AI base Alzheimer's care and Cognitive Support Mobile App

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Research Final Report

Jayacody Arachchige Ashen Madhusanka – IT21215292

B.Sc. (Hons) Degree in Information Technology specialized in

Software Engineering

Department of Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

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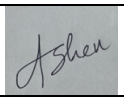
DECLARATION

I declare that this is my own work, and this proposal 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.

Group Member Name	**Student ID**	**Signature**
Madhusanka J.A.A	IT21215292	

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

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Ms. Uthpala Samarakoon Date
(Supervisor)

ABSTRACT

The cognitive impairment of Alzheimer's disease makes patients experience extreme memory failure that prevents them from performing daily tasks including prescription intake and medical attendance and basic maintenance work. The deterioration causes both patients and their caregivers to experience anxiety and confusion and a diminished patient ability to care for themselves which leads to frustration. When Alzheimer's disease develops further the healthcare load and care commitment of patients' families and medical personnel increases so research must develop efficient systematic help solutions for maintaining stability and independence of those with Alzheimer's disease.

A detailed assistive system featuring visual along with auditory alerts should be built according to this research to help Alzheimer’s patients complete their everyday responsibilities successfully. The assistive system implements a user-oriented methodology to develop its features by integrating modern devices such as mobile applications, digital calendars along with AI alerts and wearable technology to encourage users in following their daily schedules. Users can customize their reminders by choosing voices they recognize or symbols and sounds with a low volume because these features help reduce uncertainty while improving their ability to remember tasks.

The system includes a photo recognition component which stands out as its most inventive feature among all its capabilities. The system enables users or their caretakers to photograph medications so its machine learning and image processing algorithms automatically identify them. Through this feature the system generates automatic medication reminder alerts that track prescription usage while ensuring crucial medications will not be omitted. This feature minimizes the risk of medication mishandling that frequently affects individuals with Alzheimer’s disease.

The system includes a convenient feature that enables remote access for caregivers to collaborate with patients through their platform. Caregivers and healthcare professionals can review the patient's schedule while receiving task alerts and updating individual routines with remote system access. The

remote interface function supports both the delivery of dependable care and decreases the typical challenges faced by caregivers who provide remote care.

The research aims to determine how well a multisensory intelligent support platform improves patient routine adherence along with daily confusion reduction which leads to better life quality for Alzheimer patients and their care providers. The system supports independent living and proper treatment provision through timely assistance along with cognitive load reduction that enables patients to receive necessary care.

Keywords: Routine Adherence, Visual and Auditory Reminders, Memory Aids, Medication Recognition Technology

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Abbreviation	Description
AD	Alzheimer's Disease
ICT	Information and Communication Technology
UI	User Interface
UX	User Experience
AI	Artificial Intelligence
ML	Machine Learning
MR	Memory Recall
VAP	Visual and Auditory Prompt
RPM	Routine Planning and Management
HCI	Human-Computer Interaction
CDSS	Clinical Decision Support System
IoT	Internet of Things
QoL	Quality of Life

1. INTRODUCTION

1.1 Background & Literature Survey

The progressive disorder of Alzheimer's disease damages memory abilities along with cognitive functions as well as daily practical tasks. Alzheimer's disease remains among the most widespread dementia varieties worldwide and targets an estimated seven million individuals based on WHO statistics. AD produces extensive consequences that directly affect those who have it and their families besides healthcare providers through emotional strain and monetary and logistical challenges. When suffering from the disease patients confront both memory failures along with behavioral variations and problems in expression and judgment capacity. Patients with Alzheimer's experience the most destructive element of their condition through their failure to stick to proper daily schedules including their prescribed medication routes and their appointment timetables and their hygiene activities together with their social interactions. Forward stages of the illness lead to more severe complications which cause greater confusion as well as hospitalizations and quick declines in mental capabilities and physical functions. Many patients surrender their independence and develop elevated dependency on caregivers because of Alzheimer’s disease which leads caregivers to experience stress and burnout together with emotional exhaustion. Enhancing routine adherence in Alzheimer’s patients represents a fundamental aspect of care that directly enhances patient life quality while lessening the weight caregivers experience.

The establishment of organized routines stands as an absolute necessity for patients who have Alzheimer’s disease. The regular practices of patients establish familiar patterns which minimize their anxiety levels while creating mental structures that enable basic functioning in the face of their cognitive decline. AD’s gradual progression makes it progressively difficult for patients to remember fundamental tasks. Remembering to do things through verbal and written messages proves ineffective because patients suffer from memory loss. The progression of AD makes caregiver intervention necessary which results in both increased logistical duties and heightened emotional burden for them. The present time calls for technological approaches which provide customized assistance to Alzheimer's patients through accessible intelligent systems that enable independent daily functioning alongside supporting caregivers in their roles

Breakthroughs in better solutions regarding this issue become possible through Information and Communication Technologies (ICT) and its components such as artificial intelligence (AI) machine learning (ML) deep learning (DL) along with wearable devices and mobile applications. Various research studies in the assistive technology domain demonstrate that patients suffering from memory difficulties can obtain supportive assistance through digital calendars paired with reminder applications as well as wearable sensors. Advanced technology systems help patients follow their tasks and supply medication alerts in addition to linking healthcare receivers to providers through communication networks. Digital memory aids that exist today do not adequately serve Alzheimer's patients with their cognitive needs since these devices either have complex interfaces or lack essential support features. Research demonstrates that the combination of multiple sensory alert mechanisms produces superior effects but most current operational systems only display single sensory alerts. Cognitive disabilities demand systems to transmit information through multiple communication channels at once because this improvement leads to better user performance. Studies conducted within the field of Human-Computer Interaction prove dual-sensory systems featuring auditory instructions with visual notifications generate better outcomes for patients' memory retention and generate higher system engagement as well as performance improvements for individuals with cognitive limitation.

Lim et al. (2019) established through research that Alzheimer's patients achieved better memory recall when they received voice-based reminders from family members than from robotic or unknown sources. The familiarity connection between voices and memories created better memorization and triggered stronger responses in patient behaviors. Visual aids which incorporated images of familiar faces together with recognizable places along with medication pictures offered crucial contextual information that resulted in better understanding and performance of tasks. Science demonstrates how integrated auditory and visual elements produce better adherence results for daily practices with Alzheimer’s patients. The accessibility requirements must be included in designing this system. The user interfaces should remain basic yet user-friendly because these characteristics correspond with the emotional needs of a specific audience. The use of complex navigational systems together with confusing layout structures or enigmatic options makes AD-required technology unworkable for those with Alzheimer's disease.

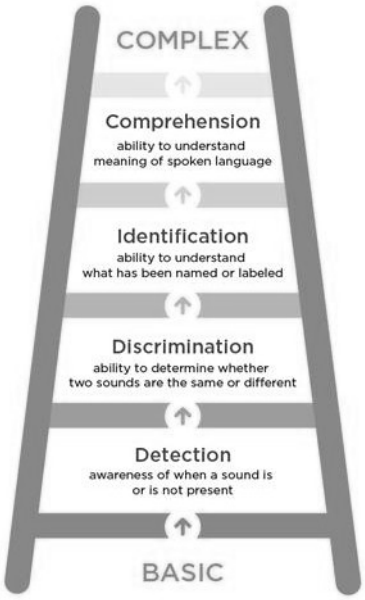

Figure 1.1 The Listening Ladder - Auditory Skills Checklist [8]

For those suffering from Alzheimer's, routine is essential. An organised routine lowers anxiety, fosters a sense of familiarity, and enhances general quality of life (QoL). However, patients in AD find it difficult to remember even the most basic tasks because of the increasing nature of their memory loss and disorientation. Verbal instructions or traditional paper-based reminders are frequently insufficient. Additionally, carer intervention is often required, adding to the logistical and emotional strain on families and healthcare professionals.

This research develops an extensive assistive digital system dedicated to care for Alzheimer's patients. Visual and auditory notification features together with intelligent capabilities including medicine photo recognition and routine management help users through the system and allow remote caregiver tracking. The central feature of this system enables the delivery of personalized prompts that users access through smartphones and representations of all three primary categories of mobile devices and wearable tech including smartwatches. The prompts activated by this system avoid ordinary alarms because they utilize familiar images and personal voices to create a touching and mental assistance experience. The medication reminder system presents to users both a pill image and an audio message from their loved one that reads "Take your morning medication now." The approach decrease patient confusion and improves medication compliance levels while providing emotional comfort through its implementation.

AI-powered medication recognition functions as a system feature which tackles the essential problem of medication adherence in Alzheimer's care. The combination of multiple medications at different dose levels and administration times presents dangerous management challenges to patients. The system allows photo insertion from users or caregivers of medicines or medications which then processes the data through deep learning models that identify the correct medication from large pharmaceutical databases. The system connects the identified medication to scheduling remnant functions and displays visual verification to avoid dosage errors or missed medications. The system plays a vital role because inadequate medication management practices produce adverse drug effects and clinical emergencies that might result in death.

The available commercial solutions include MedSnap and Pill Identifier which deliver comparable functions yet fail to accommodate users who have cognitive disabilities. The systems present difficulties in simple use and do not have intuitive interfaces along with insufficient reminder methods. The introduced system integrates medicine recognition capabilities into the same framework that handles everyday activities to provide an entire solution platform which combines simplicity with feature strength. The system enables caregivers to join in the program actively. Caregivers rely on a protected dashboard to monitor patient tasks with instant alert notifications when activities are missed while implementing real-time routine adjustments from the dashboard. By monitoring from a distance the system allows caregivers to enhance their assistance while decreasing their physical responsibility which reduces their emotional and logistical burden.

The use of voice assistants together with NLP (Natural Language Processing) technology receives additional attention in related studies because it improves elderly user interaction. Patients using voice-activated controls can interact with the system without needing to navigate menus or type because the system accepts spoken instructions. Through NLP-based voice assistance patients can carry out simple spoken commands which lead to them adding new tasks to their schedule and receiving information about their daily routine and verifying their medication intake. One holistic system can be developed by integrating these technologies which adapts its support while users change their needs throughout time.

