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Real-Time Support System for Enhancing Memory and Cognitive Health

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Abstract: Millions suffer from memory loss and cognitive impairment, two of the most devastating diseases. Recent data puts the worldwide dementia population at around 55 million and predicts an exponential rise over the next two decades. Alzheimer's disease, the most common type of dementia, steadily impairs memory, thinking, and independence. This disorder strains patients and their families physically and emotionally. Patients often forget important activities like taking medication, recognising familiar faces, or remembering their home address, which can cause confusion, discomfort, and even danger. Considering this growing concern, we developed a Memory Aid Application for Cognitive Health Disorders to support individuals experiencing memory loss. The app offers a range of basic features, including personalised reminders for daily activities and medication, facial recognition to help identify loved ones, contact storage for quick communication, smart suggestions to establish daily routines, and a share location feature for added safety. All functionalities are created with compassion for patients with cognitive disorders. Our software brings order, stability, and reassurance to patients and caretakers. This program takes a little but important step towards a safer, more familiar, and more controlled environment by offering a virtual buddy for memory and routine.

Keywords: Cognitive Health Disorders Support; Memory Aid Application; Flutter Application; Facial Recognition; Real-Time Support System; Cognitive Disorder; Memory Loss; Alzheimer's Disease; Mental Decline.

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1. Introduction

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In the world today, where the pace of technological innovation continues to shape lives, countless families and individuals quietly grapple with the emotional and practical issues associated with cognitive disorders such as Alzheimer's and dementia. As indicated in world health statistics, more than 55 million people have dementia across the globe, a figure predicted to swell exponentially in the next couple of decades. These diseases affect not just memory, but the ability to get through daily routines, recognise loved ones, speak effectively, and live independently. For caregivers and family members, watching a loved one forget their past, faces, or surroundings can be heartbreaking and infuriating. In most instances, patients become extremely dependent on others for basic routines, causing frustration, confusion, and loss of dignity. Our paper, the Memory Aid Application for Cognitive Health Disorders, was conceived out of a profound empathy for these individuals and a need to give them something that could recapture some of that lost control. The application is designed to serve as a virtual companion, aiding users through various functionalities, including reminders for medications and activities, facial recognition for identifying familiar faces, routine suggestions, memory aid features, and a function for sharing their location with caregivers. It aims to reduce confusion, enhance safety, and bring comfort not just to patients but also to their caregivers and families. By simplicity and functionality, this app is a humble but worthwhile contribution towards making the lives of individuals affected by memory disorders better day to day, to promote independence, and facilitate peace of mind.

1.1. Problem Statement

Memory loss and mental decline, particularly in diseases such as Alzheimer's and dementia, can complicate daily life and often become distressing for caregivers and patients alike. Forgetting the names of people, their daily habits, or even their location can cause confusion, anxiety, and loss of independence. Caregivers may find it difficult to offer constant care, and patients may become isolated or helpless with memory loss. Even with the greater availability of digital solutions, easy-to-use and accessible tools still do not exist that tackle the everyday issues of people with memory disorders. Most of the apps available are either too complex or too broad to meet the specific needs of these users. There is a definite need for a simple, intuitive, and compassionate system that can remind patients to complete important tasks, recognise loved ones, and stay connected with the people who matter most to them—all while taking some of the burden off of caregivers. Our paper aims to fill this need with a thoughtful memory aid app that can deliver practical, everyday support for cognitive health.

