AI base Alzheimer care and Cognitive Support Mobile App.

Project ID: 24-25J 304

Project Proposal Report

Bhagya P.S

IT21225024

B.Sc. (Hons) Degree in Information Technology

Department of Information Technology

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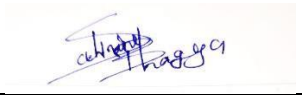
DECLARATION

We declare that this is our 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 our 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.

Candidate Name	Student ID	Signature
Bhagya P.S	IT21225024	

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

…….

Signature of the supervisor

(Mrs. Uthpala Samarakoon)

23/08/2024

……

Signature of the co-Supervisor

(Ms. Poorna Panduwawala)

23/08/2024

Abstract

The goal of this research is to create an AI-powered smartphone application that improves Alzheimer's care and cognitive support for patients, carers, and clinicians. Alzheimer's disease, which is characterized by cognitive deterioration, presents substantial obstacles in patient treatment, particularly in early detection and continued monitoring. Current systems frequently lack real-time analysis, tailored care recommendations, and user-friendly tools for non-expert carers. This research aims to fill these gaps by utilizing AI technologies including real-time voice analysis, cognitive evaluation tools, and personalized learning paths.

The study will involve designing and implementing a mobile application with features such as real-time speech analysis to detect early signs of cognitive decline, AI-powered cognitive assessment tools, and an AI assistant that provides social interaction prompts and personalized Alzheimer's care recommendations. The software will also prioritize data protection and security, ensuring that patient information is safe. To increase user engagement, the app will deliver real-time feedback and allow users to customize their cognitive workouts based on their performance. The study will follow a development lifecycle that includes requirements gathering, design, programming, testing, and deployment, as well as ongoing user feedback loops to improve features and functionality.

This novel technique stands out from previous research by providing a comprehensive, real-time, and personalized Alzheimer's care tool that incorporates numerous AI-powered features. This software, which focusses on ease of use and accessibility, will enable carers and physicians to better manage and monitor the progression of Alzheimer's disease, resulting in more prompt interventions and better patient outcomes. The projected conclusion is a scalable, user-friendly program that dramatically improves the quality of care delivered to Alzheimer's patients, thereby setting a new bar for AI integration in healthcare.

Keywords: Alzheimer's care, AI-powered mobile phone application, cognitive assistance, real-time speech analysis, cognitive assessment tools, personalized learning paths, healthcare technology, patient monitoring, data privacy and security, early diagnosis, carer support, and machine learning in healthcare.

Acknowledgement

This is to express my sincere gratitude to you for all of your help and advice when I put together my research proposal. I could not have submitted this proposal without your experience and willingness to share your knowledge.

I would like to express my sincere appreciation to my supervisor Mrs. Uthpala Samarakoon, and co- supervisor Ms. Poorna Panduwawala for their invaluable guidance and support throughout the development of this research proposal. Their expertise and insights have been instrumental in shaping the direction of my study. I am also grateful to the research panel for their constructive feedback and valuable suggestions that have significantly enriched the content and methodology of this proposal. Finally, I would like to thank you again for all of your help and encouragement. As I proceed with this study project, I am looking forward to collaborating with you more.

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LIST OF FIGURES

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LIST OF ABBREVIATION

ML	Machine Learning
AI	Artificial Intelligence
HIPAA	Health Insurance Portability and Accountability Act
GDPR	General Data Protection Regulation

01.Introduction

Alzheimer's disease is a neurological ailment characterized by progressive cognitive decline, which significantly limits patients' capacity to conduct daily activities and lowers their quality of life. With an ageing global population, the prevalence of Alzheimer's disease is rising, necessitating major research into early detection, monitoring, and management options. Historically, Alzheimer's care focused on clinical examinations, neuroimaging, and cognitive tests, but these procedures frequently detected the illness after severe cognitive impairment had occurred. As a result, there is a growing interest in using artificial intelligence (AI) and machine learning to detect early signs of cognitive decline, particularly voice analysis, which has emerged as a promising non-invasive technique.

In recent years, numerous studies have researched the relationship between speech patterns and health, demonstrating that subtle changes in speech, such as increased pauses, decreased complexity, and altered word usage, can be early indicators of cognitive decline associated with Alzheimer's disease. The primary focus of research in this sector has been the creation of machine learning models capable of detecting these changes in speech data.