The successful implementation of such systems depends on social-cultural modifications. High-income nations develop most assistive technologies but these products generally do not fit appropriately or accommodate users in low- and middle-income regions. This study establishes its deployment within the Sri Lankan healthcare system by considering both its local language needs as well as healthcare facilities and cultural practices. Proper localization remains essential for obtaining patient adoption and sustained effectiveness because non-English speaking patients need tools that understand local healthcare practices. User acceptance together with caregiver endorsement becomes likely when the system incorporates personalized approaches which maintain cultural sensitivity.

A full solution for dealing with cognitive decline along with memory loss and disrupted routines in Alzheimer's disease exceeds both traditional caregiving and single-feature technological interventions. The proposed solution integrates visual and auditory alerts with personalized content delivery and real-time caregiver backing as well as medication identification for its foundation. A system review process reveals usability and effectiveness deficits so a patient-specific design method fills the identified gaps. The proposed research addresses real-life challenges in medication following and care scheduling as well as remote tracking and implements state-of-the-art AI and NLP systems to achieve significant advancements in Alzheimer's care. This work provides quick solutions for essential needs while promoting developments of customized assistive technology through future advancements. The proposed system aims to recover dignity and diminish confusion and improve life quality of Alzheimer's patients at the same time as it supports caregivers and health systems.

1.2 Research Gap

Multiple assistive technologies designed to help Alzheimer's patients show serious weaknesses because they do not provide complete adaptive solutions according to a critical assessment. Researchers have developed multiple applications and studies to support memory functions while assisting users with scheduling along with caregiver duties. These solutions demonstrate frequent shortcomings when it comes to delivering important capabilities which Alzheimer's patients need to tackle practical and cognitive challenges. The systems also exhibit limited capability to accommodate diverse patient actions and fail to engage caregivers effectively and do not provide essential sensory stimulation. The proposed research fills an important gap by developing an intuitive support system for Alzheimer's patients which combines real-time alerts with medicine

photo recognition functionality and caregiver interfaces in addition to memory aids and dual sensory prompting mechanisms.

Research A [12] introduces a supportive digital system that focuses on elderly care according to the research. The system's well-meaning design shows various operational weaknesses which prevent effective interaction with the complex requirements of Alzheimer's patients. The lack of a medicine photo recognition feature in this system constitutes an essential flaw because dementia patients face frequent problems with medication identification resulting from their cognitive disabilities. Users possess usage benefits from medicine photo recognition technology because they can visually confirm their pills before taking them through a process that decreases mistakes from medication errors that affect elderly patients with brain impairment issues. Real-time activation of notification prompts is not possible through the system because its notification mechanism is defective. Users do not receive timely alert notifications since the system delivers its alerts either statically or with delays. The fundamental objective of assistive technology faces impairment because users do not receive timely notifications that suspend its capacity to support both safety and independence goals.

The system in Research A fails to incorporate personal media together with visual material despite research showing their role in improving memory recall. Various scientific investigations establish that diverse Alzheimer's patients experience better memory recall when exposed to affectively resonant objects including known faces, familiar voices or familiar home environments. By neglecting these features the system fails to create emotional engagement with users so attraction levels decrease significantly. This research omits an essential feature of caregiver management interface operations which should serve as the basic foundation for collaborative patient care activities. Medical caregivers support patient success through routine monitoring and emotional support and medical protocol compliance tracking duties. The absence of a caregiver portal prevents their ability to immediately respond to patient needs and check patient activities while also preventing them from making real-time routine changes. Without routine tracking the system does not allow monitoring of patient daily task compliance and behavioral analysis and cognitive development assessment. The system performance suffers from an inability to merge visual and auditory feedback during operation. A research study in Human-Computer Interaction (HCI) shows that specialized dual sensory promotion delivers significant dementia patients' recollection of information. These prompts omitted from the system lead to poorer interaction with patients who require full sensory engagement.

The mobile application assessed in Research B [13] has similar issues like Research A [6] when serving users with cognitive impairments because it lacks functionality along with responsiveness and user participation. The application lacks the capability to recognize medication images through its system. Users experience a cumbersome cognitive strain because they must manually detect pills and document their doses despite the fact that this method poses both safety and operational risks for anyone with memory problems. The absence of visual medication verification automation leads to increased risks of drug distribution errors as well as the occurrence of unsafe medication combinations. The dental alarm system of Research B does not provide real-time notification alerts to the users. Users who miss their tasks or experience delays have no access to adaptive system responses and escalation alerts when using the system. Systems that provide this capability help users maintain their regular routine practice especially when dealing with essential activities like medication intake and meals and hygiene needs.

Research B also fails to implement a comprehensive memory aid interface which would enable deep cognitive engagement of users. The application reinforces users with emotional triggers such as custom voice messages and family pictures and familiar songs that create strong connections between routines. The application's effectiveness for users involves emotional elements because their absence diminishes the system's ability to connect with their cognitive functions and behavior. The main weakness of the system arises from the lack of caregiver integration capabilities. The application lacks tools that enable caregivers to change routines on the go or monitor patient adherence or offer remote assistance. Patients need adaptable support strategies that caregivers cannot provide due to the functional gap between the application and the evolving patient needs. The application does not include mechanisms for behavioral tracking or routine analytics within its system. This absence of vital features makes it impossible for healthcare staff and caregivers to recognize behavioral patterns and monitor performance indicators or detect warning signs for medical emergency evaluation. The user prompts in Research B operate using visual indicators just as in Research A. The utilization of visual cues alone proves insufficient for the system because they fail to provide adequate support. Auditory reinforcement which includes familiar tones and voices is missing from this system thus preventing it from delivering proven enhanced communication strategies for cognitive impairment patients.

The study authored by Research C [14] introduces a technologically advanced smart ambient assistive system inside a controlled setting. Advanced system capabilities cannot address the key

requirements that are essential to the system. The system suffers from a crucial absence of medicine photo recognition functionality while this deficiency persists throughout all the examined research works. Although standing in a smart environment patients lack visual medication verification capability so they remain prone to mistakes that could result in severe health problems. The notification system in Research C produces delayed and non-instantaneous alert messages. The delay because of insufficient dynamic prompt delivery together with user behaviors prevents the system from offering help at the proper time or with relevant information. The system does not include custom memory assistance features. The environment exhibits smart capabilities yet lacks the ability to generate user-specific emotional cues similar to personal photos and voices of familiar people. The system loses its appeal to users because the experience becomes less comforting and more clinical.

One major drawback of Research C is its lack of a dashboard and monitoring system for caregivers to use. The system lacks integration capabilities which blocks caregivers from viewing patient real-time activities or receiving system alerts or modifying the user's protocols according to their evolving needs. The absence of time-based caregiver intervention tools within Alzheimer's disease causes limitations to the support system's flexibility and promptness due to the disease's progressive nature. The system does not include embedded mechanisms for behavioral check-ins and routine observation which prevents any longitudinal collection of user activities or protocol compliance records. The acquired data helps medical professionals determine patient care approaches in addition to enabling them to adjust medications and devise intervention plans. The research documentation of Study C lacks the implementation of visual combined with auditory prompts as seen in the other studies. Recent research exempts the system from operating on passive environmental triggers that lead to insufficient user engagement and conduct guidance even though multi-sensory stimulation proves effective for increasing task performance and patient focus.

Each of the presented research papers provides significant value to assistive technology development for Alzheimer’s patients yet encounters limitations which stop them from achieving complete effectiveness. None of the three systems unite the essential elements of real-time responsiveness and medication photo recognition and emotional memory reinforcement and caregiver support and behavioral analytics into one unified platform. Different systems suffer from usability problems because users experience challenges between complex interfaces and basic improper functionalities. The research and development gap in assistive technology becomes evident through the unaccommodating nature of individual patient profiles and the

inability to support caregiver collaboration and the absence of sensory-enhanced prompting capabilities.

This study recognizes these barriers as development opportunities which lead to a complete system implementation. The system employs artificial intelligence (AI)-based medicine recognition which verifies accurate medication delivery by means of smartphone cameras paired with deep learning models. The system uses real-time alerts and adaptive notifications to encourage dynamic responses against missed or delayed tasks thus improving overall reliability and effectiveness of the support system. The system integrates memory aids designed with personal images and voice recordings to boost both psychological involvement and memory retention for patients. A safe and reliable interface between healthcare workers allows real-time management of patient care with the ability to make schedule changes as well as communicate with caregivers in real-time to optimize their responsiveness and collaboration. Monitoring of routines through data analytics and behavioral tracking provides medical teams with information needed to make decisions while identifying behavioral routines. A combined visual-auditory notification system operates in the system to provide dementia patients with enhanced recall abilities and better task fulfillment effectiveness.

The shortage of appropriate assistive technology highlights an immediate requirement for an integrated system that addresses the specific requirements of Alzheimer’s patients together with their care providers. Existing solutions demonstrate performance weaknesses in three key aspects because their scattered features do not successfully transition from design layouts into practical applications. This research adds value by developing an all-encompassing solution that connects various knowledge gaps through modern technology and user-led design principles to enhance daily existence for people with Alzheimer's disease as well as their caretaking network.

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	✓	✓	✓	✓	✓	✓

Table 1.1.1 Comparison with Previous Research

Various elements within the proposed system consisting of medicine photo recognition, real-time notification system, memory aid integration, caregiver management access, routine tracking and visual & auditory functionality provide complete assistance for Alzheimer's disease patients. The system implements various functions to support both treatment adherence practice and to make tasks easier on users while granting caregivers more independence in their care activities.

Available literature has revealed multiple gaps in research which demonstrate the lack of single integrated system. Previous studies isolated specific intervention elements for Alzheimer's patients but no research examined comprehensive user-focused therapeutic methods that unite them all. A comprehensive answer requires merging modern technological solutions with customized care approaches because such combination proves vital for solving this problem.

A solution to fill this gap promises to create interventions that deliver better results through enhanced accessibility and demonstrate increased empathy toward their users. A proposed system integrates multidimensional cues from vision together with sound to manage smart medication distributions followed by flexible task scheduling and continuous caregiver assistance that empowers the delivery of holistic person-centered care. This system combines functional daily assistance with cognitive benefits for Alzheimer’s patients by using modern technological features to deliver positive treatment effects as well as enhanced quality of life for patients and their caregivers.

