

A Unified Digital Platform for Dementia Care: Bridging Memory Preservation, Safety, and Caregiver Support

Adithi H B

Dept. of Computer Science Engineering
RNS Institute of Technology
Bengaluru, Karnataka
1rn21cs013.adithihb@rnsit.ac.in

Chaithrashree H

Dept. of Computer Science Engineering
RNS Institute of Technology
Bengaluru, Karnataka
1rn21cs040.Chaithrashreeh@rnsit.ac.in

Dhanashree S

Dept. of Computer Science Engineering
RNS Institute of Technology
Bengaluru, Karnataka
1rn21cs048.dhanashrees@rnsit.ac.in

Dhruthi R

Dept. of Computer Science Engineering
RNS Institute of Technology
Bengaluru, Karnataka
1rn21cs050.dhruthir@rnsit.ac.in

Dr. Prasanna Kumar M

Associate Professor, Dept. of CSE
RNS Institute of Technology
Bengaluru, Karnataka
prasannakumar.m@rnsit.ac.in

Abstract—Dementia is a progressive neurological condition that impairs memory, cognitive function, and daily activities, profoundly affecting individuals and their caregivers. This paper presents a digital platform designed to tackle these challenges by integrating memory preservation, cognitive stimulation, safety measures, and caregiver support. Users can create personalized memory collections, engage in brain-stimulating activities, and access real-time safety features. Advanced AI-powered tools provide therapeutic recommendations and adapt to users' evolving needs. For caregivers, the platform offers progress tracking, educational resources, and tools to streamline caregiving. By merging technology with empathetic design, this platform enhances the quality of life for individuals with dementia and those who care for them.

Index Terms—Dementia Care, Memory Preservation, Care-giver Support, Digital Health Solutions, Cognitive Engagement, Personalized Care, Artificial Intelligence, Safety Monitoring, Remote Health Monitoring, Affordable Dementia Care.

I.

INTRODUCTION

Dementia profoundly affects memory, cognition, and safety, presenting challenges for patients and caregivers alike. It is a group of symptoms affecting memory, thinking and social abilities severely enough to interfere with daily life[1]. Dementia is a disease with various neurodegenerative disorders that impairs cognitive functions such as memory, orientation, executive function, language, behaviors and psychological function[2]. Existing care systems often fall short, offering fragmented solutions that fail to address the diverse needs of individuals living with this condition. This paper introduces an innovative digital platform tailored to dementia care, designed to integrate memory preservation, cognitive stimulation, safety tools, and

caregiver assistance into a unified framework.

The platform empowers users to create dynamic memory archives by uploading photos, videos, and audio clips, enabling

emotional connection and identity reinforcement. Cognitive games and mood-based therapeutic activities provide engagement and mental stimulation, while features like emergency alerts and daily reminders ensure user safety and routine management. Caregivers benefit from advanced tools, including health tracking, personalized content recommendations, and an accessible interface for streamlined caregiving.

This project redefines dementia care by merging empathetic design with advanced technology, fostering a secure and adaptive environment for patients and caregivers. Through this holistic approach, the platform offers a transformative solution to enhance the quality of life and support for those impacted by dementia.

II.

RELATED WORK

A. Literature Review of Existing Digital Dementia Care Systems

Recent research on digital dementia care systems focuses on improving the quality of life for patients through technologies like mobile apps, wearable devices, and virtual environments. Studies such as Morse et al. (2022) explore the use of mobile applications that offer memory aids and cognitive games, while Schneider et al. (2023) investigate the role of telemedicine in remote monitoring, providing real-time care and support for both patients and caregivers. While these solutions are promising, they often remain fragmented, focusing either on memory aids or caregiver assistance. Few systems integrate both aspects into a comprehensive platform, limiting their overall effectiveness in addressing the varied needs of dementia patients and caregivers. These results have indicated the heterogeneous study results of NP-I to BPSD may be related to the potential effects from caregivers, which should be interpreted cautiously[2].