To develop research in this field, it is essential to be proficient in a variety of AI and machine learning techniques, including speech recognition and natural language processing. This work relies heavily on techniques like feature extraction, which analyses specific speech qualities such as pitch, tone, and rhythm. Furthermore, understanding deep learning models, particularly Long Short-Term Memory (LSTM) networks, which can handle sequential input such as voice, is critical. These strategies enable the creation of systems that can recognize speech patterns while also adapting to new data and improving over time.

Today, the state-of-the-art in Alzheimer's care and cognitive support using AI includes systems that can analyses voice data in real time, revealing insights previously unavailable through traditional means. These technologies are increasingly being linked into mobile and web-based applications, providing tools for carers and physicians to utilize in everyday settings. Despite these gains, there are still obstacles in developing models that are both highly accurate and generalizable across populations. Current systems may also struggle with different accents, languages, and speech situations, emphasizing the need for more refinement.

Previous approaches to this challenge have primarily focused on improving the accuracy of speech analysis models or the user interface for non-expert carers. While these efforts have resulted in substantial advancements, they frequently fall short of delivering a holistic solution that combines real-time analysis, personalized recommendations, and strong security. Our method aims to fill these gaps by creating an AI-powered system that not only analyses speech patterns but also seamlessly connects with existing healthcare infrastructure, providing a user-friendly interface with customizable features for various patient demands.

Building on past work, our system will use cutting-edge voice recognition technology and complex machine learning models, but with an emphasis on adaptability and personalization. By continuously learning from the data it processes, the system will give increasingly precise assessments that are personalized to particular patients. Furthermore, our approach would priorities data security and privacy, ensuring compliance with healthcare legislation such as HIPAA and GDPR, an issue that has received less attention in earlier studies.

1.1 Background and Literature Survey

Alzheimer's disease is a progressive neurological disease that causes cognitive decline, memory loss, and, finally, the inability to perform daily activities. Alzheimer's disease is growing as a serious public health concern as the world's population ages. Traditional diagnostic approaches, like as neuroimaging, clinical assessments, and cognitive testing, frequently uncover the disease only after considerable brain damage has occurred, limiting the possibility of timely intervention. As a result, there is an increasing interest in developing non-invasive, low-cost technologies for early identification and ongoing monitoring of Alzheimer's disease [1].

One potential area of research is the examination of speech patterns as indicators of cognitive health. Speech production is a difficult cognitive task that involves several brain areas, and minor alterations in speech can indicate underlying neuronal degeneration. According to research, persons with Alzheimer's disease frequently demonstrate speech problems such as decreased fluency, greater pauses, simpler phrase structures, and impaired word retrieval. These changes can occur early in the disease process, making speech analysis an effective early diagnosis technique.

In recent years, there has been an increase in research into the association between speech and cognitive loss, with multiple studies indicating the potential of utilizing speech analysis to diagnose Alzheimer's disease. For example, while this research has built a solid foundation, there are still obstacles in developing models that are accurate and generalizable across varied populations. [1] for example, investigated the application of deep learning models such as Long Short-Term Memory (LSTM) networks, which are ideal for analyzing sequential data such as voice. Their findings indicated that LSTM networks could grasp temporal dependencies in speech, outperforming standard models. However, the models struggled with changes in speech patterns due to factors such as accent, dialect, and individual speaking style.

In addition to technological challenges, effective adoption of these AI systems in clinical settings necessitates user-friendly interfaces and interaction with existing healthcare infrastructure. [2] addressed issue by creating a mobile app that offers carers real-time speech analysis. Their method was developed for non-expert users, providing information into a patient's cognitive health during regular discussions. While this is a huge step forward, the application's accuracy is restricted by speech data unpredictability and the requirement for ongoing changes to the underlying models.

Building on these findings, our research seeks to create an AI-powered Alzheimer's care and cognitive support system that overcomes the limitations of earlier techniques. Our solution will combine powerful voice recognition technology and machine learning models, with an emphasis on adaptability, personalization, and security. By continuously learning from the data it collects, the system will provide more accurate assessments tailored to particular patients. Furthermore, we will prioritize data security and privacy to ensure that our system meets healthcare requirements and safeguards patient information.

