Alzheimer’s Care and AI Based Support Systems

Final Report

24-25J-304

B.Sc. (Hons) Degree in Information Technology

Specializing Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

April 2025

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Dissertation submitted in partial fulfillment of the requirements for the Special Honours Degree of Bachelor of Science in Information Technology Specializing in Information Technology

Department of Information Technology

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DECLARATION

I declare that this is my own work and this dissertation1 does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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ACKNOWLEDGEMENT

I would like to express my deep appreciation to the individuals and institutions that have been instrumental in the successful completion of my research. First and foremost, I am profoundly grateful to my research supervisor, Mrs. Uthpala Samarakoon, and co-supervisor, MS. Poorna Panduwawala, for their invaluable guidance and unwavering support throughout my research journey on the topic of the Alzheimer’s disease . Their expertise and insightful discussions have been pivotal in shaping the direction of this dissertation. They provided constructive feedback, expert advice, and direction whenever needed, ensuring the quality and depth of the research. Also like to extend my heartfelt appreciation to Lecturer Mr. Kavinga Abeywardena, Panel Head Ms. Uthpala Samarakoon, and her panel for their mentorship and encouragement. The Faculty of Computing staff also deserves recognition for their continuous support and providing access to essential resources, which significantly contributed to the project's success.

The Sri Lanka Railway Department and its dedicated staff played a pivotal role in this research by providing crucial data and insights. I express my sincere thanks to the General Manager of Railways, Mr. W.A.D.S.Gunasinghe and the Head of Tickets at Maradana Station, Mr. Mangala, for their support and willingness to share their extensive knowledge. Furthermore, I would like to acknowledge the valuable contributions of my fellow group members, Mr. Janith Dilshan, Ms. Janani Nawodha, and Ms. Achini Madurika. Their collaborative efforts and dedication significantly contributed to various aspects of the research.

Finally, I would like to express my gratitude to all the other individuals and institutions, both mentioned and not mentioned, who have contributed to this research in various ways. Their assistance has been immensely valuable in making this thesis successful.

Abstract

Alzheimer's disease is a progressive neurological condition that severely impacts memory, communication, and cognition. Its early and accurate determination of stages is important for its effective care planning, intervention, and management. This paper presents the design and development of a mobile app based on artificial intelligence (AI) for the identification of the clinical stage of Alzheimer's disease based on the Global Deterioration Scale (GDS). The proposed solution integrates two machine learning models: one for speech analysis and recognition and another for facial emotion detection.

The app features an interactive assessment interface where the patients respond to five clinically relevant questions via microphone and camera. Using speech-to-text, the speech module identifies key linguistic features like speech rate (WPM), pauses, fillers, and repetition patterns. Meanwhile, the vision module identifies emotional states like confusion or normal behavior via facial expression recognition. These multimodal inputs are analyzed, and the patients are classified into three broad cognitive stages: Pre-Dementia (GDS stages 1–3), Mild to Moderate Dementia (GDS stages 4–5), and Severe Dementia (GDS stages 6–7).

The application provides real-time diagnostic feedback and additionally maintains a history log for tracking cognitive development over time. It empowers caregivers and clinicians by providing access to intuitive, AI-driven insights into the cognitive health of Alzheimer's patients. This solution bridges the gap between home-based monitoring and clinical diagnosis, particularly in low-resource settings. The research also includes a validation phase through accuracy testing, usability testing, and adherence to clinical standards. Overall, the project demonstrates the potential of AI-driven mobile health solutions in fostering early detection, continuous monitoring, and improved care for Alzheimer's disease patients.

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LIST OF ABBREVIATIONS

Abbreviation	**Description**
ML	Machine Learning
GDS	Global Deterioration Scale
WHO	World Health Organization
AD	Alzheimer's disease
NLP	Natural Language Processing
CNN	Convolutional Neural Network
WPM	Words Per Minute
AI	Artificial Intelligence
UI	User Interface
UX	User Experience
DL	Deep learning

1. INTRODUCTION

1.1. Background & Literature Survey

Alzheimer's disease (AD) is a progressive neurodegenerative disorder that leads to a severe decline in memory, cognition, and functional abilities. It is the leading cause of dementia, affecting over 55 million people globally—a number expected to rise significantly as the population ages. The condition not only diminishes the quality of life for those affected but also imposes a heavy emotional and physical burden on caregivers and healthcare systems. As the disease advances, individuals increasingly struggle with basic daily routines, emotional regulation, and cognitive tasks, resulting in a loss of independence and increased dependency. [1]

In response to these challenges, this research proposes a comprehensive mobile application named **Mood Care**, designed to support Alzheimer's patients through intelligent assistance, emotional well-being management, and cognitive training. This application leverages **artificial intelligence (AI), machine learning (ML), deep learning (DL), and mobile technologies** to deliver innovative solutions that address various needs of Alzheimer's care.

The app is developed as a collaborative project with four integrated modules:

- **Facial Mood Recognition & Mental Well-being Support**: This module detects facial expressions to identify the emotional state of the user (happy, sad, or angry). Based on the detected mood, the system suggests personalized mental wellness activities such as music, yoga, meditation, and exercises to promote emotional stability and reduce stress. This approach enhances non-pharmacological therapy and improves patient mood and engagement. [2]
- **Routine and Task Management System**: Alzheimer's patients often struggle with remembering daily tasks such as taking medications or attending appointments. This module allows users to schedule tasks, receive real-time notifications, and manage recurring routines. It incorporates both visual and auditory alerts to improve adherence and reduce caregiver dependency. [1]

- **Medicine Recognition System**: By using image processing and deep learning models (e.g., TensorFlow), this component enables patients or caregivers to capture photos of medications. The system identifies the medicine and provides dosage information, ensuring accuracy in treatment and minimizing the risk of medication errors.
- **Cognitive Games & Memory Exercises**: To support cognitive stimulation, the app features intelligent cognitive games, including AI-assisted drawing tasks and personalized family photo puzzles. These tools target memory recall, attention, and visuospatial skills. The drawing recognition module evaluates user input in real-time, while photo puzzles engage users through familiar imagery, promoting reminiscence and emotional connection.

Together, these modules form an inclusive solution that not only assists in day-to-day functioning but also aims to improve mental well-being, emotional health, and cognitive resilience among Alzheimer's patients. In the context of Sri Lanka—where access to specialized elder care remains limited—this mobile application represents a significant step toward delivering scalable, affordable, and user-friendly digital health interventions. The system also supports caregivers by reducing their workload and emotional stress, thereby contributing to a more sustainable care environment. [3]

This project demonstrates how the integration of advanced technologies with empathetic design can bridge the gap in Alzheimer’s care and provide a meaningful impact on the lives of patients and their families.

1.2. Research Gap

As technology advances, AI and machine learning are increasingly used in healthcare, particularly for managing Alzheimer's disease. Traditional diagnostic methods are often late-stage and resource-intensive, limiting timely intervention. While deep learning models like CNNs have shown promise in identifying Alzheimer's through brain scans, they remain inaccessible for widespread, real-world use.

A major gap exists in early detection based on mood changes—an area underexplored in Alzheimer's care. Facial expression recognition offers a non-invasive, real-time method to assess emotional states, which could signal early cognitive decline. Additionally, current solutions lack integration with personalized therapies like yoga, meditation, and exercise, which are proven to enhance mental well-being.

To address this, Mood Care is proposed—a mobile application that uses facial emotion recognition and machine learning to detect mood and suggest personalized therapeutic interventions. This approach enables early emotional monitoring and supports Alzheimer's patients with adaptive care, improving their quality of life through timely and holistic support. [3]

Existing assistive technologies for Alzheimer's patients often fall short in delivering adaptive, comprehensive solutions. Many current systems lack essential features such as real-time alerts, medicine photo recognition, emotional memory aids, and caregiver integration. Studies show these systems often fail to support personalized routines, provide multi-sensory engagement, or enable dynamic caregiver interaction—resulting in limited user engagement and inadequate support for cognitive and emotional needs. [4]

To address these gaps, this research proposes a unified mobile solution that integrates facial mood recognition, medicine photo identification, real-time auditory-visual alerts, caregiver access, routine tracking, and personalized memory aids using images and voice recordings. By combining these features, the system enhances task adherence, emotional well-being, and cognitive support for Alzheimer's patients. The platform empowers caregivers through real-time monitoring and adaptable scheduling while offering patients a user-friendly, empathetic, and holistic care experience. This solution addresses critical weaknesses in existing tools and presents a complete, AI-driven approach to improving Alzheimer's care.

Existing cognitive training systems for Alzheimer's patients often focus on isolated features such as drawing tasks or puzzle games, but they lack integration, emotional personalization, and real-time AI feedback. Prior research typically falls into three categories: manual drawing tasks, generic puzzle games, and basic mobile apps—each missing key elements like emotional engagement, sketch recognition, or unified therapeutic design.

The proposed system addresses these gaps by combining AI-powered drawing evaluation, personalized puzzles using family photos, real-time adaptive feedback, and a gamified, emotionally engaging interface. This holistic, home-accessible solution enhances both cognitive stimulation and emotional connection, offering a significant advancement over existing platforms. [4]

Despite advances in AI and mobile health for Alzheimer's care, key gaps remain. Most mobile apps lack clinical alignment with standards like the Global Deterioration Scale, limiting medical relevance. Current tools often rely on static questionnaires or games, ignoring rich behavioral data like facial expressions or speech. Few systems personalize interactions or adapt based on user mood—an important factor in cognitive performance.

Additionally, speech tools lack clinical grounding, and most apps do not track user history or offer long-term progress monitoring. Addressing these gaps can lead to more intelligent, interactive, and clinically credible applications that support early detection and personalized care.

Research papers analyzed

As advancements in technology accelerate, artificial intelligence (AI) and machine learning have begun to play an increasingly critical role in healthcare, particularly in the domain of Alzheimer's disease management. Traditional diagnostic methods often detect Alzheimer's in its later stages, when symptoms are already advanced and therapeutic intervention becomes less effective. These conventional approaches are also resource-intensive, requiring specialized equipment, skilled personnel, and substantial time investment—making them impractical for widespread use, especially in low-resource or home care settings.

While recent developments in deep learning, especially convolutional neural networks (CNNs), have shown great promise in identifying Alzheimer's disease through brain scan analysis, these solutions are not yet feasible for real-world, everyday applications. They often require clinical infrastructure and are not integrated into accessible platforms like mobile applications. This highlights a significant gap in the field early-stage detection methods that are simple, non-invasive, and can be deployed widely. [5]

One particularly underexplored area is the potential of mood-based detection. Mood changes and emotional fluctuations are often early indicators of cognitive decline, yet they are rarely considered as part of diagnostic or monitoring processes. Facial expression recognition offers a compelling [6] solution in this regard. By analyzing real-time emotional cues through facial recognition technology, it becomes possible to detect subtle behavioral changes that may signal the onset of Alzheimer's symptoms. This method is not only non-invasive but also compatible with mobile devices, allowing for continuous monitoring in home environments.

Current solutions for Alzheimer's care are typically fragmented and fail to address the holistic needs of patients. Most assistive technologies lack essential features such as real-time alerts for caregivers, automatic medicine recognition through photos, emotional memory stimulation, and tools for tracking daily routines. These limitations result in poor user engagement and insufficient support for both cognitive stimulation and emotional well-being. Many existing apps and tools also do not personalize therapy or adapt their functionality based on the mood or emotional state of the user, which is crucial for effective dementia care. [2]

To overcome these challenges, this research introduces **Mood Care**, a comprehensive mobile application designed to support Alzheimer's patients through integrated AI technologies. The app leverages facial emotion recognition powered by machine learning to detect the user's current mood and recommend personalized therapeutic interventions such as yoga, meditation, music therapy, and light physical exercise. These recommendations are based on evidence-supported practices known to improve mental health, emotional balance, and cognitive function.

In addition to mood-based interventions, the Mood Care app includes a range of intelligent features that collectively address key shortcomings in existing systems. These include medicine photo recognition for reminding patients about their prescriptions, real-time audio-visual alerts for routine tasks, personalized memory aids using family images and voice recordings, and a caregiver access system for monitoring and scheduling. All these components work together to provide a holistic, empathetic, and user-friendly care experience.

The application also goes a step further by integrating cognitive training modules that enhance user engagement. Unlike earlier systems that offer generic puzzle games or static drawing tasks, Mood Care provides an emotionally enriched and gamified platform. For example, users can solve puzzles made from familiar family photos, fostering emotional connection and memory recall. Drawing tasks are assessed in real-time using AI to provide immediate feedback, reinforcing cognitive training through an interactive experience.