B. Gaps in Traditional Memory Aids and Modern Technologies

Traditional memory aids, like physical reminders and calendars, have been used to help dementia patients recall important tasks and events. However, these tools lack the adaptability required as the disease progresses. In contrast, modern technologies such as mobile apps and digital memory aids offer more flexibility but still face limitations. For instance, Liu et al. (2021) observed that many digital tools fail to provide personalized support, offering a one-size-fits-all solution that doesn't evolve with the patient's cognitive status. This lack of dynamic, adaptive support results in less effective memory preservation, especially for patients in advanced stages of dementia.

C. Limitations of Current Solutions: Cognitive Engagement, Personalization, Accessibility, and Affordability

One significant limitation of current dementia care solutions is their inability to provide long-term cognitive engagement. Many systems focus on short-term memory exercises that don't consistently challenge patients cognitively. Jones et al. (2020) found that sustained cognitive engagement is essential for maintaining memory retention, but current tools often fall short of meeting this need. Additionally, the issue of personalization remains a challenge, as most digital tools do not adapt based on the patient's changing cognitive abilities. Accessibility and affordability are also barriers, as many digital solutions are expensive or difficult to use. High upfront costs, complex interfaces, and subscription models make these technologies inaccessible to many families, especially those in lower-income or underserved communities.

III. PROPOSED SYSTEM

A. System Overview

1) Introduction to the Dementia Virtual Memory Website:

The Dementia Virtual Memory Website is a comprehensive digital platform designed to support individuals with dementia and their caregivers. This platform integrates functionalities for memory preservation, cognitive engagement, safety, and caregiver support into a unified system.

2) *Objectives of the System:* The primary objectives of the Dementia Virtual Memory Website are:

a) *Memory Preservation:* The platform allows users to upload and organize photos, videos, and audio clips, creating personalized memory collections. These digital archives help patients retain their sense of identity and stay connected to their past.

b) *Cognitive Engagement:* To support cognitive health, the website includes brain-stimulating activities and games. These activities are tailored to the patient's cognitive abilities, providing continuous mental engagement.

c) *Safety:* Safety features include emergency alerts and daily reminders for medications and appointments. These tools help ensure patients maintain their routines and can quickly get help in emergencies.

d) *Caregiver Support:* The platform provides tools for caregivers, such as health tracking, progress monitoring, and educational resources. These features help caregivers manage their responsibilities more effectively and provide better care. In summary, the Dementia Virtual Memory Website aims to offer a comprehensive solution that addresses the various needs of dementia patients and their caregivers, enhancing their quality of life through integrated digital support.

B. Features

1) *Memory Preservation Tools:* The system offers tools for creating personalized memory archives, where users can upload and organize photos, videos, and audio recordings. These archives help preserve the patient's memories and provide a means for reminiscing, which can be comforting and beneficial for cognitive health.

2) *Cognitive Engagement:* To keep patients mentally active, the platform includes various games and therapeutic activities. These are designed to stimulate cognitive functions such as memory, attention, and problem-solving. The activities are adaptable to different levels of cognitive ability, ensuring they remain challenging yet achievable.

3) *Emergency and Safety Systems:* The platform incorporates emergency and safety features to protect users. This includes alert systems that can notify caregivers or emergency services if the patient needs help. Additionally, fall detection and other monitoring tools are available to ensure patient safety.

4) *User-Friendly Interface and Accessibility:* The website is designed with a user-friendly interface that is easy to navigate. Accessibility features are included to cater to users with varying levels of digital literacy and physical abilities, ensuring that both patients and caregivers can use the platform effectively without frustration.

IV. SYSTEM DESIGN AND IMPLEMENTATION

A. Technological Framework

1) *System Architecture and Workflow:* The Dementia Virtual Memory Website employs a multi-tier architecture consisting of the presentation layer, application layer, and data layer. The presentation layer is responsible for the user interface, facilitating interaction with the system. The application layer handles the core functionalities, including user authentication, data processing, and game logic. The data layer manages the storage and retrieval of user data, ensuring secure and efficient access.

The workflow begins with user authentication, followed by access to various features such as memory archives, cognitive games, and safety tools. Users can upload media files, participate in cognitive activities, and set up reminders and emergency alerts. The system uses AI algorithms to analyze user interactions and provide personalized recommendations.