The literature indicates the potential of AI and speech analysis in Alzheimer's care, but it also emphasizes the need for additional study to address current obstacles. Our research aims to advance the state of the art by creating a comprehensive, user-friendly tool that allows carers and physicians to better monitor and treat cognitive decline in Alzheimer's patients.

1.1 Research Gap

The proposed system will address key gaps in existing research, particularly in dynamic emotion-cognition interaction, real-time speech analysis, personalized learning paths, and improved data security. This table clearly illustrates that existing research has yet to properly address these critical elements, emphasizing the uniqueness and potential effect of the proposed system [4] [5] [6] [7].

Below shows a summary table about the research gap.

Features	01	02	03	04	Proposed System
Real-time Speech Analysis for Dementia	✗	✗	✗	✗	✓
Cognitive Assessment Tools	✓	✗	✗	✓	✓
AI Assistant & Social Interaction Prompts	✗	✓	✓	✗	✓
Alzheimer's Care Recommendations	✗	✗	✗	✓	✓
Data Privacy and Security	✗	✗	✗	✗	✓
Personalized Learning Paths	✗	✗	✗	✓	✓
Real-Time feedback and review	✗	✗	✗	✓	✓

Figure 1 Research Gap Table

1.2 Research Problem

Despite advancements in Alzheimer's care technology, current solutions frequently lack a completely integrated approach that includes real-time analysis, personalized cognitive assistance, and secure data processing. While some research has focused on voice analysis, cognitive tests, and data security, these functions are rarely integrated into a single platform. Furthermore, critical components such as AI-powered social engagement prompts, personalized care recommendations, and real-time feedback mechanisms are either underdeveloped or completely lacking. This fragmentation hinders the possibility of detecting cognitive decline early, developing personalized therapeutic strategies, and providing comprehensive support to both patients and carers. The research challenge is to create a cohesive system that incorporates these important qualities to improve Alzheimer's disease diagnosis, monitoring, and management, hence enhancing patient outcomes and carer efficacy.

0.2 Objectives

2.2 Main Objectives

To improve Alzheimer's disease diagnosis, monitoring, and management, I will create an AI-powered Alzheimer's care and cognitive support system that includes real-time speech analysis, cognitive assessment tools, AI-driven social interaction prompts, personalized care recommendations, data privacy and security measures, personalized learning paths, and real-time feedback mechanisms.

2.2 Specific Objectives

1. Real-time Speech Analysis for Dementia.
2. Cognitive Assessment Tools.
3. AI Assistant & Social Interaction Prompts.
4. Alzheimer's Care Recommendations.
5. Data Privacy and Security.
6. Personalized Learning Paths.
7. Real-Time Feedback and Review.

2.2.1 User Requirements

1. Carers:

- The ability to monitor patients' cognitive health in real time using a user-friendly interface.
- Access to personalized care recommendations and learning paths for each patient.
- Tools to improve social connection and emotional support for patients.
- Secure access to patient data with privacy safeguards.
- Real-time feedback on the patient's progress and recommendations for future care.

2. Clinicians:

- Real-time speech analysis is being used to develop advanced diagnostic and monitoring tools for Alzheimer's disease.
- Comprehensive cognitive testing tools for ongoing evaluations.
- The ability to see thorough reports and patterns in patient data over time.
- Integration with existing healthcare systems allows for smooth data transfer and analysis.
- Options for customizing care plans based on AI-generated recommendations.

3. **Patients:**

- Engaging cognitive exercises and personalized learning paths are intended to promote cognitive wellness.
- Features that encourage socialization and emotional well-being.
- Assurance that their information is safely stored and managed.

2.2.2 Functional Requirements

1. **Real-Time Speech Analysis for Dementia:**

- The technology must analyze speech patterns in real time to detect cognitive deterioration.
- The analysis should include data such as speech rate, word usage, phrase complexity, and pause frequency.

2. **Cognitive Assessment Tools:**

- The system must have tools for carrying out cognitive assessments at regular intervals.
- Assessments should be customizable and trackable over time.