1.3 Research Problem

Today's therapies for Alzheimer's patients face strong challenges because healthcare professionals find therapy procedures complex and patients' cognitive functions deteriorate and caregiving staff numbers decline. When Alzheimer's disease advances there are too many patient needs which one caregiver or healthcare professional cannot handle simultaneously leading to worsened caregiver stress and decreased quality of care. The importance emerges for simplified therapy procedures and powerful technology tools which improve both patient routine compliance and clinical success.

Basic static methods which include scheduled reminders along with limited caregiver involvement make up the current care available for Alzheimer's patients. The existing methods prove inadequate for addressing complete cognitive requirements among patients who face difficulties with memory retention while trying to manage routine activities. Patients face challenges in effective monitoring because there are no tailored reminder options and no tools for caregiver support for assessment of behavioral changes and daily activities. Static scheduling alongside visual cues currently in use fails to provide adequate support for patients who suffer from memory deterioration along with sensory impairment. The limitation between current systems shows healthcare professionals must develop a dynamic tracking system through which patients and caregivers can monitor daily activities as they happen.

Such technology solutions enable continuous routine support to patients wherever they are located allowing caregivers to stay updated about patient progress at all times. At any point patients will receive proper care from the system whether therapists or caregivers are present or not. The research aims to create an Alzheimer's patient support system using technology which provides real-time updates alongside personalized medication alerts as well as interface with caregivers while offering visual and auditory tools to increase routine compliance. The combination of routine tracking alongside integrated memory assistance has built the necessary tracking system to sustain ongoing patient development monitoring thus providing caregivers insight regarding patient daily task accomplishment.

Current Alzheimer's treatment faces substantial challenges regarding memory difficulty and patient stickiness to routines together with care provider supervision deficits. The current memory and routine management systems exhibit significant drawbacks because they lack auditory along with visual cues, do not enable caregivers to monitor patient performance in real-time and fail to understand the multifaceted nature of Alzheimer's disease in a comprehensive way. The studied literature reveals that researchers agree intelligent and

customized healthcare systems need to adapt dynamically while also involving nursing staff in live treatment modifications. Existent therapeutic systems require improvement through integration of real-time medications coordination with routine tracking capabilities to include live caregiver participation.

This research develops a complete solution which joins medicine photo recognition to routines monitoring and caregiver supervision with visual alerts and audible notifications to support Alzheimer's patients across their daily practices and lower mental burdens. Better health results will emerge from this solution which improves patient adherence and decreases caregiver and patient stress thereby benefiting those with Alzheimer's disease.

1.4 Research Objectives

1.4.1 Main Objective

To develop a medicine photo recognition feature that allows users to capture medicine photos, recognize medicines, and provide reminders to enhance adherence.

1.4.2 Specific Objectives

1.4.3 Routine Adherence Assistance

The regular repetition of familiar routines assists Alzheimer's disease patients in performing their daily tasks because routines make them feel less disoriented and less fearful during everyday activities. Memory impairment prevents cognitive impairment patients from remembering appointments thus causing them to lose their direction while generating heightened stress levels. People with Alzheimer's disease obtain maximum advantages from customized adherence systems with person-specific alerts and reminder functions that improve operational competence and emotional steadiness. The natural digital systems serve patients as a guidance tool which helps them advance their activities to restore personal autonomy. Such systems allow healthcare staff to conduct observations that reveal patient behavioral developments to optimize treatment procedures.

1.4.4 Technological Support Tools

Alzheimer's disease management receives multiple benefits from new technologies which include mobile apps together with wearable tech and smart home capabilities. Technical tools provide users with autonomous reminder functions while ensuring continuous behavioral monitoring while generating instant alerts to caregivers. Such systems use artificial intelligence to design customized care by analyzing both user activities along with regulated procedures. The application of technological tools in Alzheimer's therapy eliminates the requirement for supervisory caregivers by offering immediate support functions to patients. Safety protocols receive enhancement through fundamental technical solutions which provide caregivers dependable continuous assistance in addition to improving communication functionality during caregiving tasks.

1.4.5 Caregiver Support.

Alzheimer's management heavily depends on caregivers who experience routine burnout due to their extensive involvement. The implementation of supportive technologies provides relatives with stress reduction because they get access to real-time alerts along with patient data dashboards while using remote monitoring functions. Such features enable professionals to step in as needed without losing track of how a patient performs throughout their daily routine. The system enables nurse caregivers to make changes to the schedule and log notes and monitor adherence reports thereby strengthening the partnership between medical professionals and technology. These support tools give caregivers increased control together with efficiency and tranquility of mind in their care activities.

1.4.6 Integration of Visual and Auditory Cues.

Multimodal communication techniques linking visual and auditory prompts provide strong communication channels for people with Alzheimer's. Visual prompts consisting of images or icons or colored codes united with audio alerts and spoken instructions make significant improvements to patient task response capabilities. A combination of visual and auditory communication features benefits patients with diverse sensory responsiveness because it engages several cognitive mechanisms to enhance memory retrieval. A combination of sensory input cues enables patients to overcome disability in their individual sensory channels by using

alternative perception methods. Task performance gets better along with user interaction levels when integration happens between systems.

2. METHODOLOGY

A smart assistive solution is developed through a practical technology-centered method to let Alzheimer's patients execute their daily tasks with better independence and effectiveness. The system integrates vital functions such as routine logging together with memory tools and medicine photo detection in addition to visual and audio alert systems since Alzheimer's disease causes memory decline and confusion. By providing real-time updates and prompts the method works to ease routine memory challenges thereby improving patient rule compliance.

Users will benefit from a user-friendly experience which was achieved by creating the mobile application through a combination of Flutter and Dart. Real-time database storage and authentication operations rely on the Firebase platform which secures cloud data and helps interfaces from patients and caregivers communicate effectively. The medication photo identification features with intelligent reminder functions operate under the power of Python and TensorFlow along with Deep Learning technology for authentic identification.

System testing and user feedback evaluation occur throughout development to refine design features while making sure the system matches the characteristics of Alzheimer's disease patients. Special attention to ethical standards happens in the system development phase particularly regarding collecting data and working with caregivers to guarantee the solution is secure as well as sensitive and medically beneficial.

2.1 Requirement Gathering and Analysis

- **Requirements gathered from Ayati Centre**

In order to gather knowledge about the research domain and the research gap, meetings via online conferencing were scheduled as the first step of the requirement analysis with Mrs. Chanuli Jayathilake, an audiologist at the Ayati Centre and Lecturer at the University of Kelaniya, and Mrs. Dinukshi Ileperuma, a speech and language pathologist at the Ayati Centre

and Senior Lecturer at the University of Kelaniya. In order to understand the real significance of this research, a field visit to the Ayati Centre, Faculty of Medicine, University of Kelaniya, Sri Lanka, was also carried out with the assistance of the previously mentioned staff members and Dr. Dharshana Kasthurirathna, Assistant Professor at the Sri Lanka Institute of Information Technology.

- **Requirements gathered from Wickramarachchi Opticians & Hearing Care**

To expand AVT's domain knowledge, visits took place to Wickramarachchi Opticians & Hearing Care, a leading company in the country for helping the deaf and blind. We were able to gain further knowledge of AVT thanks to the in-person meeting with Mrs. Nipuni Adikari, a Speech-language pathologist, at Wickramarachchi Hearing Care. The future plans were discussed and decisions regarding the work to be done were discussed during the meeting.

- **Analysis**

Following the gathering of data and ideas, it was determined to carry out this research by assisting hearing-impaired children with a gamified application that would enhance engagement of children into AVT, keep therapists updated about therapy sessions, and deliver efficient AVT by monitoring the child's progress.

2.2 Product Requirements

2.2.1 Functional Requirements

The system’s core functions align with the main objectives of enhancing Alzheimer's care through the following requirements:

- Medicine Photo Recognition: The system enables users to photograph their medication through their mobile phone interface. The application detects and recognizes medication names together with dosages automatically through deep learning models which operate on TensorFlow programming. Recognized medicines trigger the scheduling of medication reminders which notifies care providers to maintain proper medication regimens for preventing dosage errors and omissions.

- Visual & Auditory Functionality: Patients with Alzheimer's benefit from multisensory cues. The app displays visual signals using icons and animations and also shows highlighted routines together with spoken instructions and alert tones to notify users. The combination of visual and hearing cues assists patients in better understanding instructions even during situations when they have different sensory abilities.

- Routine Tracking: The system enables users together with caregivers to develop and check as well as track daily operations (for example medication schedules alongside meals and hygiene needs along with scheduled appointments). Users have the ability to record task completion status while caregivers receive a dashboard to monitor adherence levels. By studying patterns of non-compliance health care providers can adjust care plans for better results.

- Notification System: The system delivers instant notifications through its alert system both to patients and their caregivers who need to be reminded of planned tasks. Users can set notification specifications according to how critical a task is or what category it belongs to or which priority it holds. Patient information automatically raises alerts to caregivers when recurring routine failures occur.

2.2.2 Non-functional Requirements

Non-functional requirements apply necessary conditions to system usability and efficiency while guaranteeing security along with adaptability under different operational environments.

- Better user experience :A system requiring both patients and caregivers needs a user interface and user experience that is easy to access and clean. The system interface features buttons of ample size combined with clear text fonts together with auditory notifications which serve users who need cognitive help or elderly patients.

- Data privacy: Health records together with daily routines as well as medication schedules receive high protection status because of their sensitive nature. The system incorporates end-to-end encryption together with Firebase secure authentication and fulfills data protection standards like HIPAA/GDPR equivalents for different regions to maintain data security.

- Hosting the application: The backend together with database runs on Firebase Cloud to manage real-time synchronized data storage with high reliability. The system comes with capabilities that enable easy expansion to accommodate new users and extra features going forward.

- Handling large set of data: The system incorporates efficient data structures and indexing and cloud storage solutions (Firebase Firestore/Storage combined with Python-based optimized machine learning pipelines) to handle the large-scale input of medicine images and therapy logs and routine tracking data.