2) *Integration of AI and Machine Learning for Dementia Prediction Using MRI:* The platform integrates AI and machine learning techniques to predict dementia progression using MRI images. A convolutional neural network (CNN)

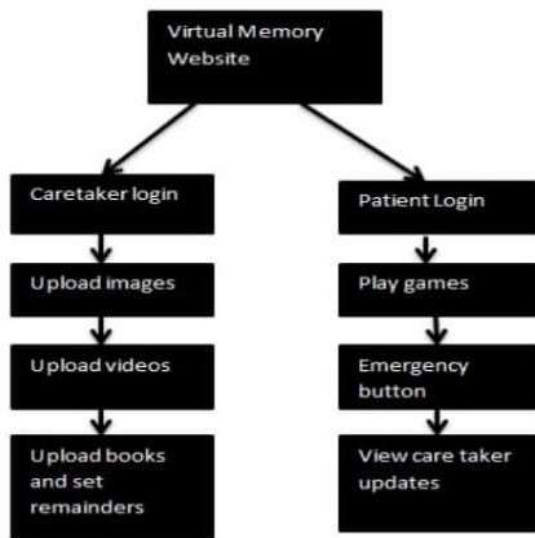


Fig. 1. Schema diagram

model is trained on labeled MRI datasets to classify the severity of dementia. The model is embedded into the application layer, where it processes uploaded MRI images and provides diagnostic predictions. This functionality aids in early detection and continuous monitoring of dementia.

V. DATA MANAGEMENT

A. Data Collection and Storage

• Types of Data Collected:

- **User Data:** Includes patient and caregiver profiles such as name, age, email, and address.
- **Media Data:** Uploaded photos, videos, audio clips, and books for memory preservation.
- **Health Data:** MRI images for dementia prediction, mood logs, and daily activity records.
- **Cognitive Engagement Data:** Interaction logs from games and activities.

• Storage Architecture:

- Relational database (MySQL) for structured data like user profiles and activity logs.
- Secure cloud storage for media files, with metadata linked to the database.

B. Security Measures

• Data Encryption:

- User credentials and sensitive information are hashed using bcrypt.
- Communication is secured with HTTPS/TLS encryption.

• Session Management:

- Sessions are token-based and include automatic logout after inactivity.

C. Data Validation

- Validation of uploaded media files and MRI images ensures:
 - Format compliance (e.g., JPEG, PNG, MP4).
 - Size restrictions to optimize storage.
 - Completeness and consistency of data.

D. Data Processing and Analysis

• Preprocessing for Machine Learning:

- MRI images are normalized, resized to 176x176 pixels, and prepared for CNN input. Investments are required in Alzheimer's dices by creating new instruments and trend setting innovation[3].

• Cognitive Progress Tracking:

- Game interaction data is analyzed to generate cognitive health metrics and progress reports.

E. Data Backup and Recovery

- Automated daily incremental backups and weekly full backups are performed.
- Disaster recovery mechanisms ensure minimal downtime and data loss.

F. Data Sharing

- Encrypted communication channels are used to securely share data with caregivers and healthcare professionals.
- Caregivers receive real-time notifications for emergency alerts, reminders, and prediction results.

G. Scalability and Optimization

- **Scalable Cloud Infrastructure:** Cloud services dynamically scale storage and computational resources based on user demand.
- **Database Optimization:** Indexing and query optimization ensure faster data retrieval.
- **Caching Mechanisms:** Frequently accessed data is cached to improve response times.

VI. FUNCTIONAL REQUIREMENTS

• User Authentication:

- Users (patients/caretakers) can log in with a username and password.
- New users can register and verify their accounts via an OTP (One-Time Password).

• Caretaker and Patient Management:

- The caretaker can set medicine reminders for the patient by providing the medicine name, medicine type, dosage to be consumed, the time to take the medicine, and days in which the medicine has to be taken by the patient[1].
- Patients can view uploaded content, including games, books, and emergency alerts sent by caretakers.