3. **AI Assistant and Social Interaction Prompts:**

- The system must have an AI assistant who delivers prompts to stimulate social interaction.
- The prompts should be tailored to the patient's choices and needs.

4. **Alzheimer's Care Recommendation:**

- The system must provide care suggestions based on real-time data analysis.
- Recommendations should be actionable and simple for carers and professionals to follow.

5. **Data Privacy and Security:**

- The system must follow applicable data protection regulations (e.g., GDPR, HIPAA).
- Patient information must be protected by data encryption and safe access controls.

6. **Personalized learning paths:**

- The system must design and alter learning paths based on the patient's performance and cognitive requirements.
- Paths should be updated in real time as new data is received.

7. **Real-time feedback and reviews:**

- The technology must offer carers and clinicians with real-time feedback during patient encounters.
- The comments should contain warning signs of impending cognitive deterioration as well as recommendations for additional investigation.

2.2.2 Non-Functional Requirements

1. Performance
2. Usability
3. Scalability
4. Reliability
5. Security
6. Maintainability
7. Compliance

0.3 Methodology

3.1. Overall System Overview

The proposed Alzheimer's care and cognitive support platform uses AI to help carers, professionals, and patients through integrating modern technologies with personalized care techniques. The system focusses real-time analysis, personalized actions and secure data storage, providing a comprehensive answer to the problems of Alzheimer's care.

The system is divided into interconnected modules, each of which performs a certain purpose to create a stable and user-friendly platform. The front-end interface was created to be accessible and usable by all users, including carers, clinicians, and patients. It is compatible with mobile phones. The user interface provides real-time updates, warnings, and insights, as well as simple access through functions such as cognitive evaluations, real-time speech analysis, and care recommendations.

The AI and machine learning (ML) engine is at the core of the system, powering real-time speech analysis and cognitive evaluation tools. This engine analyses voice data to detect patterns indicative of cognitive deterioration and provides instant feedback and alerts. The ML models are trained on a large dataset of speech patterns and cognitive performance measures, allowing the system to constantly improve its accuracy and efficacy.

The data management and security layer have a powerful module for securely storing all patient data, such as speech recordings, evaluation findings, and personal information. Data privacy and security are prioritized, using encryption mechanisms that safeguard data at rest and in transit. The system adheres to applicable standards, such as GDPR and HIPAA, and contains data anonymization capabilities to protect patient identification when data is utilized for research or AI model training.

Cognitive assessment and monitoring tools offer a series of tests and exercises suited to the patient's cognitive level, with improvement tracked over time. These technologies are connected with the AI engine, allowing for real-time monitoring and analysis of patient performance, which is then utilized to change care plans and learning routes as needed.

The personalized learning and care recommendation engine creates individualized learning routes based on the patient's cognitive evaluation results, ensuring that each patient receives the support they need to preserve cognitive function.

The AI assistant improves patient involvement by prompting for social connection and emotional support. This feature is especially useful for patients who suffer with isolation or need encouragement to participate in social activities. The prompts are personalized depending on the patient's preferences and interaction history, making them both relevant and effective.

The system also incorporates a real-time feedback and review mechanism that informs carers and professionals about the patient's present cognitive condition and prospective areas of concern.

