isolated. Diagnostic tools, reminder systems, item trackers, and caregiver records operate separately. Physical tracking tags are difficult to attach to every item, and conventional user interfaces may be hard for patients with cognitive impairment. A centralised platform is needed to connect diagnostic support, item tracking, analytics, and caregiver recommendations.

B. System Architecture

The proposed system consists of an accessible interface, AI MRI detection module, smart item tracker, analytics and heatmap module, secure database, AI model services, and recommendation engine. The patient or caregiver interacts with the platform through a simplified interface. Data from MRI inputs and camera-based item tracking is processed and summarized for caregiver review.

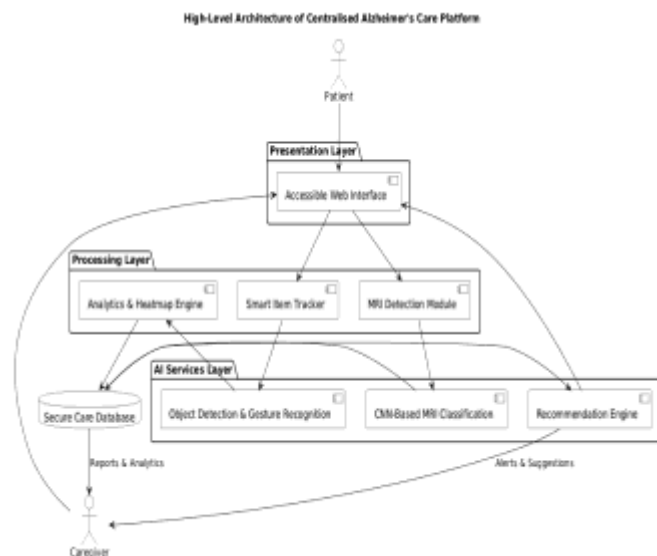


Fig. 1. High-level architecture of the centralised Alzheimer's care platform.

TABLE I. HARDWARE AND SOFTWARE REQUIREMENTS

Component	Specification / Tool
Processor	Intel i3 5th gen or equivalent
Memory	4 GB RAM minimum
Storage	500 GB available storage
Language	Python 3.10
AI libraries	TensorFlow / OpenCV
Framework	Django web framework
Front end	HTML5, CSS3, JavaScript
Database	SQL / MySQL

C. Core Modules

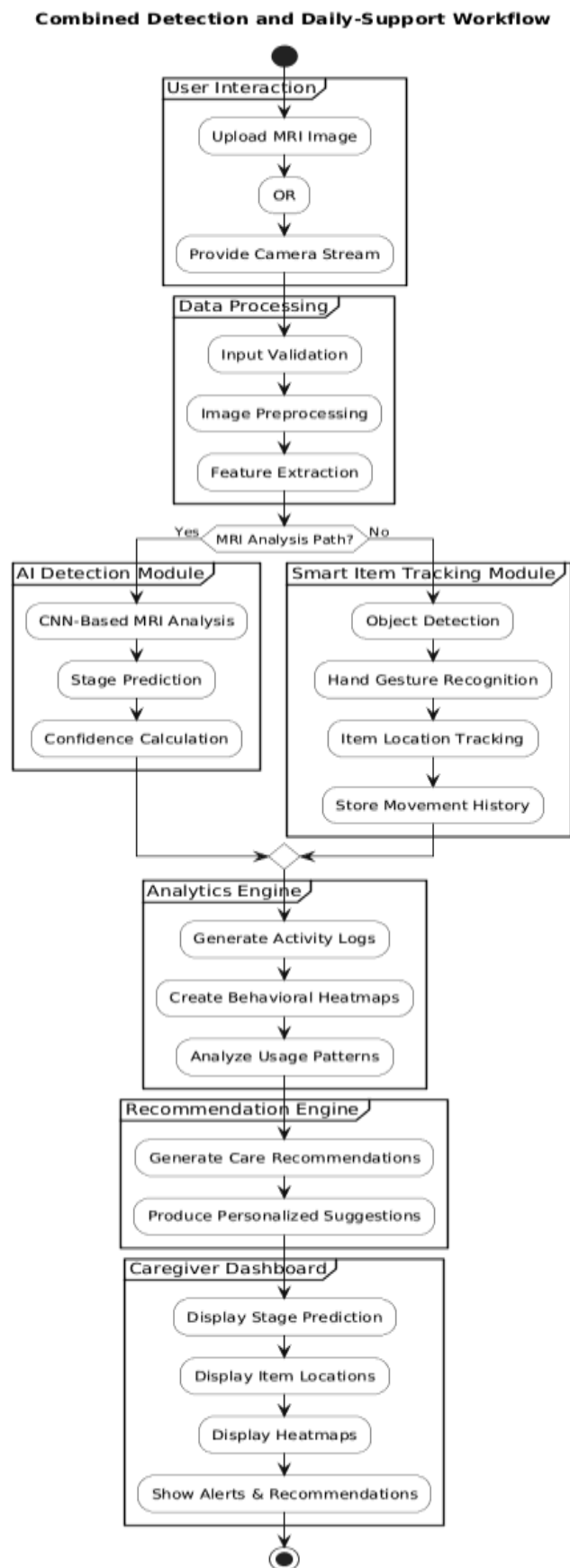
The AI detection module preprocesses MRI images and uses a convolutional neural network concept to classify dementia-related stages. The smart item tracker uses object detection and hand gesture recognition to identify where frequently misplaced objects are kept. The analytics module converts spatial logs into heatmaps and behavioral summaries. The recommendation engine provides caregiver-oriented suggestions based on detected patterns.