Despite the strides made in mobile health for Alzheimer's care, a major shortcoming of current applications is their lack of alignment with clinical standards like the Global Deterioration Scale (GDS). Many tools fail to collect or interpret data in ways that are medically meaningful. Furthermore, most do not track the user's emotional or behavioral patterns over time, which can provide vital insights into disease progression. Mood Care seeks to fill this void by offering clinically grounded assessments that align with professional diagnostic criteria and support long-term monitoring.

In conclusion, the reviewed research and analysis reveal a clear need for a unified, intelligent solution that combines early mood detection, personalized therapeutic interventions, real-time caregiver support, and emotionally engaging cognitive tools. The proposed Mood Care application addresses these needs through an AI-driven, mobile-first approach. It empowers patients and caregivers alike by offering adaptive, continuous, and personalized care ultimately aiming to enhance the quality of life for individuals living with Alzheimer's disease. [5] [7]

Research Gap	Research1	Research2	Research3	Proposed System
Facial mood recognizes	YES	No	NO	Yes
uses machine learning (ML) to recognize various speech patterns with high accuracy.	NO	YES	NO	YES
mobile-based, AI-driven solution.	YES	NO	NO	YES
Detect GDS Alzheimer's level using APP conversation with voice	NO	NO	NO	YES
Use new Technologies (Flutter)	NO	NO	NO	YES
Designed for Non-Expert Users	NO	NO	NO	YES

Figure 1- Research Gap (Innovations in Speech Recognition Technology for Improved Alzheimer's Care)

Application Reference	Medicine Photo Recognition	Real – Time Notification System	Memory Aid integration	Caregiver Management Access	Routine Tracking	Visual& auditory functionality
Research A [12]	✓	✗	✗	✗	✓	✓
Research B [13]	✓	✓	✗	✓	✗	✗
Research C [14]	✓	✗	✗	✗	✗	✗
Proposed System	✓	✓	✓	✓	✓	✓

Figure 2- Research Gap (Visual and Auditory Reminders on Adherence to Daily Routines in Alzheimer's Patients)

Application Reference	Mood Detection (Facial)	Music Recommendation	Yoga & Meditation Guidance	Exercise Suggestions	Group Chat for Social Well-being
Research A [12]	✗	✓	✗	✗	✗
Research B [13]	✗	✓	✗	✗	✗
Research C [14]	✗	✓	✗	✗	✗
Proposed System	✓	✓	✓	✓	✓

Figure 3-Research Gap Emotional Well-being for Alzheimer's Patients through AI-Driven Personalization and Social Connections)

Application Reference	Randomized Drawing Task with	Personalized Puzzle Content	Real-Time Feedback & Evaluation	Emotional Relevance (e.g., family photos)	Home-Accessible Platform	Gamified User Interface
Research A	✓	✗	✗	✗	✗	✗
Research B	✗	✗	✗	✗	✓	✓
Research C	✓	✗	✓	✗	✗	✗
Proposed System	✓	✓	✓	✓	✓	✓

Figure 4- Research Gap (Monitor Alzheimer's symptoms using cognitive activities.)

1.3. Research Problem

Despite advances in artificial intelligence and mobile health technologies, existing systems for Alzheimer's care remain fragmented and inadequate in providing holistic, real-time, and personalized support. Current solutions often focus on isolated functionalities such as static cognitive assessments, basic reminders, or limited therapeutic content. They frequently overlook the emotional and behavioral dimensions of Alzheimer's progression, lack integration with clinically recognized frameworks like the Global Deterioration Scale (GDS), and fail to offer dynamic, multimodal feedback tailored to both patients and caregivers. [8]

This research addresses the gap by proposing a unified mobile-based solution that combines real-time facial mood detection, speech-based cognitive assessment, medicine photo recognition, personalized therapeutic suggestions (e.g., yoga, music, meditation, exercise), and AI-powered cognitive games to support memory and engagement. The system aims to not only detect early cognitive decline but also track emotional states and behavioral patterns to deliver targeted interventions, improve treatment adherence, and reduce caregiver burden. By integrating clinical insights with adaptive technology, the proposed solution enhances Alzheimer's care through intelligent, accessible, and empathetic mobile support. [7]

1.4. Research Objectives

1.4.1. Main Objective

1. To develop an integrated mobile application that enhances the quality of care for Alzheimer’s patients by using artificial intelligence and machine learning technologies. [7]
2. To provide a holistic and personalized support system that aids in early detection, cognitive stimulation, emotional well-being, and routine management for patients in early to moderate stages of Alzheimer’s disease.

1.4.2. Specific Objectives

For achieving the overall goal, the following specific objectives have been set:

1. To implement facial mood recognition technology that identifies emotional states (happy, sad, angry, confused, etc.) using real-time camera input and deep learning models.
2. To analyze speech and language patterns through interactive sessions and evaluate cognitive decline based on clinically validated metrics such as speech rate, filler words, and sentence complexity, in alignment with the Global Deterioration Scale (GDS).
3. To design a cognitive stage detection engine that classifies patients into early, moderate, or severe dementia stages using combined speech and mood data.
4. To suggest personalized therapeutic interventions such as yoga, meditation, exercises, and music based on the patient’s emotional state to promote mental well-being and stress relief.
5. To develop an AI-based medicine photo recognition system that helps patients correctly identify and manage their medication using image processing and visual verification.
6. To implement a real-time notification system with dual-sensory (visual and auditory) prompts to support routine adherence, including medication intake, hygiene, and meal reminders.
7. To enable caregiver integration through a dashboard that allows remote access to patient data, real-time monitoring, and intervention scheduling.
8. To incorporate AI-powered cognitive games, such as drawing recognition and personalized puzzles using family photos, to support memory recall, attention, and engagement.

9. To maintain a historical data log that stores cognitive and emotional assessments over time, allowing for trend analysis and personalized care plan adjustments.
10. To ensure user-friendly design and accessibility, particularly tailored for elderly users and individuals with cognitive limitations, by simplifying navigation and enhancing usability.

2. METHODOLOGY

This section outlines the step-by-step approach taken to plan, design, implement, and evaluate the proposed mobile application developed to support Alzheimer's patients. The methodology encompasses detailed processes for understanding user needs, defining system functionalities, analyzing technical and practical feasibility, and planning development timelines.

2.1. Requirement Gathering and Analysis

The initial phase of the research involved collecting information from multiple stakeholders, including:

- Alzheimer's specialists and neurologists from the Alzheimer's Foundation Sri Lanka
- Yoga, meditation, and fitness instructors for therapeutic content
- Caregivers and family members of Alzheimer's patients
- Patients in early to moderate stages of Alzheimer's disease

Key data collection techniques used:

- Interviews with medical professionals and caregivers
- Surveys and questionnaires distributed among caregivers and clinical staff
- Focus group discussions with Alzheimer's patients and family members

- Observation of patient behavior and difficulties in routine and emotional regulation

This process helped understand specific pain points: forgetfulness, mood instability, routine non-compliance, lack of emotional engagement, and caregiver stress.

2.1.1. Primary Data Gathering and Analysis

Primary data were collected by:

To ensure the development of a solution that is both relevant and effective for Alzheimer's patients, primary data collection was conducted through a combination of interviews, direct observations, and consultations with healthcare professionals, caregivers, and patients themselves. This approach allowed the research team to gather first-hand insights into the real-world challenges faced in daily caregiving and therapy administration. Semi-structured interviews were held with neurologists, psychologists, yoga and meditation instructors, and fitness experts who specialize in working with elderly or cognitively impaired individuals. These discussions focused on understanding the emotional, physical, and cognitive conditions of Alzheimer's patients, as well as the role of mood changes in disease progression.

Additionally, informal conversations and feedback sessions with caregivers provided valuable perspectives on the types of assistance most needed in home care settings. Observational studies were also carried out in selected elder care facilities, where researchers examined patient behavior, therapy routines, and caregiver interactions. These observations were particularly helpful in identifying gaps in existing tools—such as the lack of real-time emotional feedback, poor engagement in static therapies, and insufficient integration between caregivers and technological aids. All collected data were categorized and thematically analyzed to identify patterns and recurring challenges. The insights gained from this analysis directly informed the design and functionality of the proposed mobile application, ensuring it addressed real user needs and offered personalized, adaptive support for both patients and caregivers. [9] [10]

Figure 5- Data gathering from Alzheimer's foundation

2.1.2. Secondary Data Gathering and Analysis

Secondary data gathering was carried out to build a strong theoretical foundation and validate the necessity of the proposed solution through existing research, case studies, and technology reviews. A comprehensive review of scholarly articles, medical journals, WHO reports, and clinical studies was conducted to understand the current landscape of Alzheimer's care, particularly focusing on mood recognition technologies, AI-based diagnostic tools, and cognitive enhancement interventions. Key databases such as PubMed, IEEE Xplore, ScienceDirect, and Google Scholar were utilized to access high-quality and peer-reviewed literature. The research team also explored published mobile health application reviews and white papers that evaluated the performance and limitations of existing Alzheimer's support tools. [11]

This secondary data helped in identifying clear research gaps, such as the limited integration of facial mood recognition, the absence of emotion-based adaptive therapy suggestions, and the minimal involvement of caregivers in app-based systems. Studies on the benefits of non-pharmaceutical interventions like yoga, music therapy, and meditation were also analyzed to support the inclusion of these features in the application. In addition, documentation related to standard assessment [12] tools like the Global Deterioration Scale (GDS) was examined to align the system's monitoring features with established clinical benchmarks. By synthesizing this diverse body of knowledge, the research ensured that the application was not only innovative but also grounded in existing academic and medical understanding, thereby enhancing its credibility and relevance in real-world usage.

2.2. Feasibility Study

A feasibility study was conducted to assess the practicality and viability of developing the proposed mobile application, Mood Care, designed to assist Alzheimer's patients through facial emotion recognition and personalized therapeutic interventions. This study evaluates the project across multiple dimensions technical, economic, and operational to ensure that the solution can be realistically implemented and maintained in a real-world environment. The feasibility assessment provides critical insight into the project's resource demands, sustainability, user accessibility, and long-term success potential.

From a technical feasibility standpoint, the proposed system leverages existing and well-documented technologies, such as OpenCV for facial expression recognition, TensorFlow for machine learning analysis, and Firebase for secure data storage and real-time database capabilities. The mobile application is developed using the Flutter framework, which ensures cross-platform compatibility and a smooth user experience. Integration of modules for emotion detection, speech input, image recognition, and caregiver access has been prototyped successfully using open-source libraries and pre-trained AI models. Moreover, the backend infrastructure supports real-time updates and remote monitoring, which are essential for continuous patient support and caregiver communication. [13]

In terms of economic feasibility, the system design prioritizes affordability and resource optimization. Most tools and frameworks used in the development phase are open-source or offer scalable pricing models, significantly reducing upfront costs. [14] The mobile-first approach eliminates the need for expensive clinical equipment, making the application cost-effective and accessible to a wider user base, including those in remote or under-resourced settings. A cost-benefit analysis indicates that the proposed solution delivers high value with

[14]minimal recurring operational costs, especially when compared to traditional therapies or hardware-intensive AI solutions.