3.2. Overall System Overview Diagram

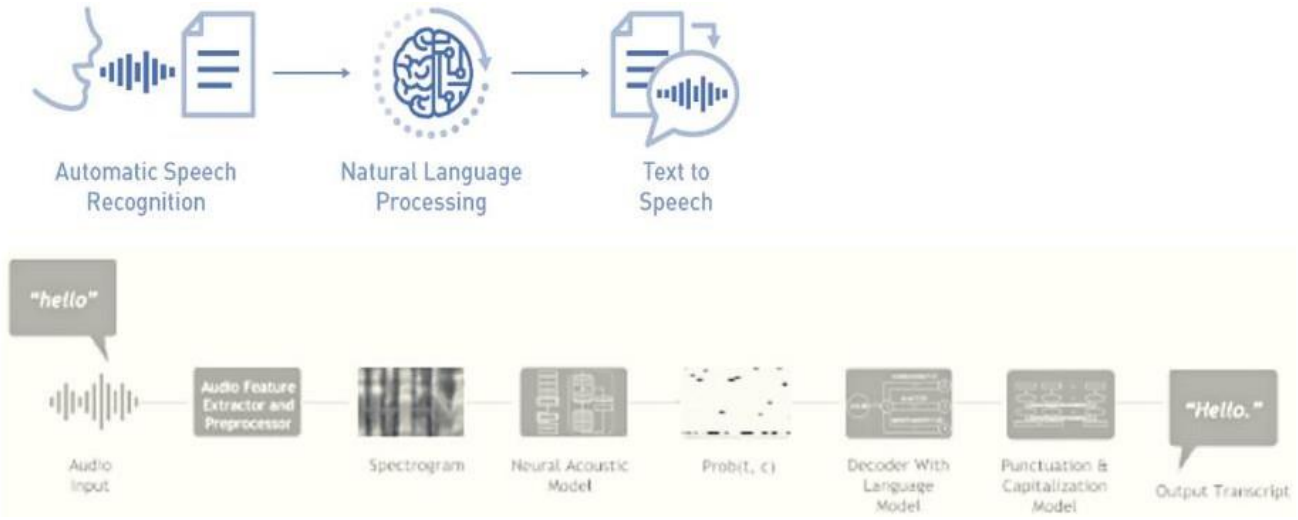

Figure 2 System overview

3.1.1 Hardware Component

Smartphones and tablets offer access to the platform's front-end interface, allowing carers, professionals, and patients to interact with the system. They enable features like as cognitive tests, real-time speech analysis, and care recommendations.