- Making the application cross platform.The application runs on Flutter framework enabling it to provide uniform performance between Android and iOS operating systems which reduces development expenses while increasing user reach. The system operates effectively on various display sizes together with different device functionalities.

2.2.3 Software Requirements

The system development used these technologies along with tools to accomplish its implementation:

- Flutter: The UI toolkit works as a mobile application development platform which builds identical interfaces supporting both Android and the iOS operating system from one unified codebase.

- Dart: Front-end and logical features for the mobile application utilize the programming language Dart within Flutter.

- Python: Its main purpose includes backend development together with the construction of AI/ML components. The system uses TensorFlow along with Python for executing complex functions involving image classification.

- TensorFlow: The platform allows developers to construct deep learning recognition models for medications with image inputs through its open-source framework.

- Firebase: Firebase enables authentication services and provides real-time database operations together with cloud functions and storage solutions as well as hosting capabilities. Real-time updates between caregivers and patients exist because of the powering capabilities of the mentioned system.

- Machine Learning: The learning nature of ML algorithms enhances user experience by capturing system routines and determining task outcomes which triggers prompt caregiver assistance.

- Deep Learning: The functionality benefits from neural networks that enable recognition of medication images and speech analysis and regular pattern recognition.

- Git: The version control system plugin performs code modifications through collaboration and ensures system recovery during development.

- Android Studio: The main integrated development environment (IDE) known as Android Studio serves as the debugging platform while running emulators and building the application through its Flutter plugins.

2.2.4 Feasibility study

Ethical Feasibility: The system requires extreme attention to ethical conduct because its main users are people with Alzheimer's disease who present a highly vulnerable and sensitive profile. The system requires patients to give access to pictures about medication along with information regarding routines and behavioral patterns. A researcher must get clearance about ethical concerns before working with actual data records. Medical institution partnerships including the Ayati Centre need to be established for effective work. Agencies participating in the project can help secure approval for ethical practices which protects patient information and responsible research methods from start to finish of the project.

Technical Feasibility: The development of an Alzheimer's support system demands multidomain technical competence. The project team demands sophisticated capabilities in cell phone and web app development together with knowledge of machine learning engineering and medical image recognition through computer vision alongside real-time information management. Essential for this work are deep insights into AI technology as well as NLP capabilities for command and reminder interpretation and experience integrating the system with dashboard tools. The system needs robust expertise regarding database systems together with knowledge about software architecture and cross-platform frameworks to guarantee secure deployment with maintenance capabilities and scalability.

Financial Feasibility: A well-designed system must operate efficiently using few resources because this accessibility enables caregivers and institutions to use it effectively. The system design should stay independent from costly infrastructure through its adoption of open-source libraries and inexpensive cloud-based services. The system needs to develop individual components for tracking and medicine identification into performance-maximizing solutions that maintain cost-efficiency. The system needs to provide maximum value at a low cost so that small-scale facilities and families will not face financial stress when adopting it.

Market Feasibility: The demand for Alzheimer's care solutions is steadily increasing as global populations age. The proposed system stands out in the market due to its integrated approach—combining medicine recognition, real-time alerts, memory aids, and caregiver tools. With limited comprehensive solutions currently available, this system is expected to fill a critical market gap. A comparative market analysis should be conducted to identify key competitors, understand current limitations in existing tools, and assess user demand. Sales forecasts, adoption potential in care centers, and user feedback will all inform the system's market positioning and future scalability..

2.3 Overall System

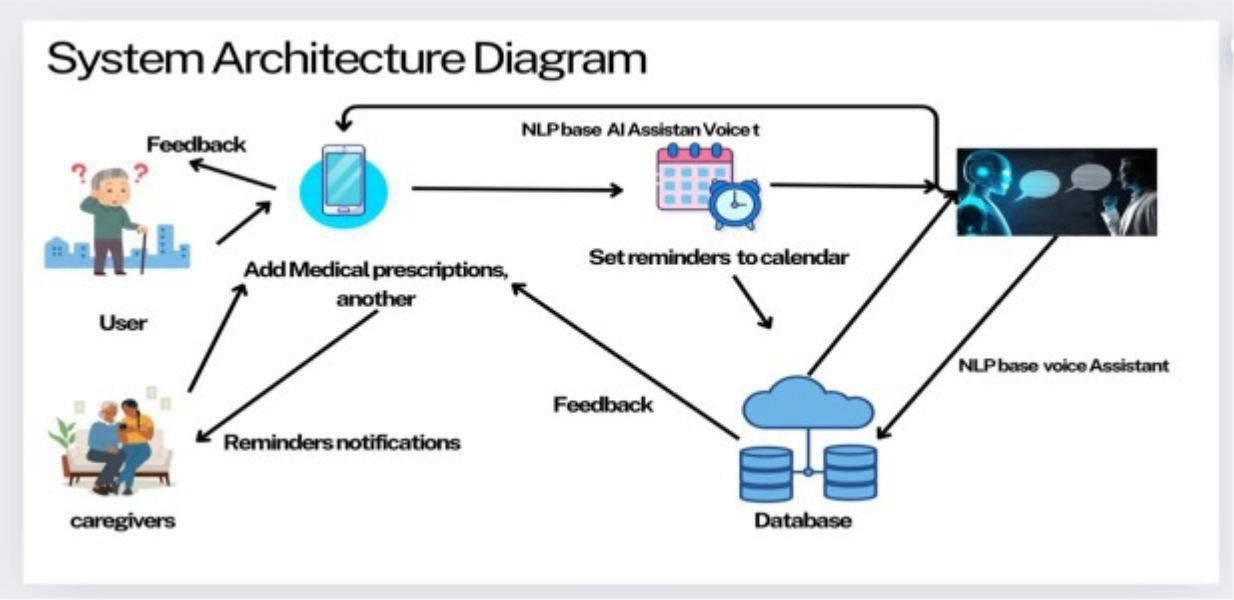

Figure 2.1 Overall System Diagram

A microservices-based architecture enables the Alzheimer's support application which combines four essential functional parts as shown in *Figure 2.1*. The application accommodates four crucial functions such as medicine photo recognition and routine tracking together with visual and auditory cue integration and notification capabilities. The system utilizes an intelligent NLP-based voice assistant which integrates components that let users control the system by speaking naturally. The fifth core element consists of a cloud database solution which handles data storage functions alongside reminders and feedback acquisition capabilities. This system uses the following core set of questions to improve both routine adherence and user independence:

1. Does the user have sufficient skills to identify and properly consume medication when shown photographic images?
2. Does the system possess the capability to differentiate various routines so it can distribute appropriate reminder alerts?
3. Does the user have the capability to respond correctly to visual or auditory directions?
4. The system needs to enhance its ability to support users in maintaining their daily awareness capacity?

System efficiency gets increased through the synchronization of the therapist web interface with the caregiver dashboard to the system database. The integration of these interfaces helps the system solve questions which are important to healthcare providers and caregivers.

1. Through what methods can caregivers support their patients to maintain routine procedures while remaining unattended?
2. What methods exist for tracking and investigating patient progress together with compliance conformity throughout time?
3. Do clinicians have the ability to provide sustained support and make remote changes to care reminders together with patient routines?

2.4 Software Solutions

High-quality software is designed, developed, and tested according to a method or plan called the Software Development Life Cycle (SDLC). However, one of the easiest and most effective ways to produce an outstanding product is through the use of the agile software development technique. The most commonly used agile framework that is easy to use and helps individuals, teams, and organizations can be identified as Scrum.

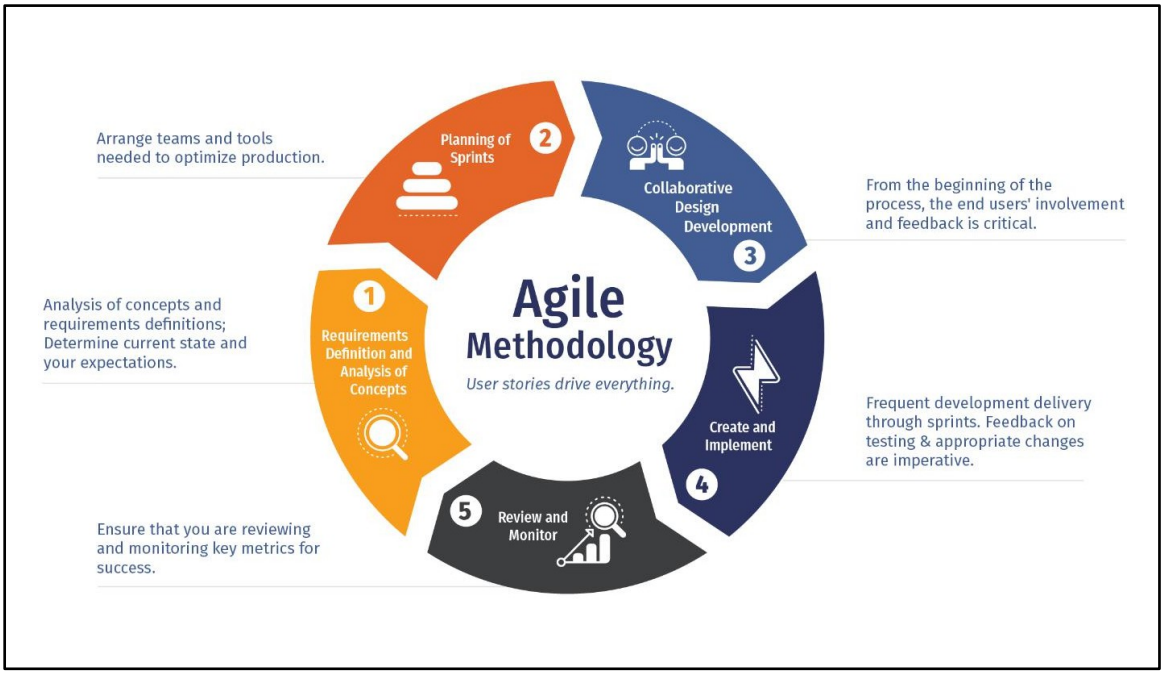

Figure 2.2: SDLC Agile Methodology [26]