• Dementia Prediction:

- Caretakers can upload MRI images for dementia prediction using a machine learning model.

– The system provides classification results, such as "Mild Demented" or "Non-Demented."

- **Emergency Alert System:**

– Patients can press an emergency button to send real-time alerts to their caretakers via email.

– The application tracks the location of the patient if he/she wanders away from home beyond a specified limit. The location has to be enabled in the patient's phone for the feature to work accurately[1].

- **Media Upload and Viewing:**

– Caretakers can upload images, videos, and books to the platform.

– The caretaker can upload photos of close friends and family for the patient to view. This is to help the patient retain memory[1].

- **Games:**

– The platform includes interactive games (e.g., Tic-Tac-Toe, Snake) to stimulate cognitive function.

- **Notifications:**

– Caretakers receive alerts for emergencies, MRI predictions, and reminders.

– Users receive OTPs for authentication and verification purposes.

- **Session Management:**

– The system maintains active user sessions and logs out users automatically after a period of inactivity.

- **Personalized Recommendations:**

– Patients receive personalized recommendations for games, books, and activities based on their cognitive profile.

– Caretakers are provided with caregiving tips tailored to patient needs.

- **Progress Tracking:**

– The system tracks patient progress through interaction with games and activities.

– Provides insights into patient engagement and cognitive improvement.

VII. AI-DRIVEN PERSONALIZATION

- **Personalized Recommendations:**

– AI algorithms analyze user data, including interaction history, mood logs, and cognitive profiles, to provide tailored recommendations for:

- * Games and activities to enhance cognitive engagement.
- * Books and media content suited to the user's interests and cognitive abilities.

- **Dynamic Content Adaptation:**

– The platform adjusts its content based on the user's real-time emotional and cognitive state.

– For example:

- * Suggesting calming activities during periods of agitation.

* Providing more stimulating content when the user shows signs of cognitive alertness.

- **Mood-Based Customization:**

– The system tracks mood variations through caregiver inputs or user interaction patterns.

– Activities and therapeutic content are recommended based on the user's current emotional state.

- **Machine Learning Models:**

– Supervised learning models are trained using user behavior data to predict preferred content and activities.

– Feedback loops refine model accuracy, ensuring improved personalization over time.

- **Cognitive Progress Tracking:**

– Interaction data from games and activities is analyzed to monitor cognitive improvement.

– AI algorithms adjust activity difficulty levels to match the user's current abilities and progression.

- **Proactive Care Suggestions:**

– Predictive analytics are used to anticipate user needs and recommend:

- * Routine adjustments.
- * New therapeutic activities.
- * Social interaction opportunities to reduce isolation.

- **Caregiver Support:**

– Caregivers receive personalized tips based on the patient's interaction trends and health status.

– AI-driven alerts notify caregivers of significant behavioral changes, enabling timely interventions.

Key Outcomes: AI-driven personalization ensures a user-centric experience by adapting to the unique cognitive and emotional needs of individuals with dementia. This feature enhances engagement, promotes emotional well-being, and provides caregivers with actionable insights for better care management.

VIII. RESULTS AND DISCUSSIONS

- **Machine Learning Prediction:** A CNN model was implemented for analyzing medical images, specifically for classifying dementia stages. Preliminary tests on validation datasets revealed high accuracy, showcasing the robustness of the trained model. For example, categories like "Very Mild Dementia" and "No Dementia" had consistent prediction reliability.

- **Web Application Functionalities:**

The web application provides an intuitive and clean interface, enabling users to interact seamlessly. X-O-X and a guessing game were integrated for user engagement. These mini-games add a recreational layer for users, especially patients, making the app appealing beyond its primary medical use. A standout feature is the emergency notification system, which allows users to send a pre-defined alert email to their caretaker, including location details.

- Database Integration:

Efficiently stores user data, media details, and model results. Schema design ensured scalable and secure operations, even with simultaneous user sessions. User authentication relies on Flask sessions, with role-based segregation (doctor vs. patient) ensuring appropriate access controls. Passwords were hashed using bcrypt for enhanced security. User-specific data such as uploaded files and predictions are stored in protected directories.