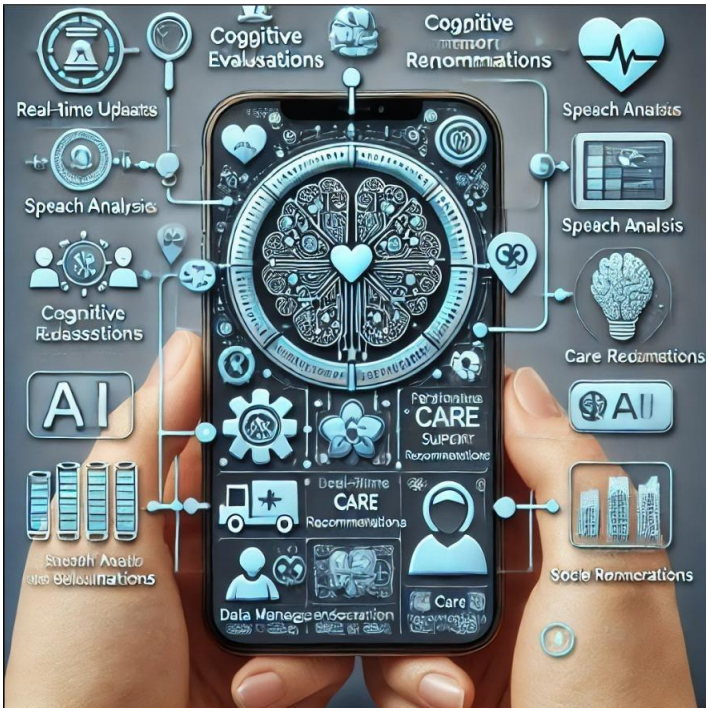

Figure 3 Mobile App

04. Description of Personal and Facilities

4.1. Functionality Of Project Component

ID Number: IT21225024

Name: Bhagya P.S

Task: Dynamic Site Suitability Analysis and Final product prediction

4.1.1. Connectivity Of the Project Component

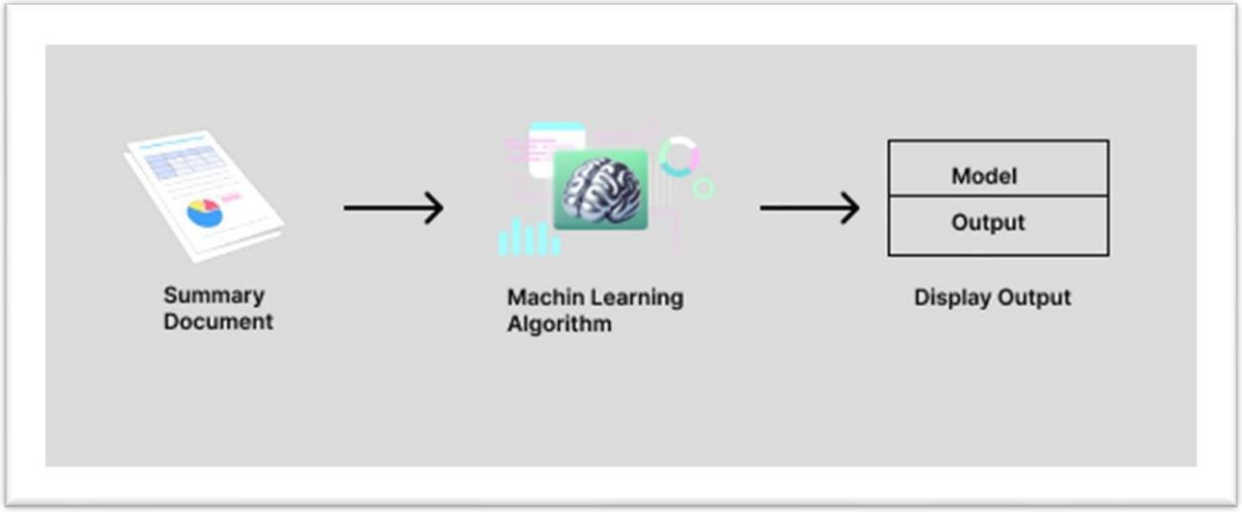

Figure 4 Connectivity Of the Project Component

4.1.2. Functionality Of the Hardware Component

- **Smartphone and Tablet**

Provide access to the platform's user interface, enabling caregivers, clinicians, and patients to interact with the system. Support real-time updates, alerts, and insights.

4.2. System Technology

1. Machine Learning - to analyze car features and classify them into different models.
2. Notification and Alert - The system will use real-time notification techniques to inform users.
3. Data Management and Security - to gather data from various sources to improve the accuracy of the classification system.

Programming Languages

- Python
- React Native
- JavaScript
- HTML/CSS

Tools

1. TensorFlow - an open-source software library for dataflow and differentiable programming across a range of tasks.
2. Visual Studio Code - A lightweight and adaptable code editor that supports a variety of programming languages and frameworks. It's great for building using React Native or Flutter.
3. Android Studio - The official IDE for Android development, which also works with Flutter. It includes comprehensive tools for designing, testing, and debugging Android applications.
4. Figma - A cloud-based design tool for UI/UX design that facilitates cooperation between designers and developers. It's perfect for developing prototypes and wireframes for mobile apps.
5. Firebase - Firebase offers a full suite of mobile app development capabilities, including authentication, real-time databases, cloud storage, and hosting.
6. Firebase Test Lab - Firebase provides a cloud-based application testing environment. It allows you to test your app across a variety of devices and setups.
7. GitHub - Platforms for hosting Git repositories that include tools for continuous integration (CI), problem tracking, and collaboration.
8. Firebase Cloud Message - FCM is a cross-platform messaging solution that lets you deliver notifications and messages to users on Android, iOS, and web apps.

Hardware parts

- Smartphones and Tablets

  A variety of smartphones and tablets with varied operating systems (iOS and Android), screen sizes, and hardware specifications are necessary to evaluate the app's compatibility, performance, and user experience.

  Examples:
  Android: Google Pixel, Samsung Galaxy, and OnePlus devices.
  iOS: iPhone models (latest versions like iPhone 12, 13, or after) and iPads.