2.5 Design Diagrams for the Component

2.5.1.1 Use Case Diagram

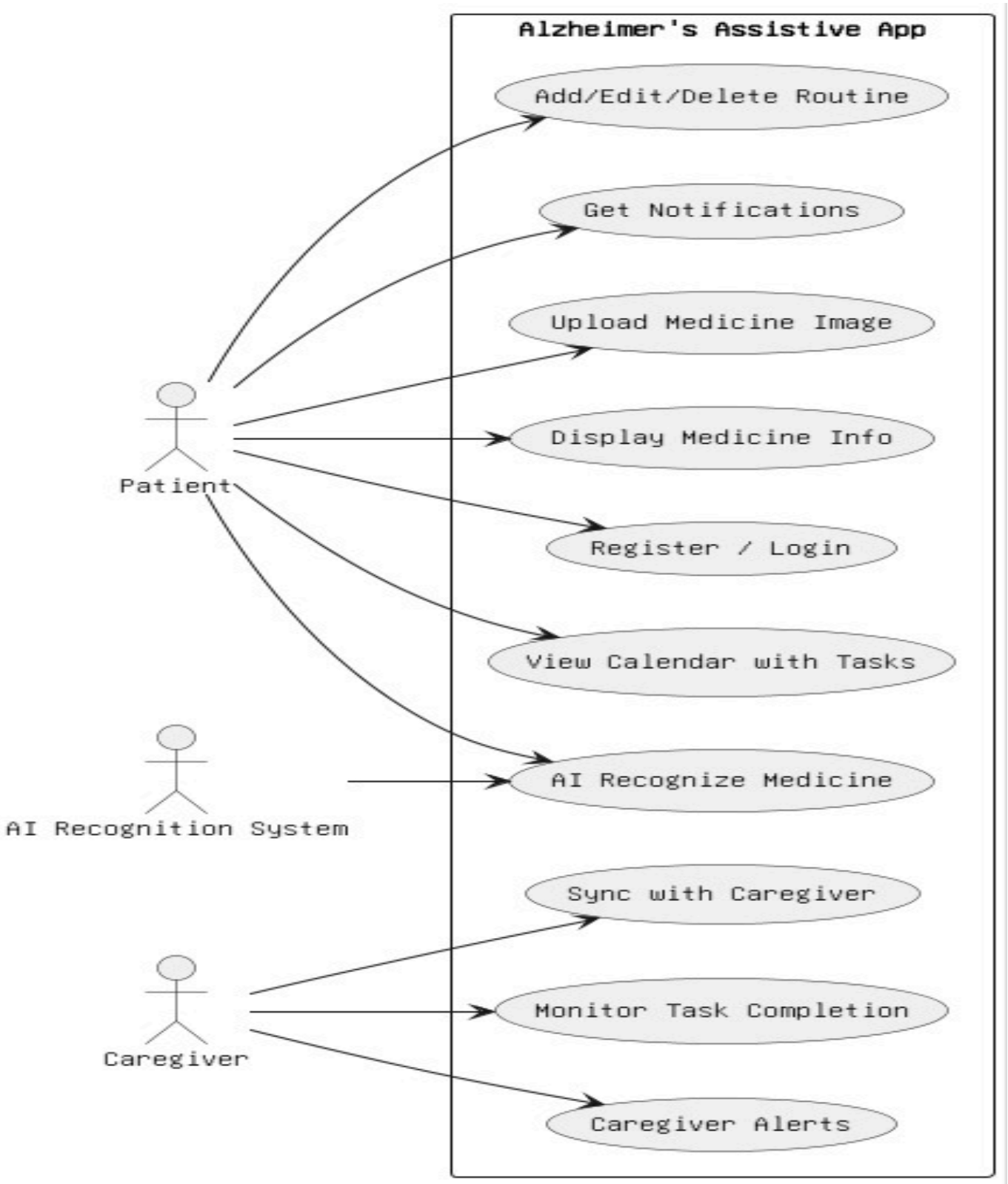

Figure 2.3: Use Case Diagram

2.5.1.2 Sequence Diagram

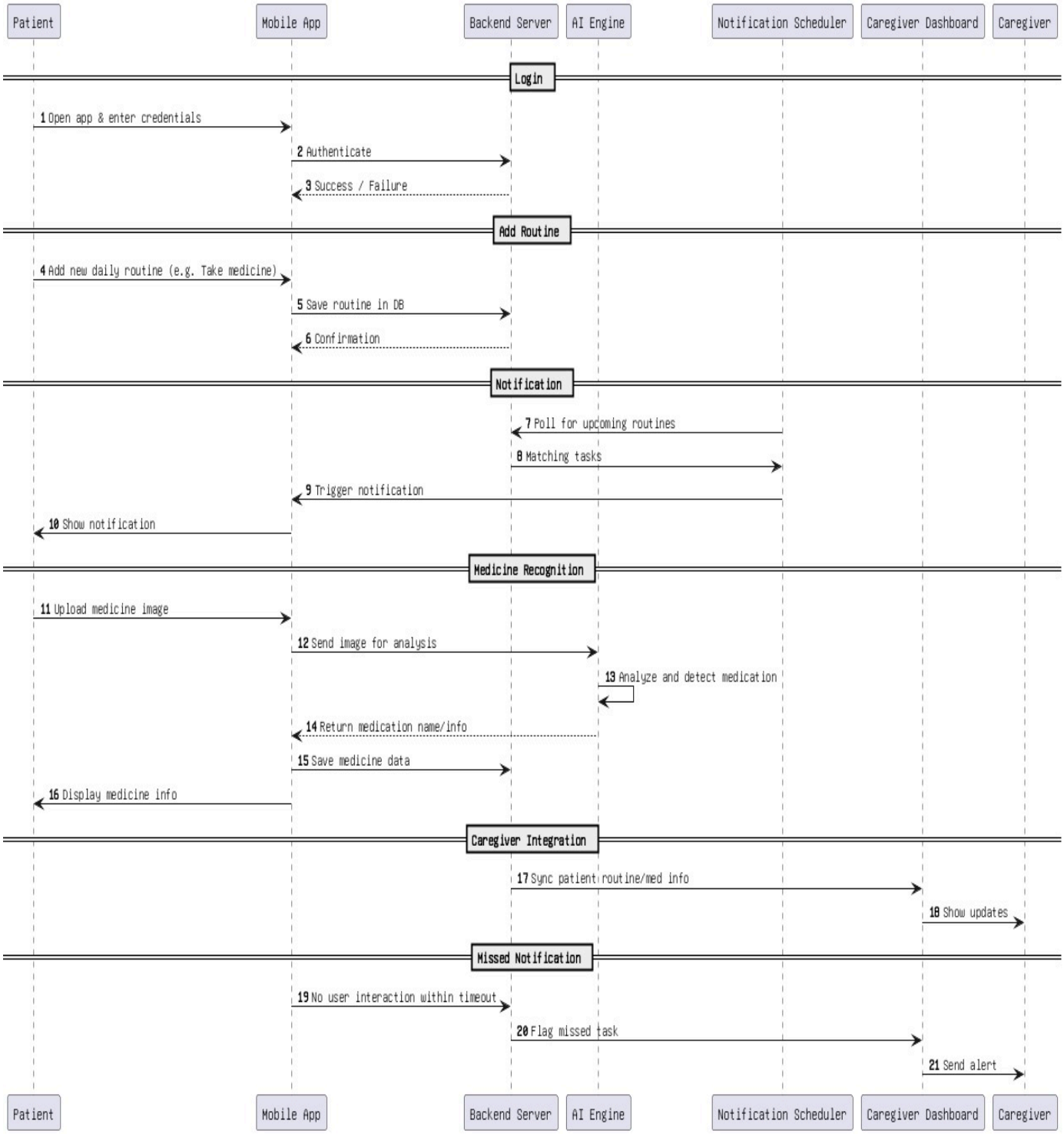

Figure 2.4 Sequence Diagram

2.6 Implementation

The presented research adopts smartphone technology to develop an interface system that supports Alzheimer's patients in medicine administration and task management. Patients access mobile patient services through an application that comes with routine management features alongside features for medicine identification and visual/audio alert systems and real-time messaging options and memory aids in addition to caregiver system authorization.

The application development combines Flutter and Dart programming languages to build an interface-based platform that suits elderly users. The application provides patients soothing visual signals and sounds for medication timing combined with functional activity alerts that help them maintain daily orientation. The application supports anxiety management along with alert customization features that help users reduce cognitive pressure and through its regular monitoring system.

The maximum functionality of the system emerges when its medicine photo recognition system becomes operational. Patients can submit photos through the system which analyzes them using TensorFlow models along with Python to identify medications. The recognition engine processes medical images until they compare patient medication dosages with training data to avoid possible treatment errors.

The system achieves optimum performance through Firebase tools because they deliver real-time database features alongside authentication and notification services for instant messaging. The system implements Machine Learning features to track patient behavior patterns which enable it to generate specific reminder schedules which adjust according to individual usage habits.

The project development took place within Android Studio platform while Git functioned as the version control platform alongside team collaboration features. The system offers basic functionality with responsive behavior and makes itself accessible to users while providing caregivers with remote access to patient data and the ability to monitor their progress.

For the implementation of the system the following technologies were used.