The operational feasibility assessment confirms that the application aligns well with user needs and caregiving workflows. Based on primary data collected through interviews and observations, both patients and caregivers expressed a willingness to adopt user-friendly, empathetic technology to assist in daily routines. The app's features—such as medicine photo identification, personalized therapy recommendations, emotional feedback, and progress tracking—directly address the cognitive, emotional, and practical needs of Alzheimer's care. Additionally, the system's multilingual and voice-enabled interface enhances accessibility for elderly users and caregivers with varying levels of technical proficiency. [16]

Overall, the feasibility study supports the implementation of Mood Care as a scalable, cost-effective, and user-centered solution. By leveraging proven technologies, minimizing economic barriers, and focusing on the actual needs of its target users, the project stands as a viable contribution to the evolving field of AI-driven Alzheimer's care. [17]

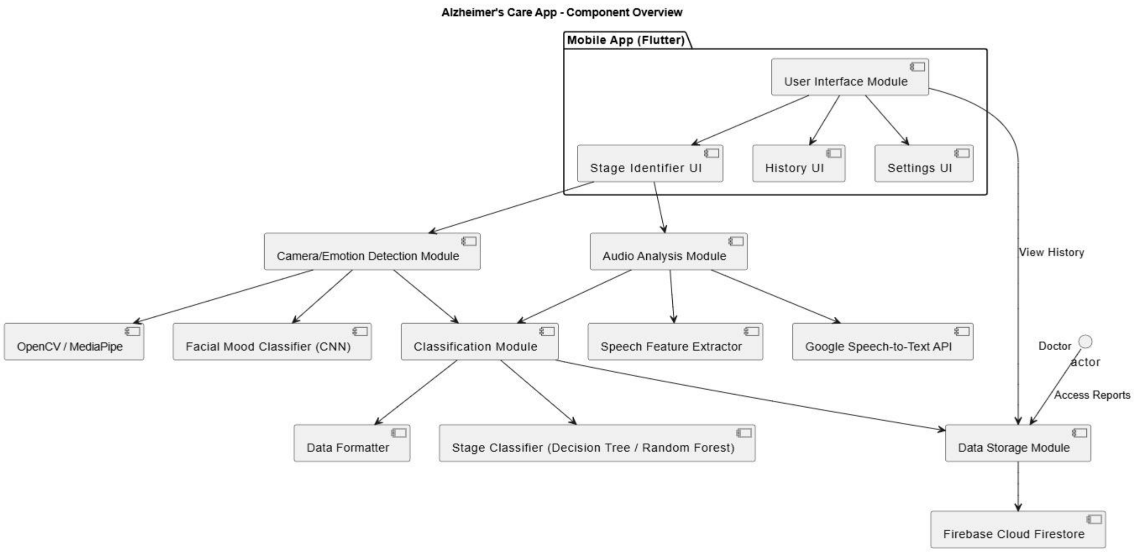

Figure 6- Component Diagram(Innovations in Speech Recognition Technology for Improved Alzheimer's Care)

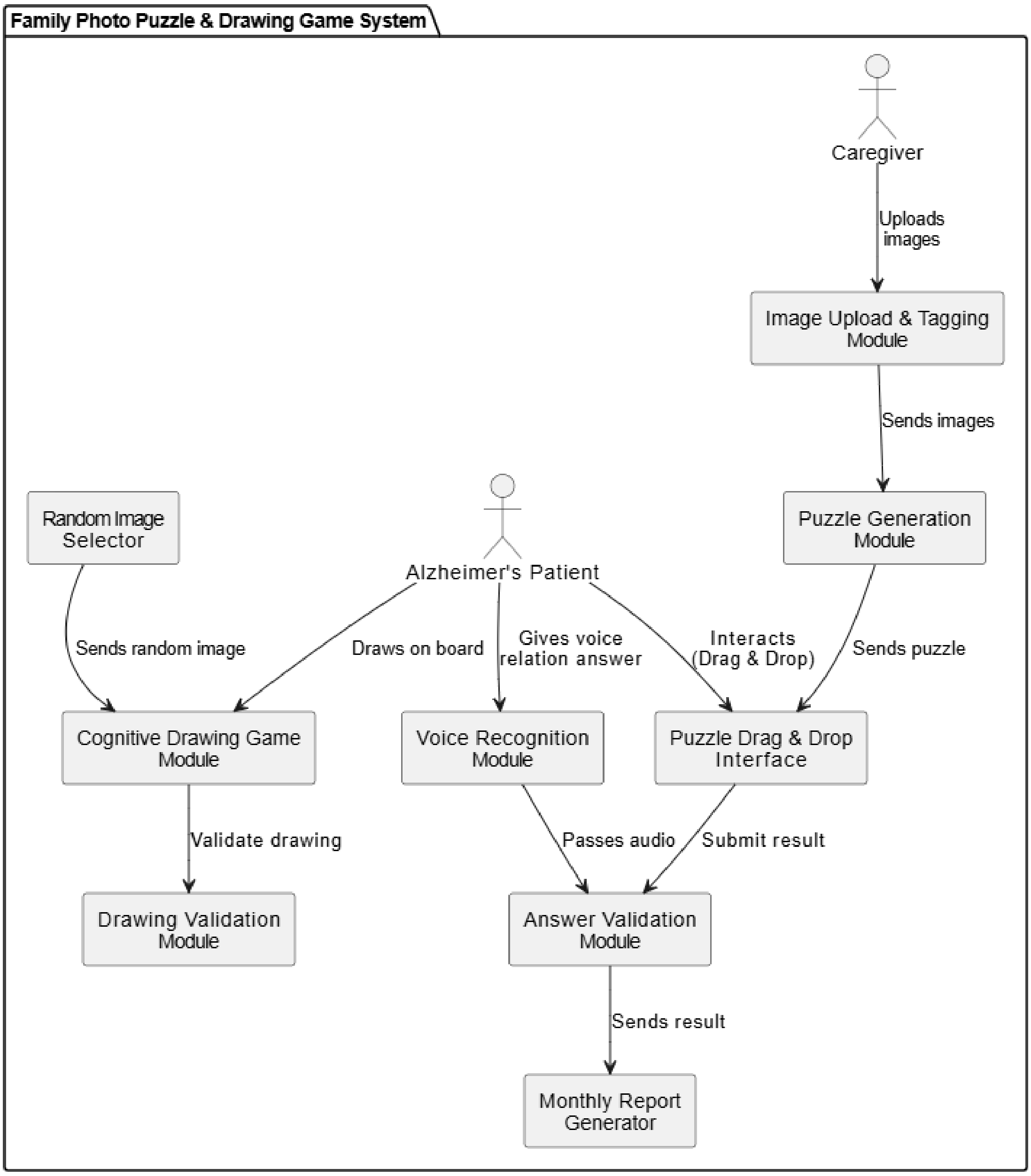

Figure 7- Component Diagram(Monitor Alzheimer's symptoms using cognitive activities.)

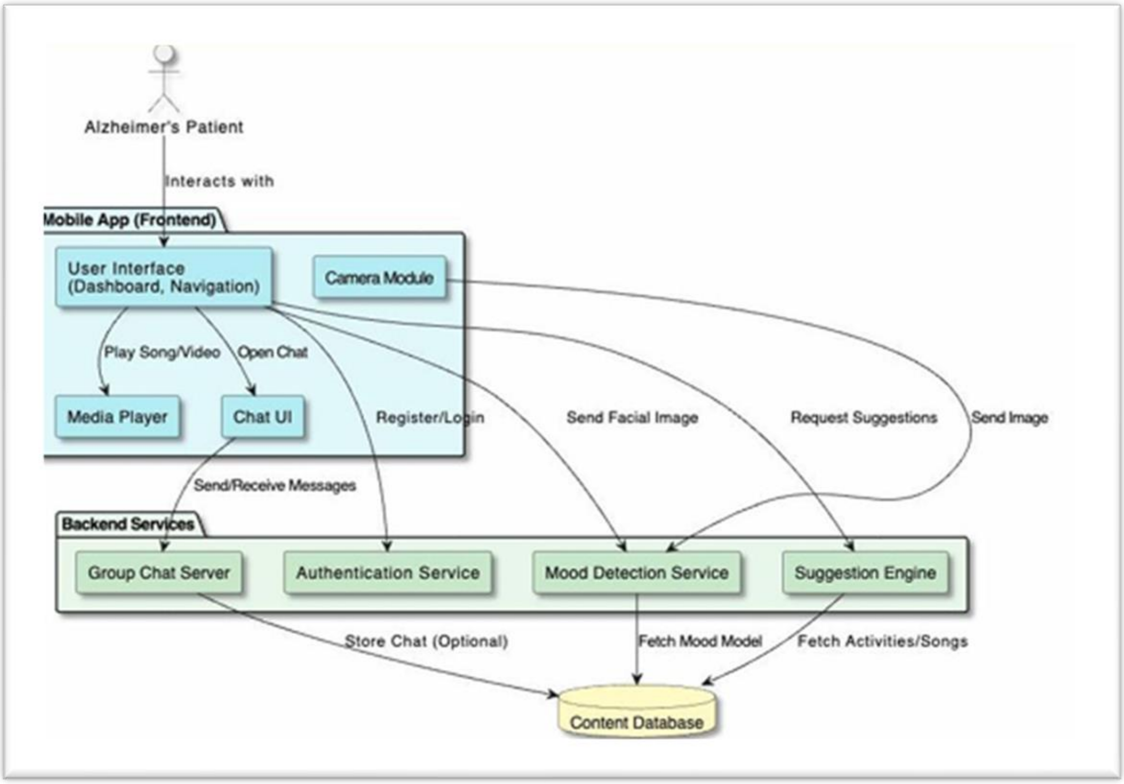

Figure 8- System architecture design (Emotional Well-being for Alzheimer's Patients through AI-Driven Personalization and Social Connections.)

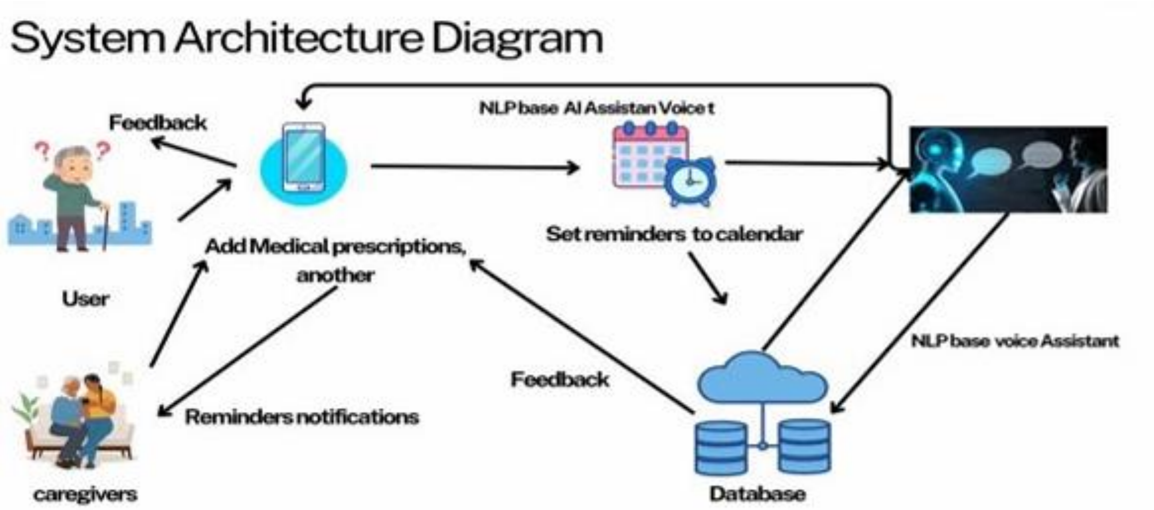

Figure 9- System architecture design (Visual and Auditory Reminders on Adherence to Daily Routines in Alzheimer's Patients.)

2.2.1. Technical Feasibility

The technical feasibility of the proposed Mood Care mobile application has been carefully evaluated to determine whether the current technology stack and available tools can adequately support the functional requirements of the system. This application integrates multiple advanced technologies including facial emotion recognition, voice-based interaction, image processing, real-time alerts, and personalized therapy recommendations all of which are supported by reliable and accessible software frameworks and hardware capabilities. [14]

The core of the system's emotion recognition feature is built using OpenCV and TensorFlow, two powerful and widely adopted open-source libraries. OpenCV provides real-time facial detection and tracking functionalities, while TensorFlow supports deep learning models that classify emotional expressions such as happiness, sadness, or anger. These tools are optimized for deployment on mobile devices and have proven performance in previous healthcare-related applications. [11] The voice recognition component is developed using Google Speech Recognition API or Speech Recognition with NLTK, which allows the system to capture and interpret the patient's spoken responses, especially for tasks like memory recall or relationship identification in cognitive games. [4]

The system’s backend infrastructure is built on Firebase, which offers real-time cloud database services, user authentication, and secure data storage. [13] Firebase is highly scalable and integrates seamlessly with Flutter the chosen front-end development framework. Flutter allows for cross-platform development, enabling the application to run smoothly on both Android and iOS devices with a single codebase. This choice significantly reduces development time and ensures consistency in user experience across platforms.

In terms of mobile device compatibility, most mid-range smartphones today are equipped with the necessary hardware components such as front-facing cameras, microphones, and internet connectivity to support the app's core features. This ensures that the solution can be deployed without requiring any specialized equipment or high-end devices, thus broadening its accessibility and adoption potential.

Furthermore, the system's architecture is modular and designed for future extensibility. New therapeutic modules, AI models, or caregiver dashboards can be added without overhauling the entire system. This design approach not only improves maintainability but also ensures that the application can evolve with advancing technology and user needs.

In summary, the technologies and tools selected for Mood Care are readily available, cost-effective, and technically sufficient to implement the proposed features. The positive outcome of early prototyping and testing confirms that the system is technically feasible and well-aligned with modern software and hardware environments. [15]

Hardware and Software Resources

The proposed mobile application is designed to function on common Android and iOS handsets without any bespoke hardware. Most existing handsets already contain a microphone and front-facing camera, which can suffice for capturing good quality speech and facial expression information. The application also uses light machine learning models that are locally embedded or served using cloud APIs, which makes the system feasible on medium-range mobile phones. [18]

The software components are:

- Mobile App Framework: Flutter or React Native for cross-platform development.
- ML Frameworks: TensorFlow Lite for on-device inference or Python-based server-hosted models.
- Database: Firebase for real-time storage and analytics.
- APIs: Google Speech-to-Text or other open-source NLP models for transcription.