05. Gantt Chart

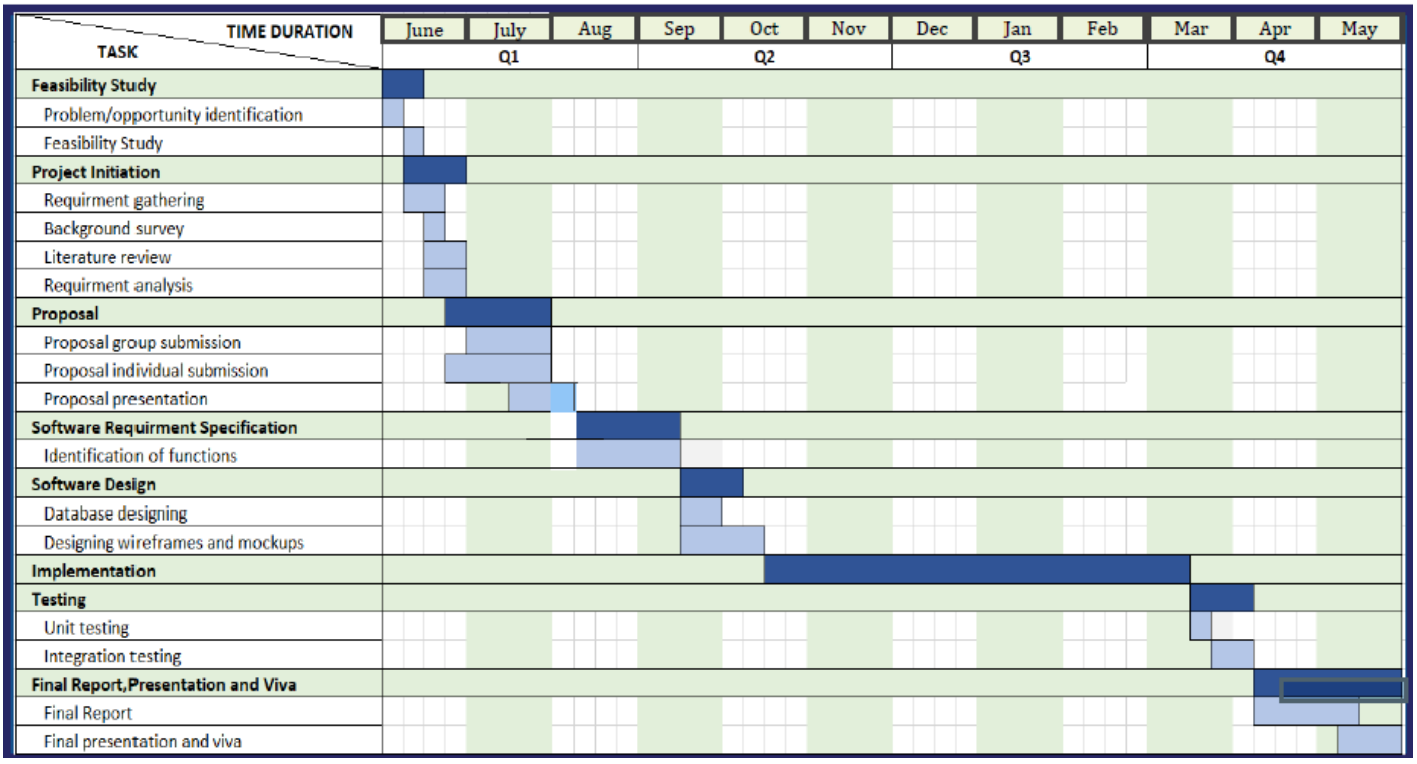

Figure 5 Ghant Chart

06. Work Breakdown Structure

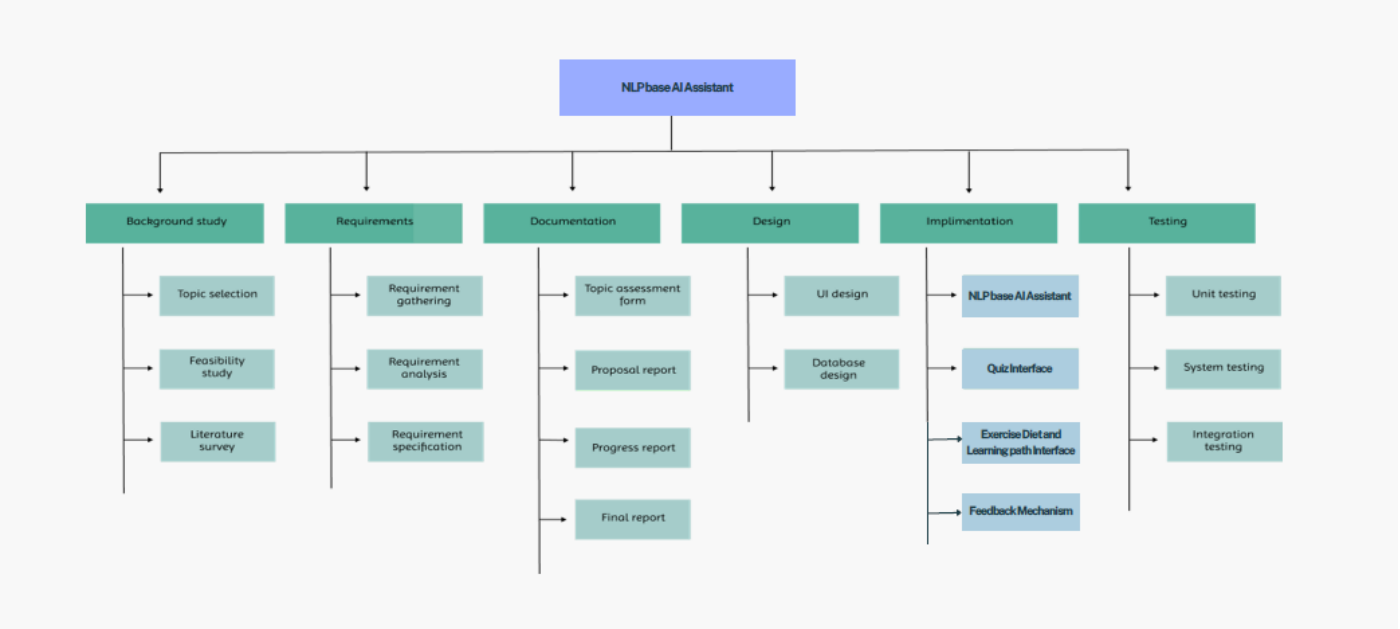

Figure 6 Work Breakdown chart

07. Commercialization

Commercializing an AI-powered Alzheimer's care and cognitive support mobile app requires a multifaceted approach that includes market entrance tactics, pricing models, collaborations, and scaling initiatives. This is a breakdown of the commercialization strategy.

1. Target Market: Alzheimer's patients, caregivers, and clinicians.

2. Pricing Model: In Basic Plan It has innovative features such as personalized learning routes, AI-powered emotional support, and real-time feedback. Targeted for major healthcare organizations and institutes.

3. Distribution Channel: Launch the app on key platforms such as Google Play and the Apple App Store.

4. Marketing and Promotion: Raising awareness can be accomplished through internet commercials, social media campaigns, and content marketing.

08. Budget

Description of Tasks	Estimated
1. Clod Infranstructure	Rs. 8000
2. Internet Charges	Rs. 5000
3. Travelling Cost for Information Collection	Rs. 10000
4. Data gathering	Rs. 10000
Total	**33000**

09. Reference List