- **Flutter** – For building the cross-platform mobile application interface
- **Dart** – Programming language used with Flutter
- **Python** – For backend services, AI model training, and logic implementation
- **TensorFlow** – To develop and train the medicine photo recognition model
- **Firebase** – For real-time database, authentication, and cloud notifications
- **Machine Learning** – To personalize routines and improve recognition accuracy
- **Deep Learning** – For advanced image recognition capabilities
- **Android Studio** – Primary IDE for mobile app development
- **Git** – Version control and collaboration during development

2.6.1

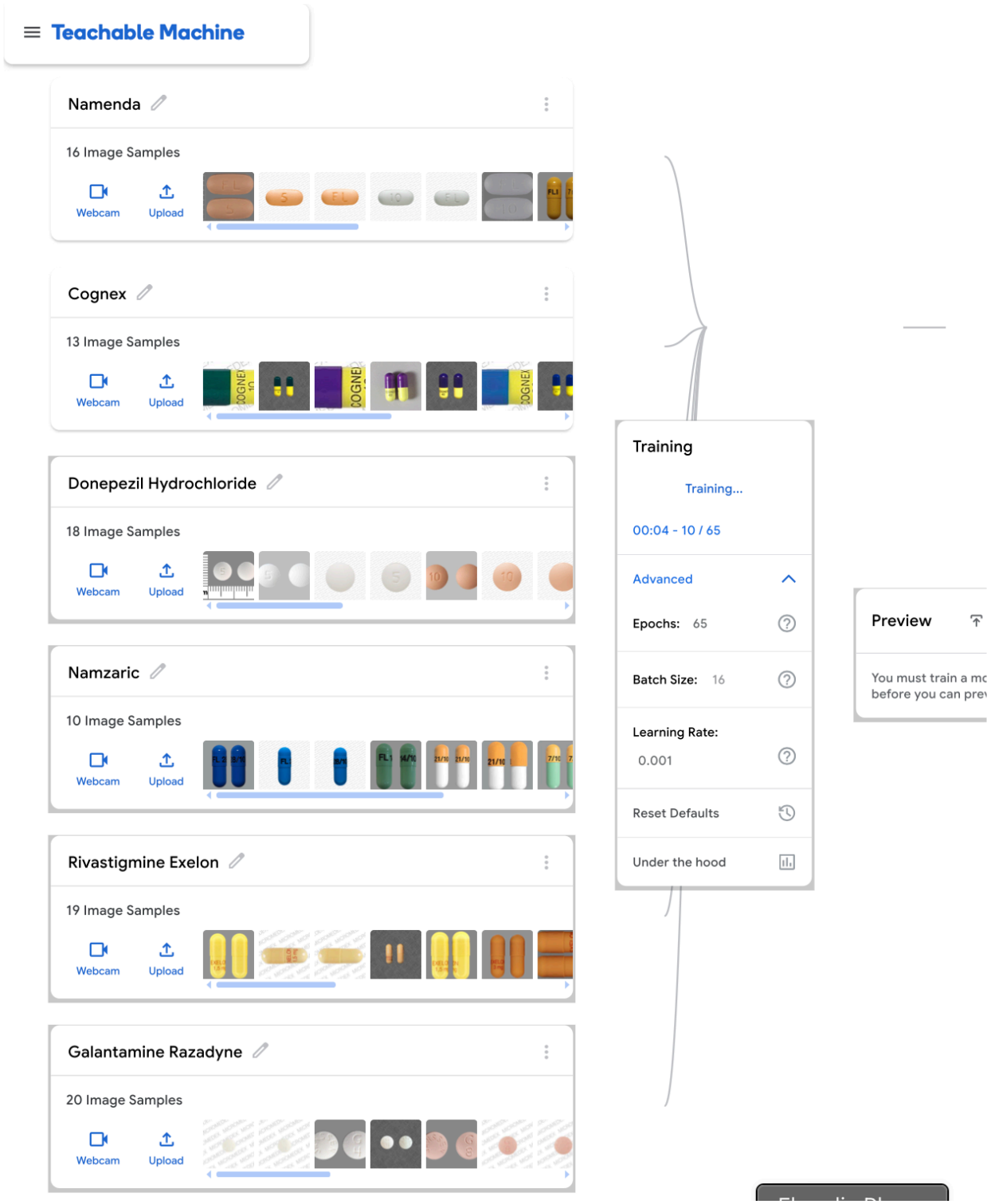

Figure 2.5 Teachable Machine Traning

2.6.2

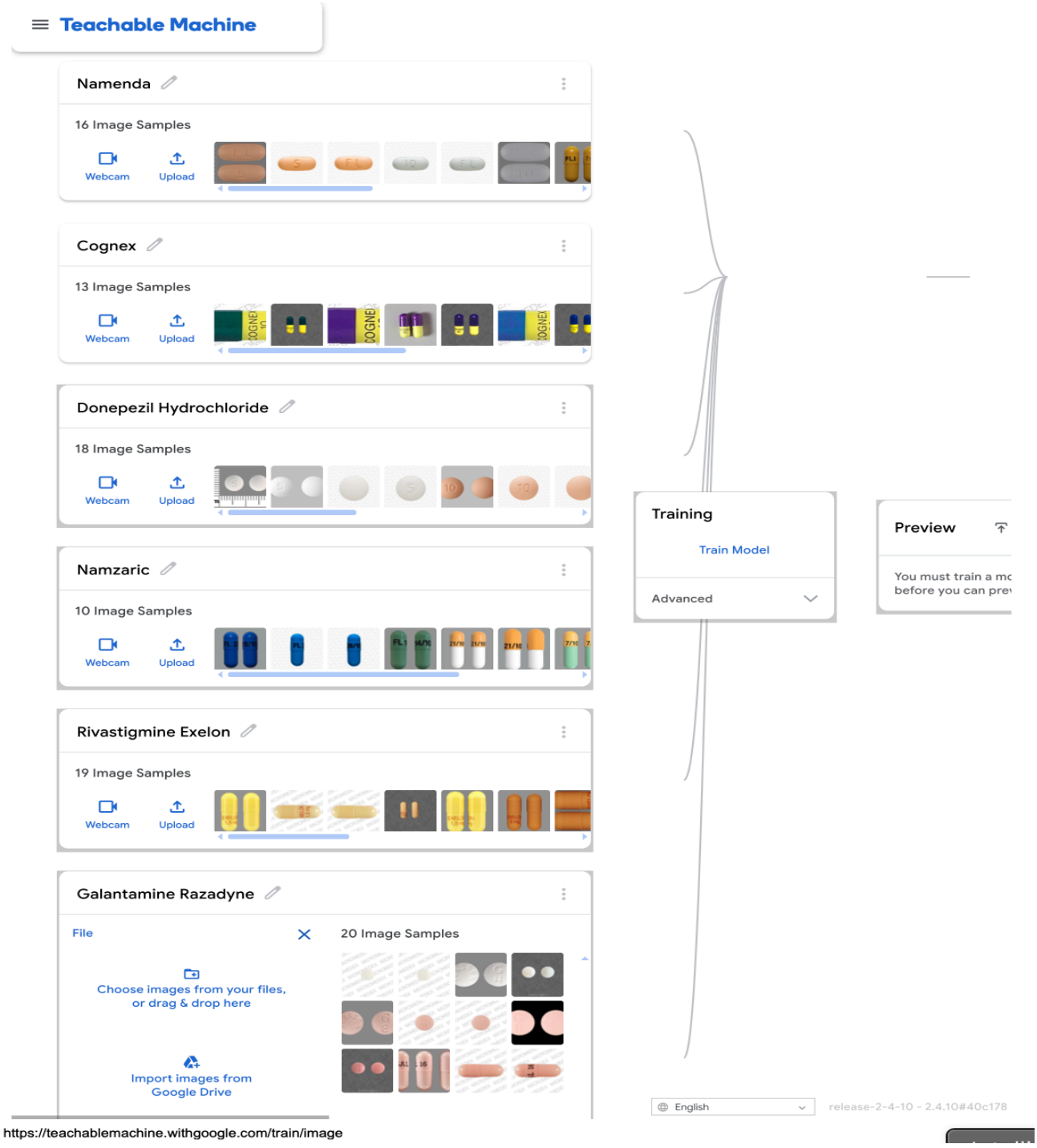

Figure 2.6 Teachable Machine Traning

2.7 Testing

Test Case ID	Test Case Description	Input	Expected Output
RS-001	Add a new routine task to the schedule	Task: Take medicine at 8 AM	Task added to schedule and listed under daily tasks
RS-002	Trigger notification at scheduled time	Time reaches 8 AM	Notification is sent to patient
RS-003	Edit an existing scheduled task	Change time from 8 AM to 9 AM	Task updated and listed under 9 AM
RS-004	Delete a task from schedule	User deletes task 'Take medicine at 9 AM'	Task removed from daily schedule
RS-005	View all scheduled routines for the day	User opens daily task list	Displays all routines scheduled for that day
RS-006	Reschedule a missed task	Patient missed 8 AM medicine task	Prompt to reschedule appears
RS-007	Set recurring routine tasks	Add 'Morning walk at 7 AM' daily	Task is scheduled to repeat every day at 7 AM

Test Case ID	Test Case Description	Input	Output
MR001	Capture clear photo of a known medicine	Image: Namenda 28mg tablet	Output: " Namenda 28mg tablet " recognized with dosage details
MR002	Capture blurry or unclear photo	Blurry image of pill	Error: Unable to recognize medicine. Try again.
MR003	Upload image of unknown medicine	Image: Unregistered or generic pill	Error: Medicine not found in database
MR004	Capture photo of multiple medicines	Image: Two different pills in one frame	Warning: Multiple pills detected. Please scan one at a time.
MR005	Recognize medicine with damaged label	Image: Crushed pill with label torn	Error: Unable to recognize due to unclear label
MR006	Recognize medicine with correct dosage	Image: Congnex 40mg capsule	" Congnex 40mg capsule “ with dosage schedule added to routine