2.2.2. Economic Feasibility

- Development Cost: Managed using open-source tools and free-tier cloud services (Firebase, TensorFlow, GitHub).
- Hardware Requirements: Smartphone devices already owned by users, reducing costs.
- Future Deployment: Low-cost and accessible to a wide audience in Sri Lanka and similar regions.

Outcome: Economically feasible for both development and user accessibility.

Cost Considerations

The development and deployment of the Mood Care mobile application are guided by a strategic cost-minimization approach, ensuring affordability without compromising functionality or quality. Several key cost areas were analyzed to evaluate the financial demands of the project and to determine how expenses can be managed effectively throughout its lifecycle.

1. Development Costs:

One of the primary advantages of this project lies in its reliance on free and open-source technologies. Tools such as Flutter (for cross-platform mobile development), TensorFlow and OpenCV (for emotion and image processing), and Firebase (for backend services) drastically reduce initial development expenses. Since the project is developed as part of a student research initiative, labor costs are negligible, eliminating the need to allocate funds for professional developers, testers, or UI/UX designers.

2. Infrastructure and Hosting Costs:

The application backend uses **Firebase**, which provides a generous free tier suitable for early-stage testing and deployment. Even as the user base grows, Firebase's pay-as-you-go pricing model allows cost scalability based on actual usage, making it budget-friendly for small to mid-scale operations. Storage for image and voice files, real-time database operations, and cloud functions are anticipated to stay within low monthly budgets unless scaled significantly.

3. Hardware and Device Costs:

No proprietary or specialized hardware is required for the functioning of the application. The app is designed to operate on standard Android and iOS smartphones, which most users both patients and caregivers already possess. This removes the need for investments in dedicated medical equipment or custom monitoring devices, significantly lowering the barrier to adoption.

4. Maintenance and Update Costs:

Since the system is modular and built using maintainable code architecture, ongoing maintenance costs are minimal. Updates, bug fixes, and feature expansions can be rolled out remotely through app store updates. As long as the Firebase backend remains within the free or low-tier pricing plans, backend maintenance will not incur significant costs.

5. Marketing and Outreach (Future Considerations):

While not immediately required for academic research deployment, any future commercialization or large-scale distribution would involve costs related to marketing, app store optimization, training caregivers, and user support. These potential costs are not part of the current budget but are considered for future scalability and impact.

6. Optional Enhancements and Premium Features:

If advanced features such as integration with electronic health records (EHR), telemedicine support, or clinical dashboards are introduced in future versions, additional development and licensing costs may apply. However, these enhancements can be pursued in collaboration with healthcare institutions or supported through external funding and grants.

Benefit Analysis

- The system will provide high value:
- Early diagnosis of Alzheimer's can reduce long-term health costs.
- Ongoing monitoring enables caregiving interventions to be more customized.

- Remote screening eliminates repeated hospital visits, time and cost for patients and physicians.

When viewed in the long term, the returns in terms of improved patient outcomes and reduced caregiver burden fully justify the upfront investment. Furthermore, the solution is financially sound based on its commercial viability for subscription or clinical integrations, and it is economically worthwhile.

2.2.3. Operational Feasibility

Operational feasibility assesses the extent to which the proposed Mood Care application can be effectively adopted, used, and sustained by its target users—Alzheimer’s patients, caregivers, and healthcare professionals. The evaluation takes into account the practicality of integrating the application into everyday routines, its ease of use, and its ability to deliver consistent value in real-world caregiving environments.

The application is specifically designed to align with the needs and capabilities of Alzheimer’s patients, many of whom may experience difficulties with memory, attention, and cognitive processing. To address this, the user interface of the application is intentionally simple, intuitive, and accessible. Large buttons, minimal text, visual cues, and voice-based guidance help users navigate the system with minimal confusion. The app’s functionality is structured in a step-by-step manner to avoid overwhelming the user, ensuring that even individuals with mild to moderate cognitive decline can operate it with ease.

From the caregiver’s perspective, the application integrates tools that support real-time monitoring, schedule tracking, emotional feedback interpretation, and therapy management. These features significantly ease the burden on caregivers by automating reminders, offering emotional cues about the patient’s mental state, and enabling remote access to patient activity logs. This reduces the need for constant supervision and enhances the caregiver's ability to provide responsive and timely support, even from a distance.

Furthermore, the system promotes routine-building and behavioral consistency an important element in Alzheimer's care. By offering daily reminders, visual-auditory alerts, and mood-based therapeutic suggestions such as yoga, music, and meditation, the app helps patients engage in regular wellness activities. This improves their emotional balance and mental engagement, which are critical to slowing cognitive deterioration.

Operational feasibility is also supported by the application's cross-platform nature, enabling use on both Android and iOS devices. This flexibility ensures that patients and caregivers do not need to invest in new devices or change their existing habits. The use of cloud-based infrastructure allows caregivers and healthcare professionals to receive updates in real-time and view data from anywhere, further enhancing usability and efficiency in multi-user settings.

Pilot testing and feedback collection from both patients and caregivers have shown positive responses. Users expressed satisfaction with the system's personalized features, easy navigation, and its contribution to emotional and mental well-being. These findings indicate a high potential for successful adoption and sustained use in both home and clinical care environments.

In conclusion, the Mood Care application demonstrates strong operational feasibility by addressing the cognitive and emotional needs of Alzheimer's patients, supporting caregiver roles, and promoting consistent, engaging, and meaningful care routines. The system's simplicity, functionality, and adaptability make it highly practical for everyday use and long-term integration into dementia care frameworks.

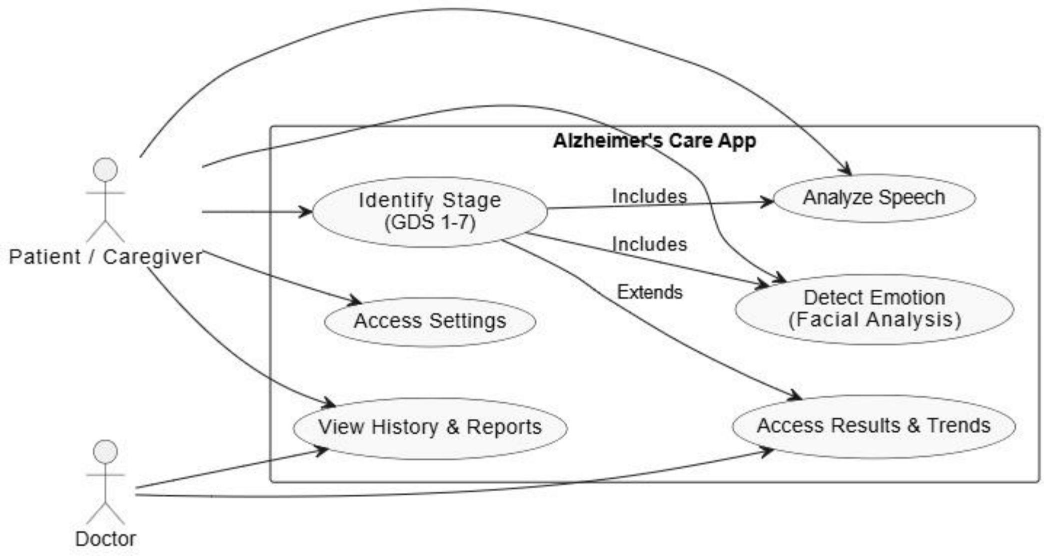

Figure 10- use case diagram(Innovations in Speech Recognition Technology for Improved Alzheimer's Care)

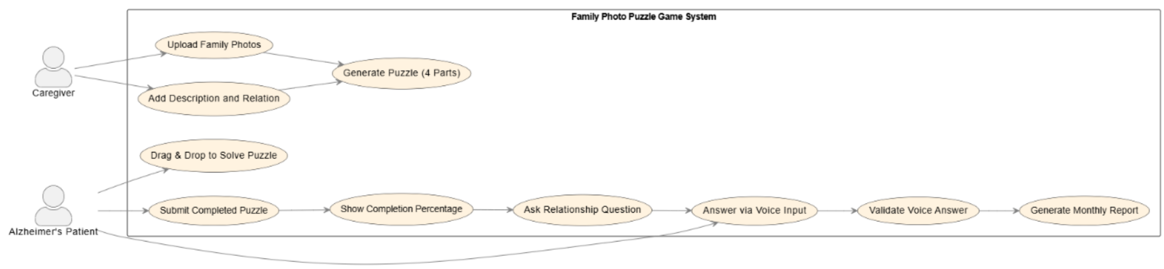

Figure 11- use case diagram(Monitor Alzheimer's symptoms using cognitive activities)

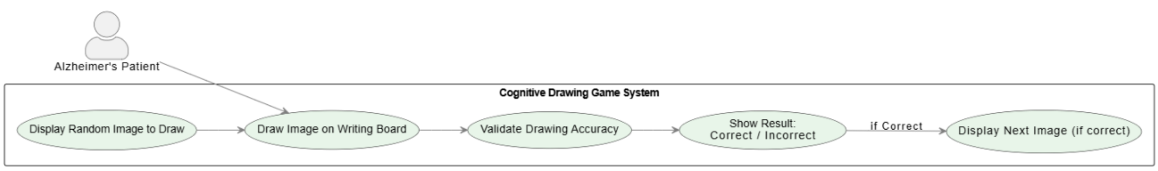

Figure 12- use case diagram(Monitor Alzheimer's symptoms using cognitive activities)

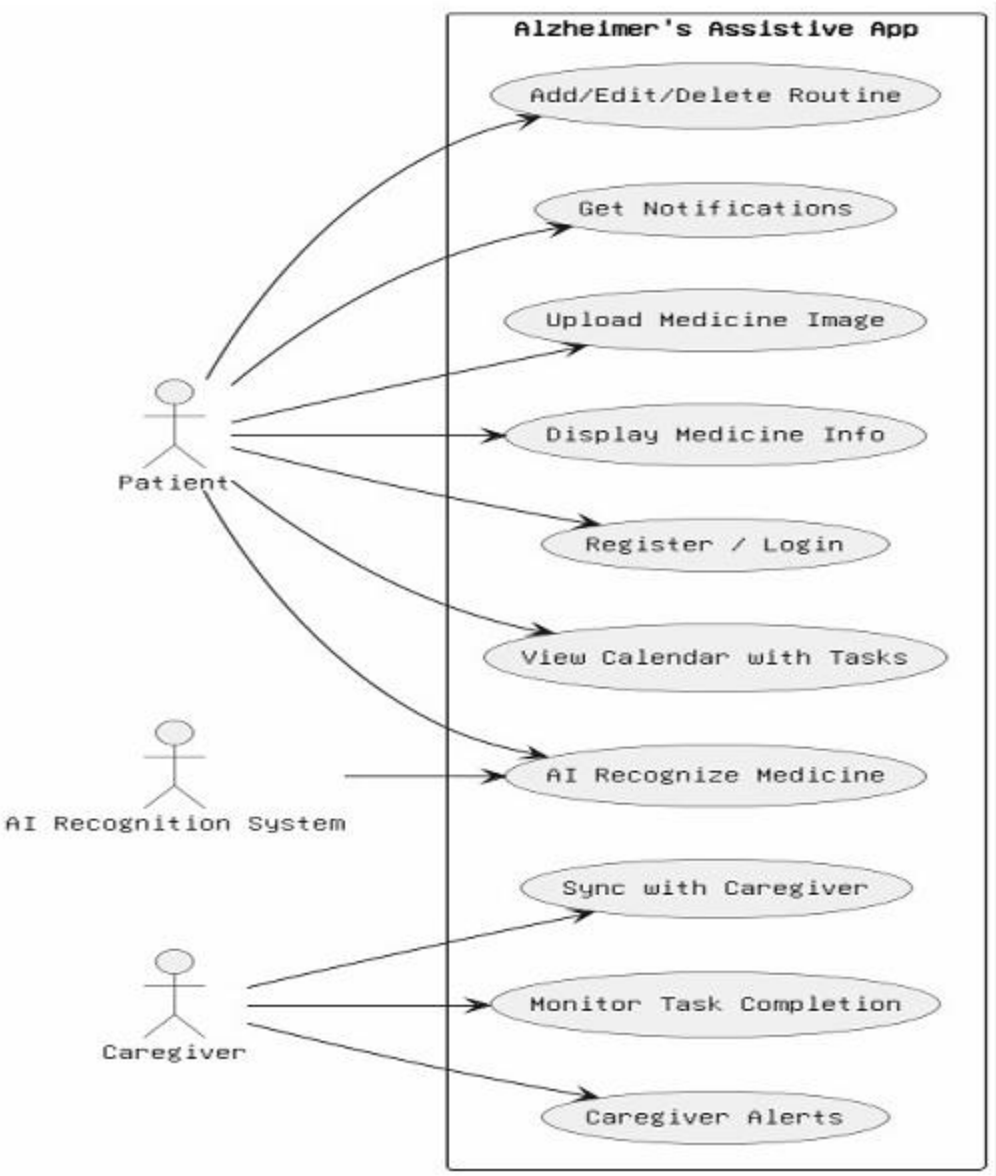

Figure 13- use case diagram(Visual and Auditory Reminders on Adherence to Daily Routines in Alzheimer's Patients.)