[1] C. e. a. Jack, "Toward a biological definition of Alzheimer's disease." Alzheimer's & Dementia,," *NIA-AA Research Framework,* vol. 14, pp. 535-562, 2018.

[2] M. &. R. Yancheva, " "Vector-space topic models for detecting Alzheimer's disease.," *Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics,* vol. 2, no. 2016, pp. 233-237, 2016.

[3] K. e. a. Williams, "A Mobile Application for Real-Time Alzheimer's Detection Using Speech Analysis," *Journal of Biomedical and Health Informatics,,* vol. 24, pp. 1872-1882, 2020.

[4] V. &. P. N. (. ". p. i. A. d. a. m. c. i. A. c. r. J. o. C. a. E. N. Taler, ""Language performance in Alzheimer's disease and mild cognitive impairment: A comparative review.," *Clinical and Experimental Neuropsychology,* vol. 30, pp. 501-556, 2008.

[5] B. &. S. M. Beffara, "The potential of speech data in the detection of Alzheimer's disease: a systematic review.," *Alzheimer's Disease Reports,* vol. 2, pp. 95-104, 2018.

[6] A. e. a. König, "Fully automatic analysis of verbal fluency performance in patients with neurodegenerative diseases," *2018,* p. 13.

[7] K. e. a. Fraser, "Automated classification of primary progressive aphasia subtypes from narrative speech transcripts.," vol. 83, pp. 54-68, 2016.