Table 2.2 Test Case Scenarios

2.8 Mobile Applications Ui

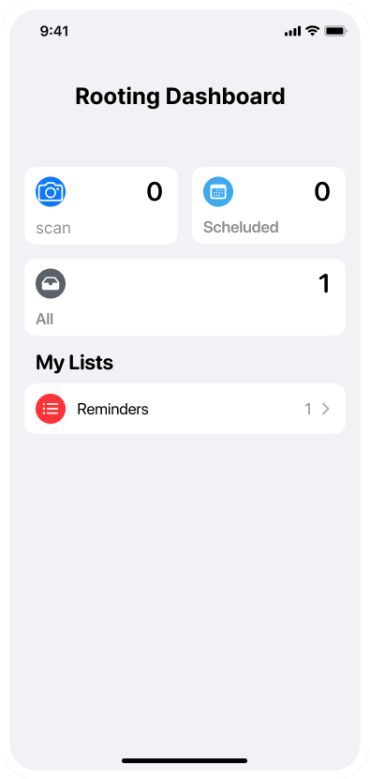

Figure 2.7 Mobile Ui Home

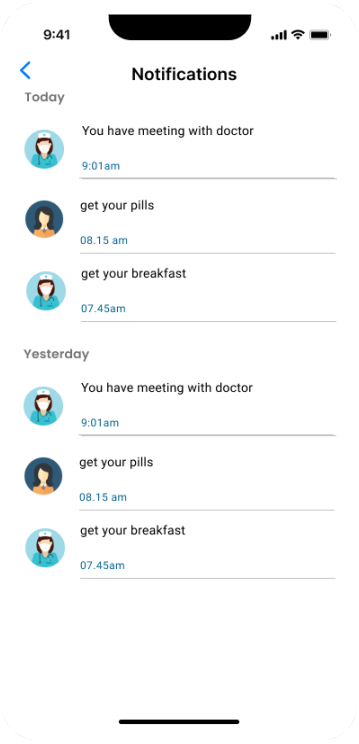

Figure 2.8 Notification Ui

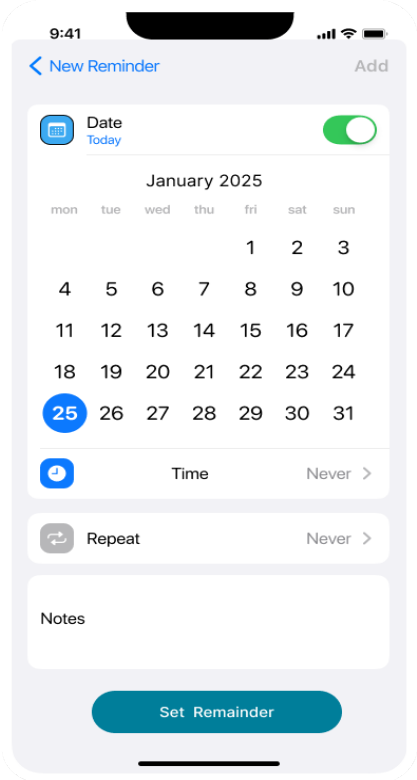

Figure 2.9 Calander Ui

Figure 2.10 Scanning medicine

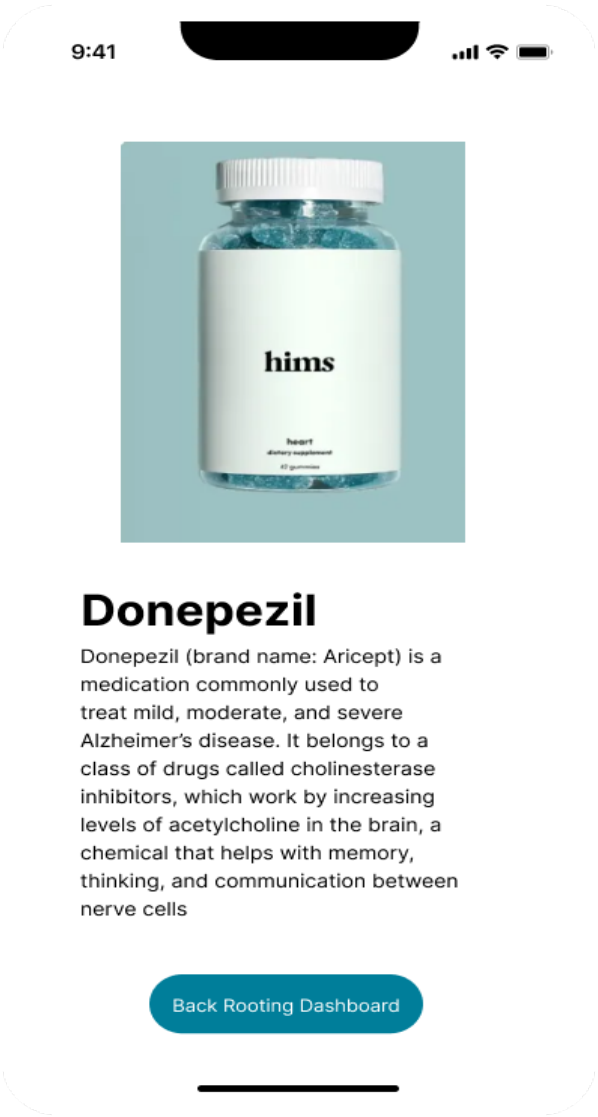

Figure 2.11 Identifying medicine

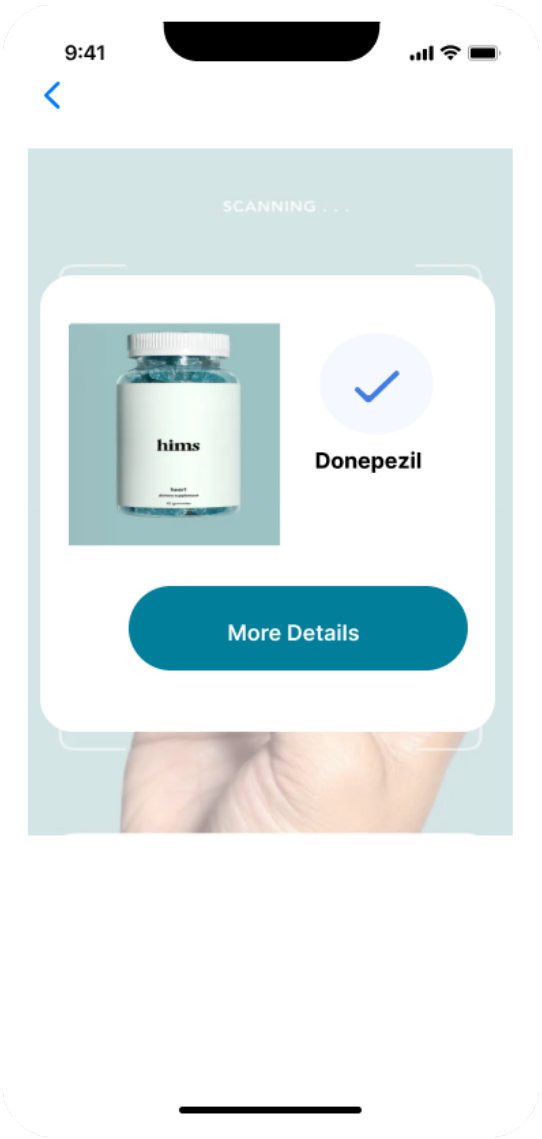

Figure 2.12 More Details

2.9 Commercialization

A dual approach of social impact and sustainable financial growth holds the commercialization of this Alzheimer's support system. In proposing the system, the underlying technology is used to create a solution that will aid Alzheimer's patients, caregivers and clinicians through providing routine adherence with to tools such as medicine photo recognition, real time notifications, and visual-auditory reminders. A complete commercialization strategy has been created so as to make the system viable and accessible over the long term. All of this is a subscription based Software as a Service (SaaS) model for individuals and families, a licensing model for healthcare institutions and senior care centers, and a very narrow target market approach to achieve the broadest possible reach and usage. Moreover, potential business to business (B2B) deals with pharmaceutical companies, assistive device manufacturers, and non profits working in elderly care further support the product's commercialization. Revenue will scale, in proportion, with initial project user base of 1k first year, 5k second year, with the support of premium subscriptions and institutional partnerships. However, this strategy ensures that the end user remains affordable and profits are generated by the revenue streams to support development, customer support and technological advancement.

2.9.1 Target Audience

- Caregivers
- Patients
- Clinicians

The Alzheimer's support system focuses its primary target market on three essential user groups which include patients together with both professional and familial caregivers and healthcare professionals. All affected user groups need efficient and user-friendly tools that maintain clinical relevance to manage their Alzheimer's routines. Through its real-time features the system delivers three essential support functions: daily routines compliance assistance together with medication solutions and emotional assistance using AI-driven monitoring and reminder technology.

The first demographic target consists of urban and semi-urban smartphone users who exhibit minimal digital capabilities. The global number of dementia cases reaches 55 million persons and among these patients Alzheimer's disease exists in 60–70% of verified cases due to pressing demands for accessible scalable support systems. Through the system interface adult children serving as patient caregivers can access remote care management tools as primary users.

The initial market deployment of the AI-based system will concentrate on English-speaking regions that frequently detect Alzheimer's cases which include America, Britain and Australia as well as Canada. The regions possess cutting-edge digital health infrastructure which creates supportive conditions for healthcare system integration and novel system adoption.

Through its technological setup the system creates opportunities for businesses to work together in addition to serving individual customers and institutional groups. The system has the potential to partner with multiple businesses including pharmaceutical companies together with hearing aid manufacturers together with elderly home care providers together with insurance firms for sponsorship. Possible alliances between these sectors create additional revenue streams because they facilitate product bundling and enhanced marketing opportunities as well as data-based study partnerships.

Putting localization capabilities together with cultural adjustments and multilingual voice prompts into the system will make the platform highly suitable for global market expansion. The developed system will be able to assist elderly populations across Asia and Europe and Africa because elderly care has grown as a vital policy issue in these regions.

The target market strategy employs three essential elements for broad adoption: accessibility, caregiver skills improvement and productive partnerships. I blends a patient-centered approach with a broad commercial outlook to ensure sustainability, market relevance, and long-term impact.

2.9.2 Subscription Plans

The Subscription-Based SaaS model functions as the core element of the product's commercialization approach because it targets single users including patients together with family caregivers and team-oriented caregivers. The mobile and web-based Alzheimer's support platform implements a freemium pricing framework because it wants its users regardless of their financial capacities to access it. Users who choose the free option can access vital functions which include routine monitoring as well as reminder systems and fundamental caregiver communication functionalities. Users of the premium account gain access to medicine photo recognition and progress reports and caregiver assignment tools and cross-device synchronization and multilingual auditory prompts which are not available in the free version.

The payment structure enables forecastable revenue streams which require minimum initial payments from customers. Free and professional plans through subscriptions provide monthly and annual billing but include discounted rates for extended commitments. The first pricing offer will start at $1 monthly for every user but will rise based on the incorporation of new features according to user feedback. The estimated annual revenue during the first year with 1,000 users amounts to $100 per month which equals $1,200. In the second year a projected 15% subscriber base from 5,000 users will raise monthly revenue to $750 which accumulates to $9,000 annually.