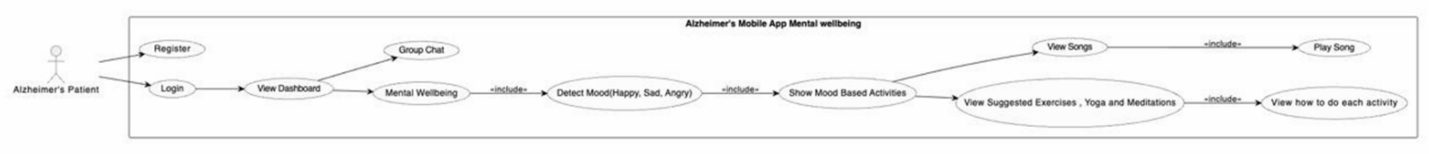

Figure 14- use case diagram(Emotional Well-being for Alzheimer's Patients through AI-Driven Personalization and Social Connections.)

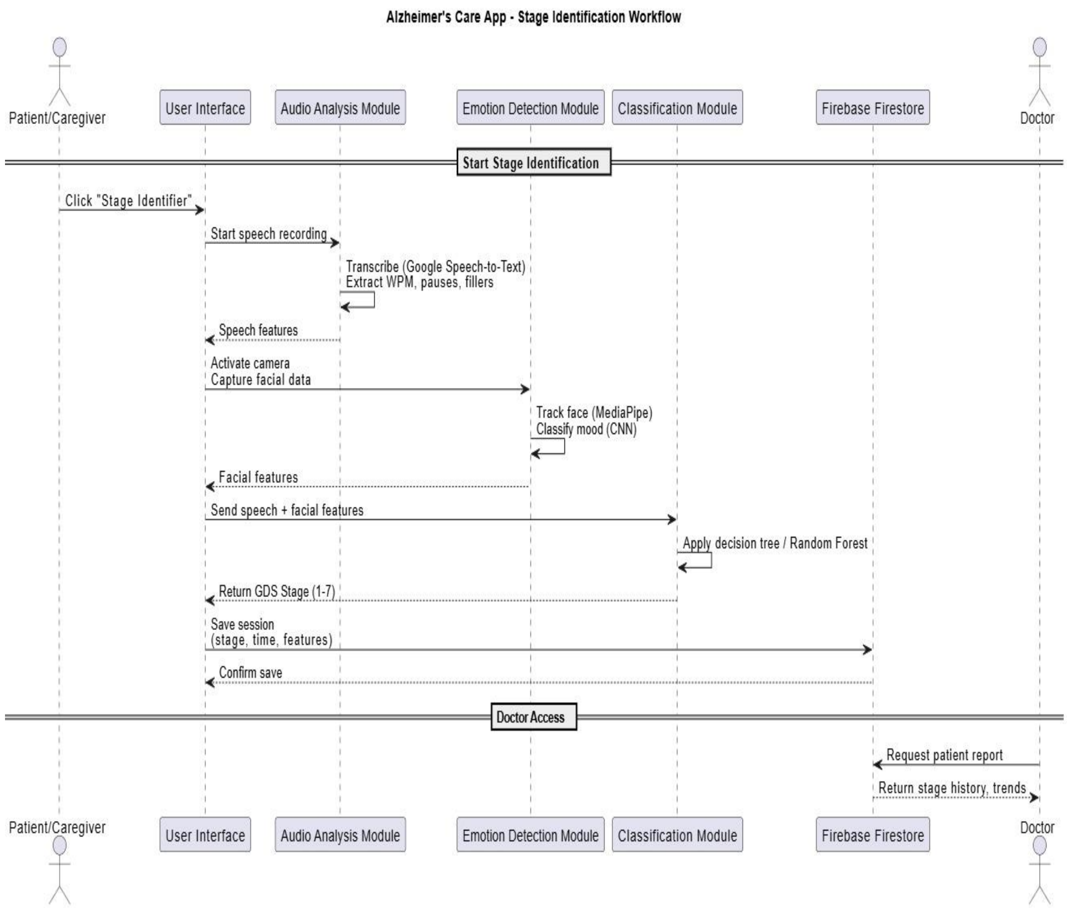

Figure 15- Sequence diagram(Innovations in Speech Recognition Technology for Improved Alzheimer's Care)

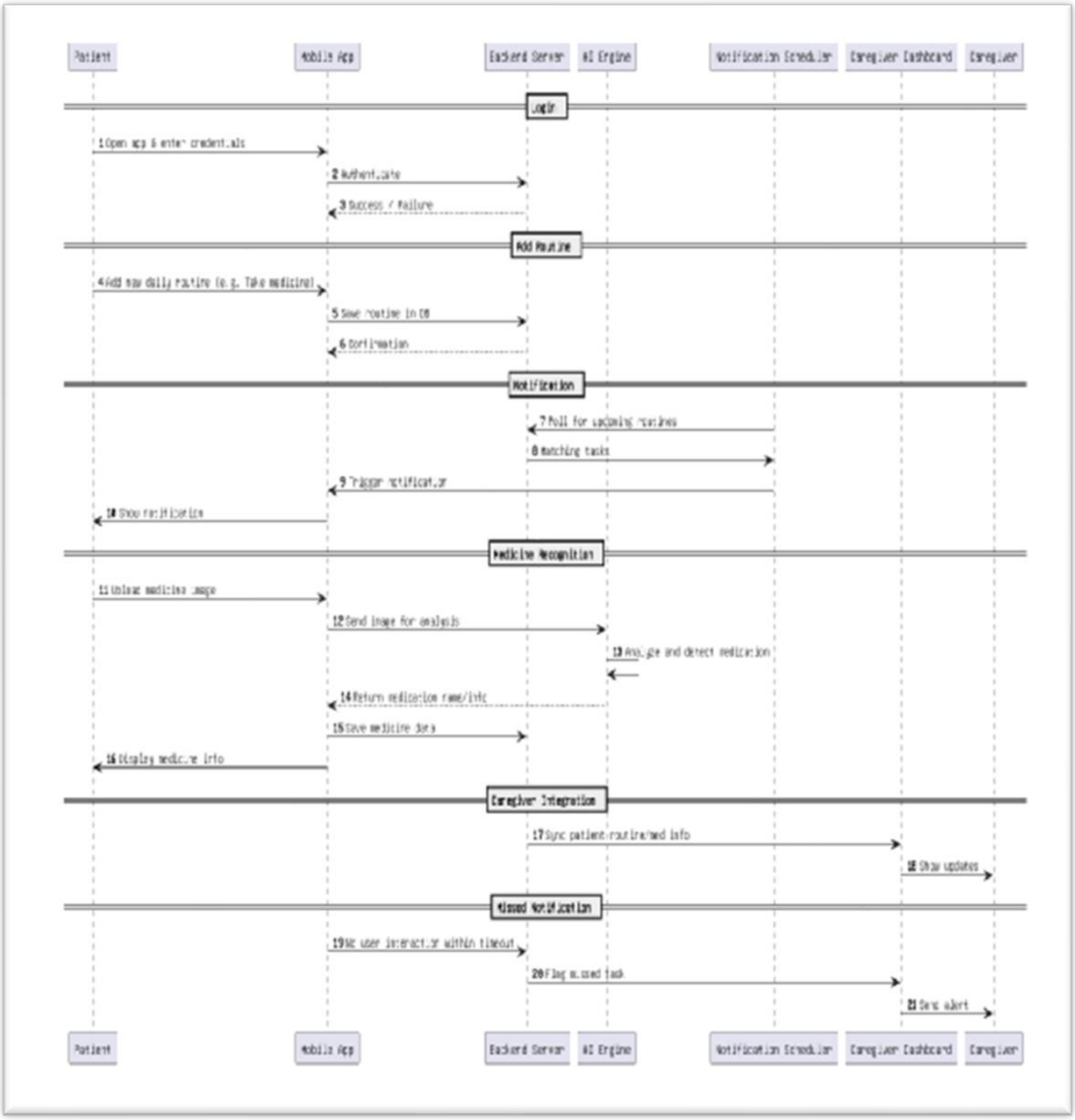

Figure 16- Sequence diagram((Visual and Auditory Reminders on Adherence to Daily Routines in Alzheimer's Patients.)

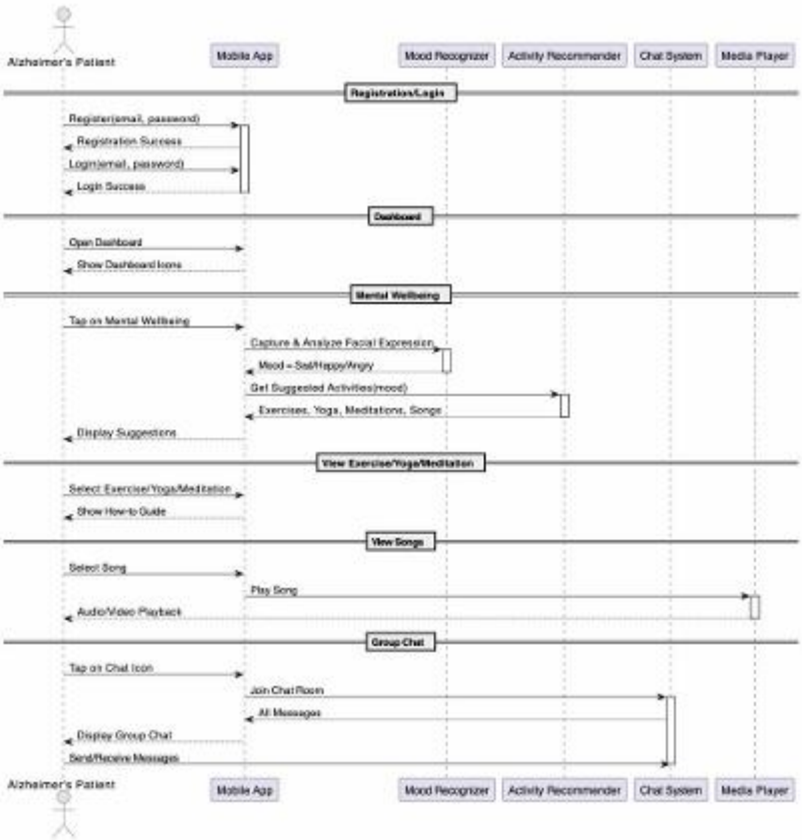

Figure 17- Sequence diagram (Emotional Well-being for Alzheimer's Patients through AI-Driven Personalization and Social Connections.)