IV. METHODOLOGY AND IMPLEMENTATION

A. MRI Detection Flow

The MRI flow begins with image upload and validation. Images are resized, normalized, and passed to the detection model. The model output is displayed as a stage-oriented prediction with a confidence value and a reminder that the result is not a medical diagnosis. Healthcare professionals remain responsible for diagnosis and treatment decisions.

Fig. 2. Combined detection and daily-support workflow.



B. Item Tracking and Heatmaps

The daily-support flow uses a camera input to detect objects and hand movements. When an object is placed or moved, the system logs an approximate location and timestamp. Repeated logs are used to create heatmaps showing common placement zones. These visual summaries can help caregivers identify patterns and reduce time spent searching for misplaced objects.

C. Accessible Web Platform

The proposed platform is developed using a robust and scalable technology stack consisting of a Python-based backend, the Django web framework, SQL/MySQL database management systems, and modern front-end technologies including HTML5, CSS3, and JavaScript. This architecture enables efficient data processing, secure information management, and seamless communication between system components. Django provides a reliable foundation for handling user requests, authentication, database interactions, and integration with artificial intelligence modules, while the database layer securely stores medical records, behavioral logs, activity histories, recommendation data, and caregiver information. A key design objective of the platform is accessibility, particularly for elderly individuals and users experiencing cognitive impairments. To address usability challenges, the interface incorporates high-contrast visual elements, large and clearly labeled buttons, readable typography, intuitive navigation structures, and simplified workflows that minimize user confusion. The dashboard is designed to reduce cognitive load by presenting information in an organized and easy-to-understand manner, allowing patients and caregivers to access important features without requiring extensive technical knowledge. Caregiver-oriented panels provide consolidated views of patient activities, MRI analysis results, behavioral summaries, heatmaps, alerts, and personalized recommendations, supporting more effective monitoring and decision-making. Given the highly sensitive nature of healthcare and behavioral information, strong security and privacy measures are integrated throughout the platform. Role-based access control mechanisms ensure that users can only access information relevant to their responsibilities and authorization levels. Secure authentication procedures, protected communication channels, encrypted data storage practices, and controlled database access help safeguard patient confidentiality and prevent unauthorized use of personal information. These security mechanisms contribute to maintaining user trust while supporting compliance with responsible healthcare data management principles. By combining accessibility, usability, scalability, and security within a unified framework, the proposed web platform provides a practical foundation for delivering intelligent Alzheimer's care support services to patients and caregivers.

D. Results



Fig. 3. Home Page of the Centralised Alzheimer's Care Platform

Description:

The figure presents the home page of the proposed Centralised Alzheimer's Care Platform. This interface serves as the primary entry point for patients, caregivers, and healthcare users to access the system's functionalities. The dashboard provides intuitive navigation to AI-assisted MRI analysis, smart item tracking, caregiver monitoring tools, and personalized recommendation services. The design emphasizes accessibility through a simple layout, clear visual elements, and user-friendly controls, ensuring that elderly users and caregivers can easily interact with the platform. The home page acts as a centralized gateway for managing diagnostic support and daily assistance features within a unified environment.



Fig. 4. Patient Input and Data Submission Interface

Description:

The figure illustrates the input page where users provide the information required for system analysis and support services. Depending on the selected functionality, users can upload MRI images for cognitive assessment or provide camera-based inputs for object tracking and daily activity monitoring. The interface performs input validation and ensures that the

submitted data is correctly processed before being forwarded to the corresponding AI modules. This page plays a crucial role in facilitating secure and accurate data collection while maintaining ease of use for both patients and caregivers.



Fig. 5. Detection and Caregiver Results Dashboard

Description:

The figure displays the results page generated by the proposed Alzheimer's care system. The dashboard presents AI-generated outputs such as cognitive stage predictions from MRI analysis, object location tracking information, activity logs, behavioral heatmaps, and personalized caregiver recommendations. Results are organized in a clear and understandable format to support decision-making and daily care management. Caregivers can review patient activity patterns, monitor frequently misplaced items, and access recommendations derived from system observations. The results interface enhances situational awareness and provides actionable insights that support patient assistance and caregiver coordination.

V. TESTING AND DISCUSSION

The prototype was evaluated through functional testing rather than clinical validation. Functional testing checks whether MRI files are accepted, detection paths run, object tracking records item placement, heatmaps are generated, and caregiver summaries are displayed correctly. A real clinical deployment would require ethics approval, medical expert review, dataset validation, and long-term patient evaluation.

TABLE II. REPRESENTATIVE FUNCTIONAL TEST CASES

ID	Scenario	Expected Output	Result
T1	MRI upload	Image validated	Pass
T2	Detection	Stage prediction shown	Pass
T3	Object view	Item recognized	Pass
T4	Hand gesture	Placement logged	Pass
T5	Heatmap	Pattern displayed	Pass
T6	Caregiver view	Alert and summary shown	Pass

The main risks are false classification, camera privacy, biased training data, and usability problems for cognitively impaired users. The system should never provide final medical diagnosis. Instead, it should support awareness, routine assistance, and caregiver organization. Privacy-preserving storage, consent controls, and transparent model reporting are essential for responsible use.

VI. CONCLUSION AND FUTURE WORK

This paper presented a Centralised Solution for Alzheimer's care that combines AI-assisted MRI detection, smart item tracking, heatmap analytics, and caregiver recommendations. The platform aims to reduce fragmentation by connecting clinical support concepts with daily-living assistance in one accessible interface.

Future work should include clinically validated datasets, transfer learning, multimodal sensing, explainable AI, privacy-preserving model training, voice navigation, multilingual support, wearable integration, and real user testing with patients and caregivers. Such work is necessary before the system can move from a student prototype to a reliable healthcare-support platform.

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