Scalable development coupled with simple system updates takes place without forcing interruptions in user experience under the SaaS model. The system allows automatic distribution of new features and enhancements to all operational devices through a single platform. This business model enables upcoming possibilities for device and smart home technology integration. User-provided feedback will assist in refining product features according to actual requirements which will boost satisfaction and continue user retention. The premium subscription includes exclusive customer support together with personalized onboarding and tutorial content that increases overall value and prevents customers from leaving. Decisions based on this approach maintain steady user interaction which leads to

lasting value creation for each customer. The platform develops naturally as it sustains its financial stability while maintaining its core mission objectives.

2.9.3 Marketplace

Sri Lanka serves as the main market focus for our Alzheimer's support system because the elderly population continues to increase whilequality cognitive support remains scarce in the country. Sri Lanka's Ministry of Health predicts dementia and Alzheimer's cases will increase substantially as the elderly population aged 60 and above will form more than 20% of total people by 2030. An affordable tech-enabled solution for cognitive care must be developed specifically for local contexts because such solutions do not exist at present.
The Alzheimer's care system in Sri Lanka functions predominantly through physical staff and insufficient therapists while offering inconsistent therapy periods alongside minimal technological support. Your system solves these problems through an affordable mobile solution with AI technology and gaming elements that helps patients interact better while tracking their care needs and medicine usage and providing regular help.
The project can achieve early market momentum when it establishes partnerships with existing entities in the area including:

- Ayati Centre for Disability
- National Institute of Mental Health (NIMH)
- Private hospitals and elderly care homes
- Pharmaceutical distributors and local pharmacies

A freemium SaaS model from the product provides basic features for free and costs minimal monthly rates for premium service access which makes it accessible to Sri Lankan households.
Upon achieving successful adoption in Sri Lanka the platform will move toward rolling out service in nations tackling similar elderly care problems including India, Bangladesh and the Maldives followed by global market expansion.

3. SUMMARY

The research has made a major impact on digital healthcare through the development of a purpose-built smart system which supports Alzheimer's patients in following their daily routines and providing cognitive help. The proposed system contains technological instruments that assist Alzheimer's patients through independent behavior promotion and safety protection while delivering caregiving assistance despite their memory loss and confusion and regular activity difficulties.

The system achieves its main contribution by combining the use of visual display with auditory alert systems for routine management. The system supports navigational tasks by providing patients with voice-based alerts and visual indicator systems which decreases mental stress and enhances clarity. The execution of multimodal cues serves as an essential component to maintain memory connections while familiarizing people with cognitive decline regarding their routines.

Medicine photo recognition functions within the system through deep learning algorithms to recognize medications when a camera is used for input. By identifying medications through camera input the system provides two benefits: it decreases the chance of medication mix-up while simultaneously ensuring proper drug timing to strengthen both safety and adherence.

The solution brings together real-time routine tracking features with caregiver support functions among its capabilities. The mobile and web interface enables remote caregiver monitoring of patient activities with alert notifications and daily schedule updates and viewing of patient behavioral data and routine completion records. This technology supports both early warning capabilities and it enhances the relationship between healthcare providers and their patients.

The system uses a combination of Flutter for development with Dart programming language together with TensorFlow machine learning libraries and Python as its foundation. Additionally it utilizes Firebase platform and modern technical components such as Dart and Flutter and Python and TensorFlow and the Firebase platform. The Android platform enables efficient operation of the application together with real-time processing of intelligent data. The research adds to ethical and practical guidelines for developing systems which focus on sensitive users along with principles promoting accessibility combined with affordability and

user-friendly features. Halasis demonstrates that using artificial intelligence with structured user interfaces leads to solutions that effectively solve healthcare requirements.
This research offers an integrated technology-based Alzheimer's care approach that incorporates smart automation and visual and audio support and caregiver collaboration to enhance patient life quality and assist caregivers throughout their duties.

4. CONCLUSION

Patients with Alzheimer's disease together with their caregivers face major obstacles because the disease leads to worsening memory function combined with confusion coupled with impaired ability to perform daily activities. This research developed a smart assistive system providing a complete technological answer to address the mentioned issues by enhancing independence while maintaining routine compliance and caregiver support through real-time monitoring and engagement.

The mobile application solution unites visual and audio prompts with maintenance tools and medicine photo recognition and memory aids and caregiver tracking systems to create an all-inclusive functional system that patients will find easy to use. The solution integrates Flutter, Dart, Python, TensorFlow, Firebase alongside machine learning and deep learning techniques together with both Python and Firebase for its development. This technology establishes a framework which produces reliable performance and intelligent data analysis as well as real-time communication abilities necessary for cognitive-impaired users.

These combined features within the system create an accessible practical solution for Alzheimer's care. Patients can stay oriented through visual and auditory alerts which help them accomplish daily routines by themselves. Through the caregiver portal family members and clinical providers receive real-time access to monitor patients' tasks which leads to decreased levels of physical and mental stress. The medicine photo recognition capability enables another safety measure by ensuring proper drug management which stands as an essential aspect of Alzheimer's support.

Such research investigates the deployment of this system from the perspectives of ethics together with technology implementation and finances while exploring market potential. The research responds to increasing requirements for economical widespread options which allow personalized adjustments according to disease progression and severity levels.

This research creates an encouraging foundation which will enable progress in Alzheimer's care technology development for upcoming generations. The system shows how design built from technology with user requirements at its center can connect vital patient care needs and improve life quality. Such a system shows potential to replicate its design approach for cognitive disorder therapy through AI technology thus advancing healthcare solutions that combine intelligence and compassion

5. REFERENCES

[1] S. Alyafeai, R. Duhaithem, S. Alamoudi, K. Moria and M. Tharwat, "Smart Assistive Wearable Device for Alzheimer's Patients," *IEEE EUROCON*, 2023.

[2] K. Yawale and S. Thorat, "A Smart System for the People Enduring through Alzheimer's Disease," *2019 International Conference on Intelligent Computing and Remote Sensing*, 2019.

[3] N. Saleh, A. Ali and O. Ezzat, "Face Recognition-Based Smart Glass for Alzheimer's Patients," *2022 International Japan-Africa Conference on Electronics*, 2022.

[4] L. Boppana, P. Kumari, R. Chidrewar and P. K. Gadde, "Smart Cap for Alzheimer Patients using Deep Learning," *TENCON 2019 - IEEE Region 10 Conference*, 2019.

[5] N. Gupta et al., "Intelligent Music Recommendation System Based on Face Emotion Recognition," *2023 International Conference on Computing*, 2023.

[6] A. V. Iyer, V. Pasad, S. R. Sankhe and K. Prajapati, "Emotion based mood enhancing music recommendation," *2017 IEEE International Conference on Computing, Communication, Control and Automation (ICCUBEA)*, 2017

[7] J. Meinzen-Derr, S. Wiley, J. Creighton, and D. Choo, “Auditory Skills Checklist: Clinical Tool for Monitoring Functional Auditory Skill Development in Young Children with Cochlear Implants,” *Annals of Otology, Rhinology & Laryngology*, vol. 116, no. 11, pp. 812–818, Nov. 2007.

[8] G. W. Rebok et al., “Ten-Year Effects of the Advanced Cognitive Training for Independent and Vital Elderly Cognitive Training Trial on Cognition and Everyday Functioning in Older Adults,” *Journal of the American Geriatrics Society*, vol. 62, no. 1, pp. 16–24, Jan. 2014.

[9] M. L. Seelye et al., “Remotely Monitored Computer Activity and Mild Cognitive Impairment: Indicators of Executive Function,” *Computers in Human Behavior*, vol. 31, pp. 179–186, Feb. 2014.

[10] B. Parmar et al., “Activity Recognition and Fall Detection in Dementia Patients Using Smart Home Technology: A Review,” *IEEE Journal of Biomedical and Health Informatics*, vol. 24, no. 2, pp. 475–486, Feb. 2020.

[11] A. Botella et al., “Mood Disorders and Technology: A Promising Treatment,” *Clinical Psychology & Psychotherapy*, vol. 23, no. 1, pp. 1–6, Jan. 2016.

[12] E. Akl et al., “Wearable Technology for Early Detection of Dementia: An Exploratory Study,” *Journal of Alzheimer's Disease*, vol. 67, no. 4, pp. 1105–1114, 2019.

[13] K. P. Subramaniyam, R. A. Khan, and R. U. Islam, “AI-Driven Healthcare Solutions for Dementia Patients,” *Procedia Computer Science*, vol. 167, pp. 2432–2441, 2020.

[14] M. A. Nasrallah, “Digital Therapeutics for Alzheimer’s Disease: Opportunities and Challenges,” *Frontiers in Digital Health*, vol. 2, 2020.

[15] H. A. Abbass et al., “The Role of Artificial Intelligence in Tackling Alzheimer's Disease,” *Nature Machine Intelligence*, vol. 3, pp. 492–500, 2021.

[16] A. Khan and J. Lee, “Designing a Personalized Digital Assistant for Alzheimer’s Patients,” *Journal of Medical Systems*, vol. 45, no. 7, 2021.

[17] B. Yu, C. Wang, and H. Huang, “Mobile Health Applications for Alzheimer’s Disease: A Systematic Review,” *Aging and Disease*, vol. 11, no. 5, pp. 1203–1212, 2020.

[18] L. T. Thanh, A. D. Phan, and T. N. Ha, “A Smart Reminder and Monitoring System for Alzheimer’s Patients Using Machine Learning,” *Sensors*, vol. 20, no. 18, p. 5333, 2020.

[19] M. R. Bhatt, “AI-Based Cognitive Training Systems for Early Stage Alzheimer’s Patients,” *Journal of Healthcare Engineering*, vol. 2021, Article ID 5524086, 2021.

[20] C. Delaney, R. Clark, and D. Wittenberg, “Gamification in Cognitive Training for Alzheimer’s Disease,” *JMIR Serious Games*, vol. 9, no. 2, 2021.

6. APPENDICES

6.1 Plagiarism Report