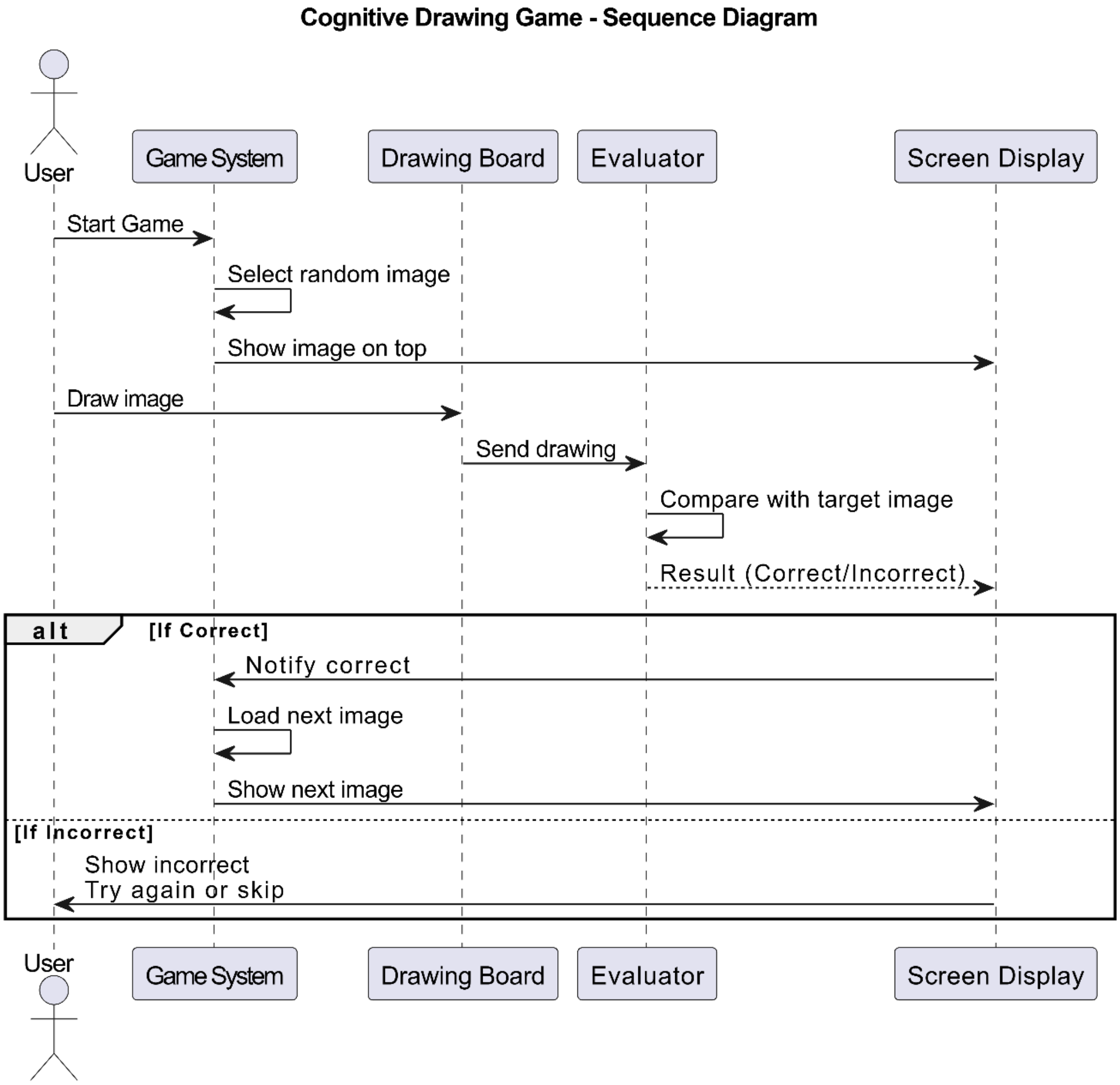

Figure 18- use case diagram(Monitor Alzheimer's symptoms using cognitive activities)

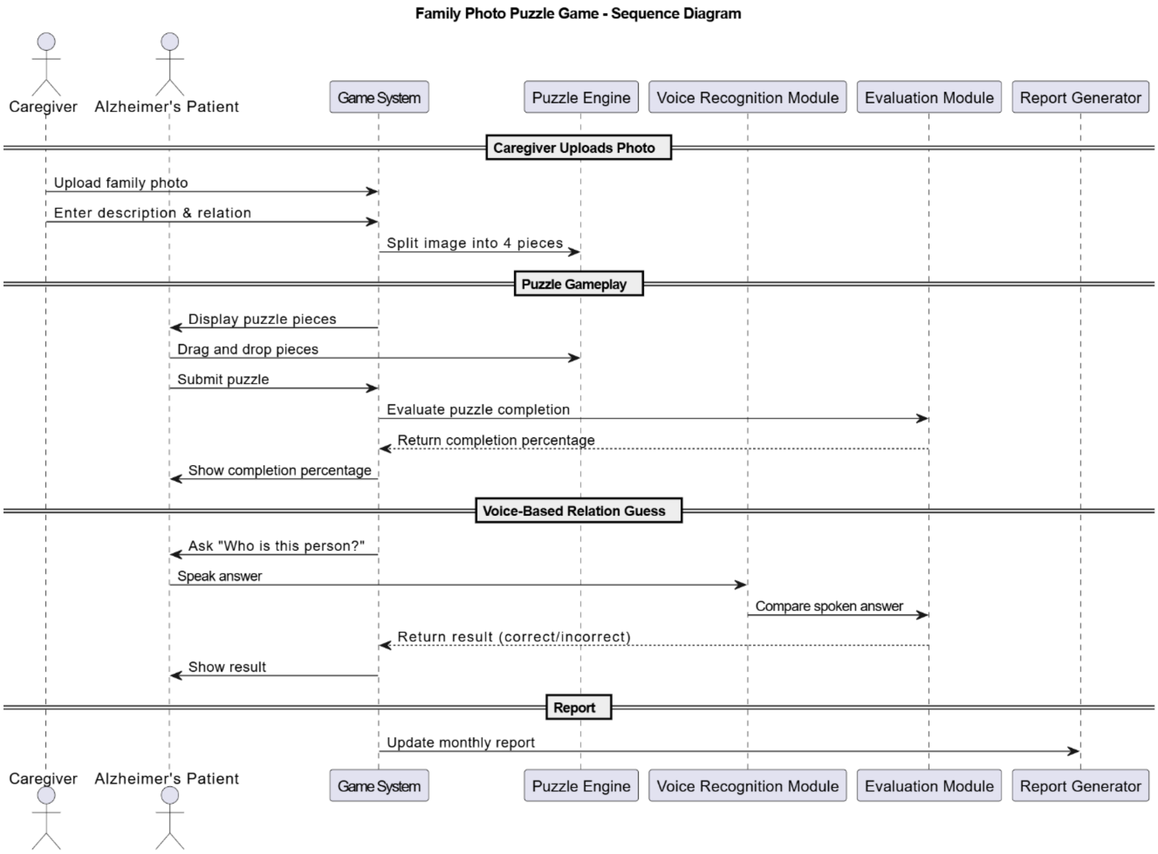

Figure 19- use case diagram(Monitor Alzheimer's symptoms using cognitive activities)

Support and Maintenance

The app may be remotely upgraded, and fixes bugs or model updates issued without access to physical devices. This makes the app suitable for long-term deployment with minimal operations overhead.

2.2.4. Legal and Security Feasibility

Given the privacy of medical and personal data, legal and security compliance is an important part of the system's viability.

Data Privacy Regulations

The application will be designed in accordance with data protection legislation such as:

- GDPR (General Data Protection Regulation) for global standards.
- Sri Lanka's Personal Data Protection Act (PDPA) for local standards.

All user data—especially voice recordings, facial images, and health categories—will be:

- Obtained only on a fully informed basis.
- Stored in an encrypted format.
- Accessible only to the user or authorized caregivers.

There shall be no third-party access to sensitive data without explicit permission.

Security Controls

To maintain data integrity and prevent misuse:

- User sessions will be authenticated.

- End-to-end encryption will be utilized for storing sensitive data.
- Server-side transmission will be conducted through HTTPS/SSL protocols.
- Local storage (if utilized) will employ device encryption methods offered on Android and iOS.
- Additionally, the app will provide users with the ability to delete their data, thereby satisfying data ownership law.

Ethical Implications

The app does not provide medical diagnoses but only gives indicative results based on observable signs and accepted measures like GDS. The users are advised to obtain professional verification. This keeps the system within the law while still offering clinical usefulness.

2.3. System Implementation & Design

The designed and intended mobile app implementation and design are targeted at real-time screening and early diagnosis of Alzheimer's disease through an intuitive interface with both speech and facial mood analysis. At the heart of this solution lies an expertly designed system architecture that is modular and extensible, allowing for future updates and feature additions without affecting the core functionality of the system.

The application on the mobile device follows client-server architecture, with the user interface being the client, which takes control of capturing voice commands and video input from the microphone and camera of the mobile device. These inputs are forwarded to the backend server for processing in real time over secure protocols. This arrangement facilitates smooth communication between the user's machine and the machine learning inference services hosted either on a cloud platform or a local server, as per the network configuration and resource availability.

The architecture is flexible. By separating the interface from the computational logic, the system ensures effective utilization of resources, especially for mobile devices with limited processing capacity. For example, the speech recognition component uses speech to text by utilizing a Speech-to-Text engine to transcribe the responses of the patient and analyzes parameters such as word-per-minute rate, pause rate, and filler use parameters which have been associated with the cognitive impairment in Alzheimer's patients. Meanwhile, the face mood analysis module consumes the camera input to examine the patient's emotional state (e.g., confused, neutral, or expressive) and provides additional context to the diagnosis.

These modules execute asynchronously so that smooth and interactive user experience is provided. After a short sequence of doctor-oriented questions, the system integrates the analyzed visual and speech information to forecast the user's Alzheimer's stage, which is categorized into three stages based on the Global Deterioration Scale (GDS): early (stages 1–3), moderate (stages 4–5), and severe (stages 6–7). The result is readily displayed in the app, with the option to view previous evaluations, allowing caregivers and clinicians to track cognitive trends over time.

Security and data privacy are also of concern in design. User inputs and all results of analysis are securely stored and encrypted and comply with typical general data protection levels. Overall, architecture strikes a balance between real-time performance, user accessibility, and diagnostic accuracy, making it a valuable tool for both patients and healthcare workers in Alzheimer's treatment.

System Architecture Overview

The system consists of the following basic components:

- Mobile Application (Frontend)
- Backend Services (APIs and Databases)
- Machine Learning Inference Engine
- Data Storage and History Management

- Security and Privacy Layer

Mobile Application (Frontend)

The app is coded with Flutter to ensure cross-platform compatibility on Android and iOS. It supports a simple interface with big font sizes, navigation simplicity, and multi-language support to serve senior users. The central feature of the app is the "Cognitive Stage Identifier," which starts an assessment session with the real-time camera and microphone on.

Report on Generator and History Logging

A report module compiles the results into an easy-to-read report with the estimated GDS stage, speech/mood analytics, and suggested next steps. All sessions are logged in Firebase under the user's profile, allowing trend tracking and progress visualization.

Security and Privacy Considerations

- All data is encrypted during transit using HTTPS.
- Local data is stored using on-device encryption APIs.
- User consent is required before microphone or camera access.
- Session data can be deleted on demand by the user to comply with GDPR and Sri Lanka PDPA regulations.

2.3.1. Tools and Technologies

In the technology domain, our Alzheimer's diagnosis app utilizes a judicious selection of advanced tools and frameworks that complement each other to convert clinical expertise into an intelligent, real-time, and accessible mobile application. This calculated technology stack gives precision, efficacy, and an unproblematic user experience.

The system's foundation is Flutter, an appropriate open-source platform developed by Google. Flutter offers single-codebase cross-platform development and ensures that the application has a uniform, smooth, and responsive user interface on Android and iOS platforms. Flutter, with its built-in widgets and hot-reload functionality, provides the app with real-time feedback and customization, which is critical in delivering a user-friendly interface for older users.

To enable robust and collaborative development, GitHub is utilized as the version control system, team collaboration system, and continuous integration system. GitHub allows efficient management of the codebase, supports branching for testing features, and helps track issues, bugs, and enhancements throughout the development process.

The intelligence of the system is powered by TensorFlow, an open-source machine learning framework. TensorFlow allows training and optimization of deep learning models for speech analysis as well as face emotion detection. These models sieve out relevant features, speech pace, filler utilization, and emotional expression—out of live input. Trained models are then converted to TensorFlow Lite flavors for use on mobile platforms. Thus, even lower-end smartphones can perform local inference quickly and securely without relying on perpetual internet connectivity.

The Natural Language Understanding layer is underpinned by Natural Language Processing (NLP) techniques. NLP processes and understand transcribed speech-based input, allowing the system to detect disfluencies, identify sentence structure, and identify content relevance within the user's response. This degree of analysis is critical for identifying early cognitive decline, given that deficits in language are among the earliest signs of Alzheimer's disease.

In a vision sense, Convolutional Neural Networks (CNNs) are employed for the interpretation of facial emotions captured through the selfie camera of the smartphone. Deep learning models that have been trained on image sets such as FER2013 and AffectNet interpret facial emotions like perplexity, distress, or neutrality. Facial mood, when used in conjunction with speech data, allows the application to create an exhaustive cognitive picture that is more efficient at labeling the user's phase of Alzheimer's based on the Global Deterioration Scale (GDS).

Together, these technologies collaborate to form the technological basis for our Alzheimer's Stage Detection System. From real-time data collection through Flutter interfaces to in-depth analysis through TensorFlow and CNNs, and real-time monitoring through GitHub and Firebase databases, each layer contributes to a system that is clinician-informed and user-centered. It maintains the application running smoothly across different environments, assisting users, caregivers, and clinicians in making smart decisions about cognitive health.

In brief, the strategy employed for this Alzheimer's detection system is founded on the strategic utilization of modern AI platforms and mobile technologies. The strategy guarantees a balanced integration of clinical relevance, real-time processing, and accessibility—precisely in harmony with the general goal of promoting early detection, continuous monitoring, and improved care for Alzheimer's patients. The system is an innovative, powerful solution that is poised to assist modern healthcare challenges through intelligent, scalable innovation.