- Transforming Healthcare Through Technology: The application utilizes machine learning, specifically a convolutional neural network (CNN), to enhance healthcare accessibility by providing reliable dementia stage predictions. This feature empowers users, particularly in remote or underserved areas, to take proactive steps toward treatment and care. The model's ability to process medical images efficiently ensures a practical tool for early detection and regular monitoring, reducing the need for frequent clinical visits.

- Versatility in Functionality: The system goes beyond healthcare, offering a multifunctional platform that combines prediction services with features like emergency alert systems and interactive games. This diversity makes the application more than just a medical tool, transforming it into a holistic platform for patient engagement. The seamless integration of functionalities, such as multimedia uploads and real-time model inference, showcases the application's capability to manage complex tasks effectively.

- Pathway to Scalable Innovation: The modular architecture ensures scalability, paving the way for significant advancements. Future extensions, such as adding predictions for other medical conditions, cloud hosting, and mobile app integration, enhance the system's potential. These developments position the platform as a comprehensive healthcare solution, adaptable to evolving user needs while maintaining robust performance and user satisfaction.

IX. FUTURE SCOPE

- Integration with Wearables and IoT Devices: Incorporate wearable devices and IoT sensors to monitor patients' vitals, physical activity, and environmental conditions. This data can support real-time tracking and predictive health analytics.

- Advanced Personalization via AI: Leverage artificial intelligence to adapt activities and interventions dynamically based on user behavior and progress. AI models can enhance content relevance and improve user engagement over time.

- Global and Multilingual Accessibility: Develop the platform to support multiple languages and cultural contexts, ensuring global applicability and inclusivity for diverse demographics.

- Enhanced Caregiver Support: Introduce features specifically designed for caregivers, such as real-time

alerts, educational resources, and stress management tools, to improve the caregiving experience and reduce burnout.

- Data Security and Privacy: Strengthen compliance with global standards like GDPR and HIPAA to ensure the secure handling of sensitive patient data. Implement blockchain for tamper-proof record management.

- Longitudinal Studies for Validation: Conduct long-term clinical trials to evaluate the platform's effectiveness in enhancing cognitive and emotional well-being.

- Multi-model Data Integration: Incorporate data like speech patterns and facial expressions to enhance assessments and offer precise, tailored interventions for dementia care.

X. CONCLUSION

This project successfully merges advanced machine learning techniques with practical web-based applications to create a versatile platform tailored for healthcare and user engagement. By leveraging a convolutional neural network (CNN) for dementia stage prediction, the system provides an efficient, reliable tool for early diagnosis and monitoring, reducing dependency on traditional healthcare facilities. The inclusion of emergency alert features, multimedia file management, and interactive games transforms the application into a holistic solution that addresses both critical medical needs and recreational aspects. The system's modular and scalable architecture ensures flexibility for future developments, such as expanding predictive capabilities to other medical conditions, integrating advanced security protocols, enabling cloud-based deployment, and introducing mobile application support. These enhancements will further broaden the application's utility, catering to a wider audience while maintaining high performance and reliability. By bridging the gap between healthcare accessibility and technological innovation, this project demonstrates how modern computing solutions can deliver impactful outcomes in real-world scenarios. It sets a precedent for building systems that not only solve medical challenges but also enrich the user experience through thoughtful design and seamless functionality.

REFERENCES

- [1] DemeAssist - Dementia Assist Mobile Application by Sundar C Assistant professor (Sr. Grade), Computer Applications, PSG College of Technology, Coimbatore, India, Vol. 6 No. 3 (October-December, 2021)
- [2] Application of virtual reality for dementia management Yuan-Han Yang1, Rocksy FV Situmeang, Paulus Anam Ong, Rajka M Liscic, 19 July, 2022.
- [3] Y. Bayahyaa, Wadee AlHalabia, Sultan H. Al-Amrib a King Abdulaziz University, Faculty of Computing and Information Technology, Department of Computer Science, Jeddah, 16th International Learning Technology Conference 2019.
- [4] K. Elissa, "Title of paper if known," unpublished.
- [5] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.