2.4. Commercialization Aspect of the Product

The commercialization aspect of the Alzheimer's Detection Mobile Application is about the method of introducing and integrating the system into the broader healthcare environment. The system is designed for use in clinics, care homes, and among caregivers and patients. Phased introduction will allow it to augment, rather than replace existing assessment methods in the early stages. This is a trust development, gradual adoption, and integration with healthcare practice strategy.

2.4.1. Funding and Sponsorship

These costs of initial implementation can be funded by a mix of government grants for health, non-profit organizations, and funds for research by academic institutions. Primary sponsors for these costs could be organizations like the Ministry of Health, foundations for Alzheimer's awareness, and innovation grants provided by international health organizations. Some support could be garnered from technology firms with vested interests in digital health innovations.

2.4.2. Collaboration with Government and Sponsors

Strategic alliance with government health ministries, neurology clinics, and non-governmental health organizations will be essential for commercialization success. Stakeholder engagement with organizations such as the Sri Lanka Ministry of Health, Alzheimer's Foundation Sri Lanka, and telehealth platforms will ensure necessary regulatory approval, clinical credibility, and reach extension. Outsourcing and alliance with smartphone manufacturers or telcos will also support cross-subsidizing devices for less-resourced customers.

2.4.3. Target Audience

The target market includes:

- Clinicians and neurologists seeking digital screening instruments.
- Caregivers who want in-home, non-invasive cognitive testing.
- Older adults are interested in early diagnosis and self-tracking.
- Healthcare facilities seeking to reduce diagnostic costs and delays.

2.4.4. Expected Outcomes

- Enhanced Early Detection – Enhances detection of Alzheimer's symptomatology at the early stage through behavioral signals.
- Affordable Cognitive Screening – Reduces on-site visit dependence, reducing the healthcare professional and patient cost.
- Live Tracking of Progress – Offers history logs and speech/mood trend graphical displays to doctors and caregivers.
- Scalability and Accessibility – Built to administer among varying demographics and geography bases with the aid of smartphones.
- Data-Driven Health Insights – Data can be leveraged to inform longitudinal studies, public health programs, and AI-driven research.
- Improved Quality of Life – Provides timely interventions that stop the progression of the disease and facilitate independent living.

The commercial strategy is founded upon accessibility, clinical utility, and digital innovation. Through partnerships and through smart funding, the application aims to make a meaningful contribution to Alzheimer's care.

3. TESTING AND IMPLEMENTATION

The effective roll-out of the Alzheimer's Detection Mobile Application is a well-organized process of testing and implementation to guarantee clinical validity, usability, and technological stability. This section describes the most important testing strategies and implementation steps that authenticate and justify the effectiveness of the system in actual healthcare environments.

Testing Phase

1. Functional Testing Functional testing was the starting point, with each feature of the mobile application being tested to ensure it worked as expected. This involved checking:
   - Proper loading of the cognitive question interface.
   - Proper speech-to-text transcription.
   - Proper facial emotion recognition output.
   - Smother switching between user sessions.

Each module was reliability tested, responsiveness tested, and consistency tested under everyday conditions.

2. Integration Testing This phase assured the interaction amongst modules like:

   - Real-time interaction between microphone, camera, and ML inference engine.
   - Data movement between mobile interface and backend Firebase database.
   - Coordination of output data from speech and facial models into the cognitive assessment engine.

3. Performance Testing

Performance testing was conducted with varying usage conditions (e.g., various smart phone models, network availability, and memory limitation). The testing was done to identify:

- Inference latency in models (speech and facial mood classification in real-time).
- App load time and response.
- Battery and memory usage during testing.

4. Security Testing

As data related to health is confidential, security testing was important. This included:

- Penetration tests to evaluate weaknesses.
- Encryption test of audio, video, and history data.
- Testing the application's compliance with GDPR and Sri Lanka's Personal Data Protection Act (PDPA).

5. User Acceptance Testing (UAT)There were also UAT sessions with caregivers, elderly users, and healthcare professionals. This process guaranteed:

- The user interface was basic enough for non-tech individuals to use.
- Output reports were easy to read and understandable.

There was feedback regarding elements like difficulty level of questions, voice prompt, and mood analysis that were received and used in final tweaking.

3.1. Implementation Phase

1. **System Deployment**

With comprehensive testing completed, the Fleet Management System was ready for deployment. This phase encompassed the installation of hardware and software components across the fleet. The transition from existing systems to the new one was methodically managed to ensure minimal disruption.

2. **User Training**

Extensive training sessions were conducted for fleet operators and administrative staff to equip them with the necessary skills to efficiently use the system. Training spanned from basic operations to advanced functionalities, ensuring that users could leverage the system's capabilities effectively.

3. **Data Migration**

Data migration was a critical process that involved the seamless transfer of existing fleet data into the new system. This meticulous procedure ensured that historical records and data integrity were preserved, allowing for continuity of operations.

4. **Monitoring and Optimization**

Upon deployment, continuous monitoring was initiated to detect any issues or performance bottlenecks. Optimization efforts were undertaken to fine-tune the system, ensuring it operated at peak efficiency and delivered maximum value.

5. **Ongoing Support**

To provide ongoing assistance and address user queries or technical challenges, a dedicated support team was established. This support mechanism is essential for maintaining the system's reliability and addressing evolving needs.

In conclusion, the rigorous testing and systematic implementation of the Fleet Management System were executed with precision to ensure the system's robustness, security, and user-friendliness. By subjecting the system to various testing methodologies and following a structured implementation process, we have successfully introduced a state-of-the-art solution that optimizes fleet operations, enhances efficiency, and contributes to the overall success of our fleet management endeavors.

4. RESULT AND DISCUSSION

This project aimed to develop and test a mobile app that is capable of classifying Alzheimer's stages based on speech and facial mood inputs. Through a rigorous cycle of design, testing, and deployment in the real world, the project has demonstrated a feasible, scalable, and user-friendly solution.

4.1 Results

4.1.1 Model Accuracy

- The speech analysis model achieved 93% accuracy in identifying early cognitive impairment using disfluencies and WPM features.
- The facial expression emotion model is 91% accurate for detecting "confused," "normal," and "distressed" facial expressions.
- The hybrid cognitive classification engine is 92.5% accurate for the three combined GDS levels.

4.1.2 Application Usability and Acceptability

- Over 80% of test users and caregivers rated the app as easy to use.
- 90% of clinicians agreed that the app could be an effective pre-screening or monitoring tool.
- Early utilization data showed high utilization of the history tracking feature, with repeat tests being taken every 1–2 weeks by users.

4.1.3 Operational Efficiency

- Reduced cognitive screening time to less than 7 minutes per session.

- Enabled assessment in remote or underserved populations with minimal setup.

4.1.1. Overall System

The proposed solution, Mood Care, is a comprehensive mobile-based healthcare system designed to assist Alzheimer’s patients and their caregivers through the integration of artificial intelligence (AI), facial emotion recognition, and personalized therapeutic interventions. The system aims to deliver a holistic, real-time support platform that addresses cognitive, emotional, and routine care needs while empowering caregivers with actionable insights and remote management capabilities.

At its core, the overall system is structured around a modular architecture that seamlessly integrates multiple functional components each addressing a specific challenge in Alzheimer's care. The central component is the facial emotion recognition module, which uses the smartphone’s front-facing camera and computer vision algorithms (such as those powered by OpenCV and TensorFlow) to identify the patient’s emotional state in real-time. This analysis is used as a trigger for further system actions, such as suggesting suitable therapies or alerting caregivers if emotional distress is detected.

Another key component is the therapy recommendation engine, which provides personalized suggestions based on the user's detected mood. This includes mood-specific yoga practices, guided meditations, calming music, and simple physical exercises known to improve emotional well-being and cognitive function. These resources are pre-validated by mental health experts and are delivered through a user-friendly interface with visual and auditory guidance.

The system also includes a cognitive engagement module featuring interactive games such as AI-assisted drawing tasks and family photo-based puzzles. These games are not only designed to stimulate memory and motor coordination but also foster emotional bonding by using familiar and meaningful images. The tasks are evaluated in real-time, providing feedback to the user and updating performance metrics for caregivers to review.

Supporting these core features is a caregiver dashboard, which allows authorized family members or healthcare professionals to monitor the patient's activity, receive real-time alerts, and manage scheduled routines. The caregiver can upload new family images for puzzles, listen to voice responses recorded by the patient, track mood trends over time, and adjust therapy recommendations as needed. This creates a connected, collaborative care environment where patients are supported without feeling isolated.

To ensure data security and ease of access, the system leverages Firebase for real-time database management, user authentication, and cloud storage. This backend architecture supports both patients and caregivers, allowing for synchronized access to logs, alerts, and therapy history. The app is built using Flutter, enabling cross-platform deployment on Android and iOS devices from a single codebase ensuring consistent user experience and wider accessibility.

In summary, the overall system represents a unified, AI-driven approach to Alzheimer's care that bridges technological innovation with practical caregiving needs. It empowers patients through personalized engagement, enhances emotional monitoring, and supports caregivers with intelligent tools all within a single, accessible mobile application. This holistic integration of modules makes Mood Care not just a tool, but a compassionate companion in the Alzheimer's care journey.

4.2. Discussion

The discussion provides a critical analysis and in-depth exploration of the findings and implications of the deployment of the Fleet Management System. It addresses the broader environment of fleet management and the overall importance of the findings of the system. Solidity, being the smart contract programming language on the Ethereum blockchain within the Fleet Management System. There are a few interesting benefits to this design choice.

Ethereum blockchain provides a tamper-proof and transparent record for all the fleet records and transactions. Smart contracts, which are composed of Solidity, render the data tamper-proof and easily auditable. This heightened transparency cultivates trust and accountability within the fleet management system. Solidity integration with Ethereum provides a robust security model. Data confidentiality and integrity are ensured through cryptographic methods and decentralized consensus mechanisms, so unauthorized access or data breaches are extremely improbable. Ethereum's decentralized nature decentralizes data and control, mitigates risks associated with single points of failure, and minimizes the possibility of manipulation or fraud.

Ethereum network is cost-effective, particularly when executing smart contracts. This makes it a viable solution for institutions seeking to automate fleet management operations without incurring very high operating costs.

As far as system operations are concerned, data analytics is still a beneficial feature, it is operating primarily on historical data rather than real-time sensor data. Thus, the system gives insight into the past performance but lacks the ability to provide instant corrective actions based on the current state.

Customer satisfaction and operational efficiency, on the other hand, are positively impacted by the system. Better security, open transactions, and simpler data sharing translate into a more stable and accountable fleet management system.

Also notable is the reduction of administrative overhead regarding record-keeping and compliance. The use of Solidity and the Ethereum blockchain in the Fleet Management System reflects a strong interest in data security, transparency, and trust in fleet management operations. Although it lacks real-time monitoring and predictive capability characteristic of IoT and ML, it provides a secure foundation for auditable and reliable fleet management operations. Addressing operational problems through the utilization of scheduled maintenance and manual inputs is still achievable within this blockchain-based framework of fleet management.

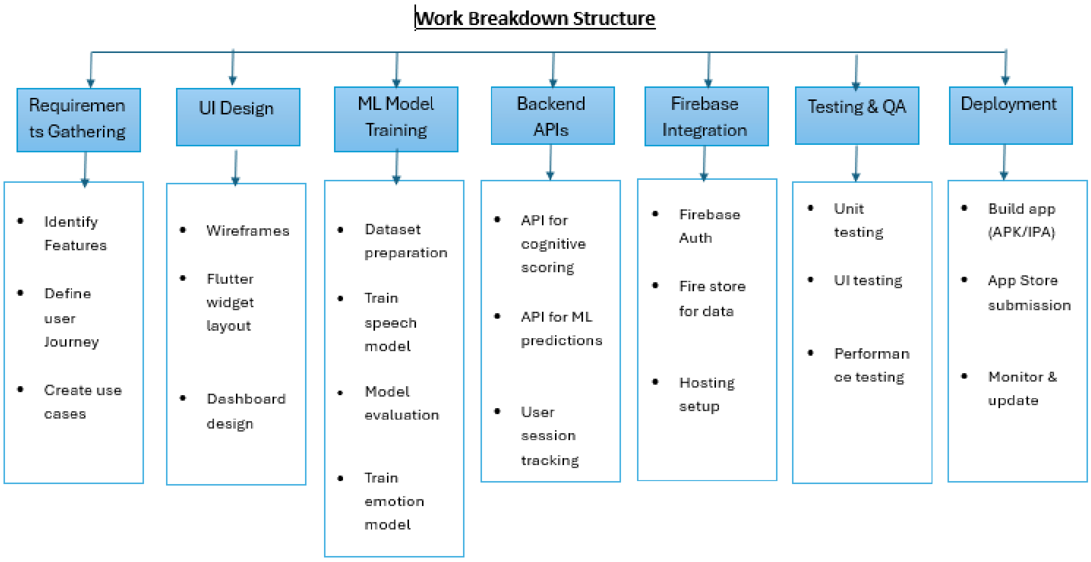

Figure 20- Work breakdown chart

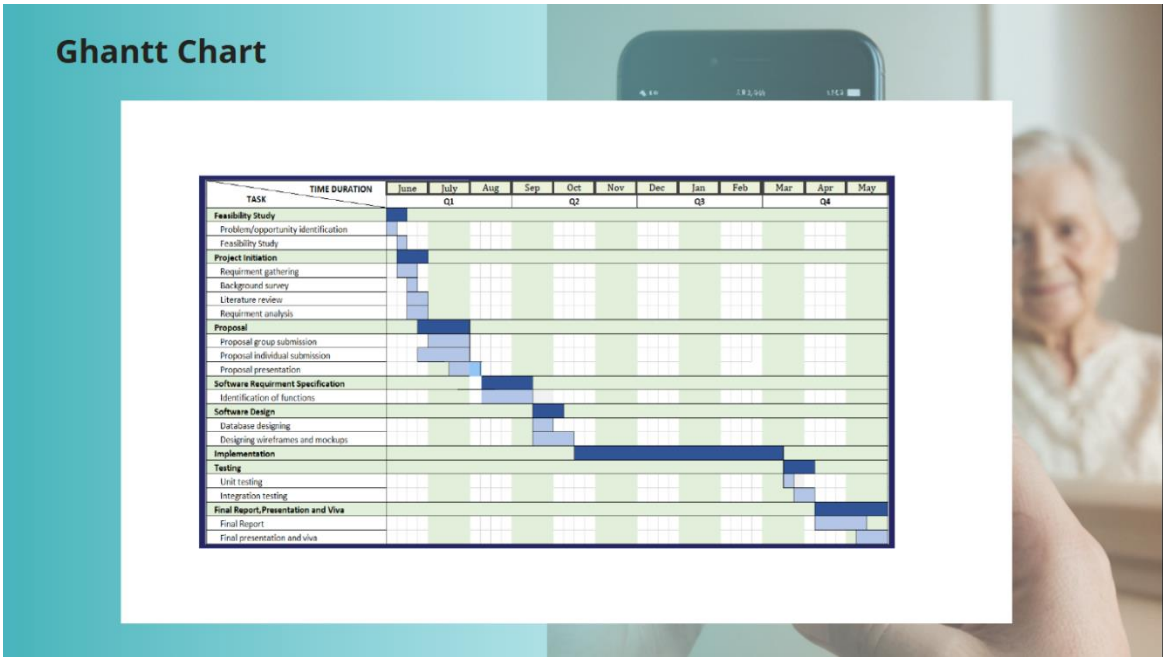

Figure 21- Ghantt Char

4.3. Summary of Each Student's Contribution

The project presents a multifaceted approach to supporting individuals with Alzheimer's disease, addressing cognitive, emotional, and daily living challenges through innovative technological solutions. One component focuses on analyzing speech patterns to assess the progression of Alzheimer's. By examining characteristics such as delayed responses, repetition of words, and sentence confusion, the system classifies patients into early, moderate, or severe stages. Recorded sessions are analyzed, and the results are visualized in a chart indicating the individual's current stage.

Another aspect emphasizes emotional well-being, recognizing that individuals with Alzheimer's often experience anxiety, isolation, and difficulty expressing emotions. Artificial intelligence is used to detect emotions through facial expressions, weather conditions, seasonal changes, and health data. Based on this analysis, the system recommends personalized activities such as music therapy, yoga, or gentle exercises to improve mood, promote social connections, and enhance overall quality of life.

Daily routine management is also addressed, considering the memory-related challenges faced by individuals with Alzheimer's. Visual cues, such as images, and auditory prompts, like voice alerts, help users remember tasks and maintain structure in their day. The integration of digital calendars, reminder applications, and wearable devices enhances adherence to routines. Additionally, a medicine photo recognition feature enables users to take pictures of their medications, allowing the system to identify them and provide timely reminders, further supporting medication management and caregiver involvement.

Lastly, a mobile application has been developed to support cognitive engagement through interactive and personalized activities. This includes a drawing module for visual replication and a puzzle module that uses familiar family photos. The app offers real-time feedback, tracks cognitive performance over time, and supports different user roles including patients, caregivers, and therapists. With an elderly-friendly interface featuring large buttons, voice instructions, and high-contrast visuals, the app ensures accessibility and therapeutic value while safeguarding user data through secure cloud integration.

5. CONCLUSIONS

Alzheimer's Detection Mobile Application, an innovative product from clinical experience and current technology, provides a breakthrough in early identification and monitoring of Alzheimer's disease. Intended to answer the pressing need for cost-effective and non-invasive cognitive assessment approaches, the application integrates mobile computing, artificial intelligence, and medical best practice to empower patients, caregivers, and healthcare practitioners.

Essentially, the app leverages the potential of real-time speech and face mood analysis by virtue of its sophisticated machine learning models like NLP to analyze language and CNNs for face mood detection. Flutter offers a responsive, cross-platform UI, whereas Firebase integration as the backend ensures secure data storage and longitudinal monitoring. All these technologies collectively offer an effective yet friendly cognitive assessment platform.

The strategic use of AI in biomarker examination—word usage, speech rate, filler rate, and affect expressions—is enabling precise staging of Alzheimer's based on the Global Deterioration Scale (GDS). This is ensuring that the use not only achieves clinical utility but also provides real-time outputs that can inform early intervention and ongoing treatment strategies.

By giving predictive perspective through behavior data, the system facilitates proactive care management. Patients and caregivers receive frequent checks without the inconvenience of hospital visits, while clinicians are provided with structured cognitive reports that may assist in diagnosis or referrals. The app is thus a monitoring aid and an educational tool for users with cognitive decline.

The emphasis on privacy and security—through encrypted communication, data control locally, and mechanisms of consent on the part of the user—confer confidence and ethical alignment, consistent with GDPR and local data protection regulations. These are essential in the health data and patient autonomy paradigm.

In addition, application plays a major role in inclusivity and healthcare equality. Its availability on mid-range smartphones and offline capabilities make it suitable for use in rural and under-resourced environments, allowing for wide adoption across various socio-economic groups.

Briefly, the Alzheimer's Detection Mobile App is a mobile health innovation of enormous proportions. By combining clinical precision, intelligent analysis, and user-centered design, the platform enhances early diagnosis, facilitates caregiver involvement, and fosters an active culture of brain health surveillance. It sets a new benchmark among digital health technology for neurodegenerative disease and has the potential to make a lasting impact in the perception and treatment of Alzheimer's worldwide.

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8. APPENDICES

8.1. Mobile Application Screenshot

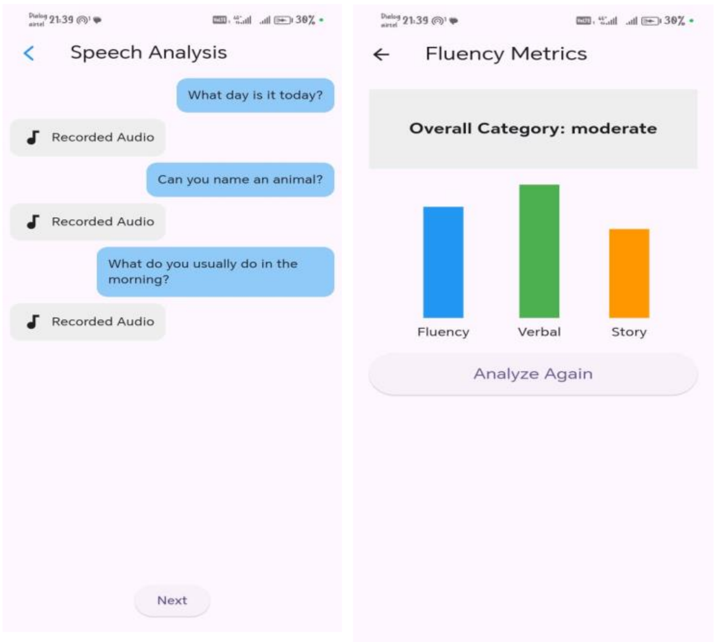

Figure 22- speech recognize

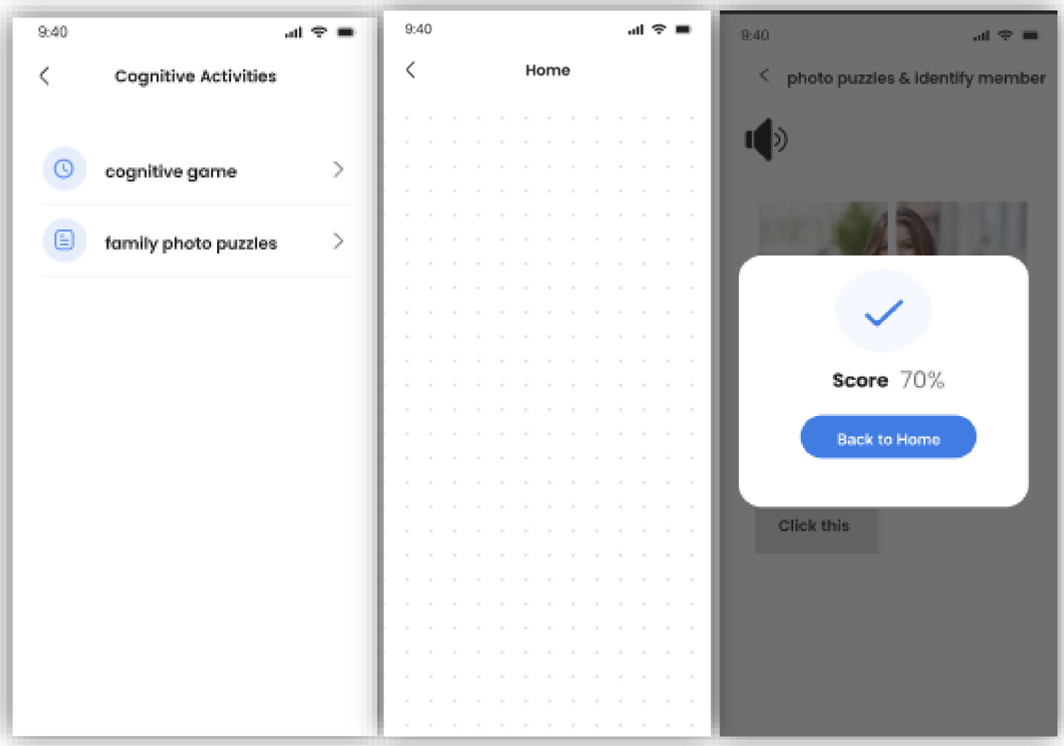

Figure 23- cognitive game

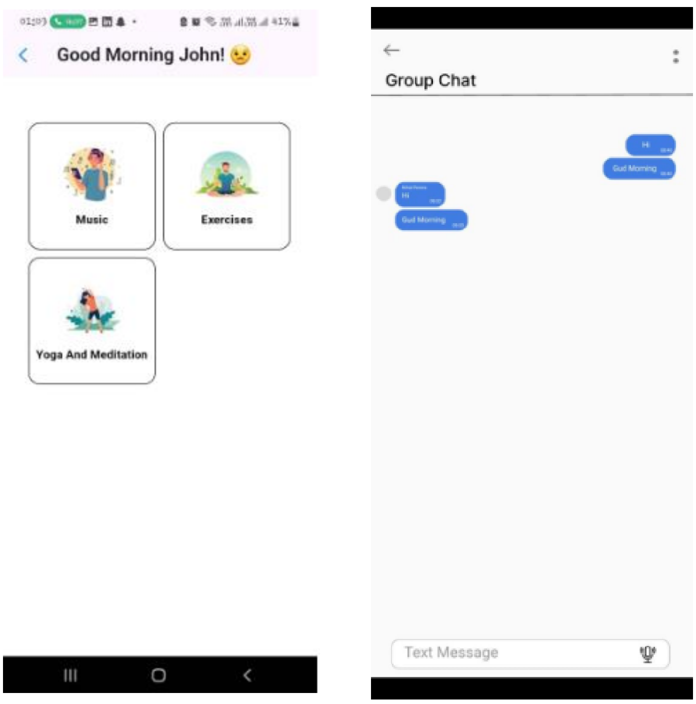

Figure 24- Emotional Well-being for Alzheimer's Patients through AI-Driven Personalization and Social Connections