1.2. Objective

The ultimate purpose of our paper, Memory Aid Application for Cognitive Health Disorders, is to build a helpful and friendly app that can make daily life easier and safer for patients with memory diseases, such as Alzheimer's and dementia. We aimed to create an application that transcends mere technology, offering patients a more confident and independent approach to addressing their everyday challenges. We aimed to develop features that address real, everyday needs. These include setting important reminders for medication and daily activities, providing familiar face recognition to alleviate concerns about recognising loved ones, and offering location-sharing capabilities to enhance user security and confidence. We also aimed to streamline communication by storing valuable contact information and making it easily accessible, allowing patients to stay in touch with their loved ones more conveniently. At the heart of our mission is empathy—the desire to build something not only technically successful, but emotionally supportive. Through this memory aid application, we aim to enable patients to regain a sense of autonomy and dignity, while also reducing the caregiver burden. Our purpose is to bridge the gap between technology and human compassion, ultimately enabling those affected by cognitive disorders to lead more manageable and connected lives.

2. Literature Review

Golbabaei et al. [1] present a network-based analysis of cognitive-related resting state networks in Alzheimer's disease. This study explores brain connectivity patterns using resting-state fMRI, providing insights into cognitive impairments in Alzheimer's patients. Graham et al. [2] present a framework for designing interactive healthcare systems that bridge the gap between patients and healthcare professionals. The study emphasises user-centred design to improve communication and engagement in clinical environments. Taurino and Bellomo [3] present a system engineering model for healthcare service performance analysis through a case study on a territorial healthcare agency. It aims to optimise operational efficiency and resource management in healthcare delivery.

Chen et al. [4] present U-Care, a comprehensive living and healthcare network for older people. The system integrates various services to support independent living, health monitoring, and emergency management. Sreelakshmy et al. [5] present a patient health monitoring system using smart IoT devices for medical emergency services. The system ensures continuous health status tracking and timely alerts during emergencies. Kareem and Faust [6] present a safety validation framework for a smart heart health monitoring service. This work focuses on establishing reliability and trustworthiness in real-time health data processing systems. Lakshmi et al. [7] present a smart health monitoring system for older people. It leverages sensor-based IoT technologies to monitor health metrics and ensure timely intervention in case of abnormal conditions.

Ramzan et al. [8] present a new method for facial and corporal expression recognition. This approach enhances human-computer interaction by improving the accuracy and responsiveness of emotion recognition systems. Nwosu et al. [9] present an AI-based facial emotion recognition system aimed at enhancing patient-provider interaction in healthcare settings. This system supports empathetic and effective care delivery. Wangberg and Psychol [10] present personalised technology for supporting health behaviours. The work advocates for customised digital interventions that cater to individual health needs and behavioural motivations. Madhu et al. [11] present advanced machine learning methods for predicting cognitive functions. This study contributes to the early detection and monitoring of cognitive decline using predictive modelling techniques.

Enna et al. [12] present a cognitive assistance system for dementia patients. The solution integrates multiple technologies to support memory, orientation, and communication tasks. Lulle et al. [13] present an AI-powered application that enhances cognitive health and provides caregiver support for dementia patients. The system combines assistive tools with real-time data to improve quality of life. Golbabaei et al. [14] present a machine learning approach for classifying Alzheimer's disease and mild cognitive impairment using resting-state fMRI brain graphs. This work aids in early diagnosis and differentiation of neurodegenerative conditions. Saribudak et al. [15] present a computational model to analyse the effects of pharmacologic therapy on the cognitive abilities of Alzheimer's disease patients. The study quantifies treatment efficacy through cognitive performance metrics.

3. Methodology

3.1. System Architecture

The Memory Aid Application is designed in detail to help individuals suffering from cognitive health problems, specifically victims of memory loss. Essentially, the application offers a Reminders feature—medical and general alike—which allows patients or caregivers to schedule important activities with suitable times, regulated through the file in Flutter. Besides assisting with routine tasks, the Smart Suggestions feature provides subtle reminders and recommendations based on the patient's routines, reminding them to adhere to a structured and predictable routine. As a countermeasure to the periods of forgetfulness, the Search Memories feature enables patients to scroll and recall past events stored in the app, providing a comforting sense of continuity and connection.

Maintaining contact with loved ones is also easy via the Contacts feature, where the patient's significant contacts are stored, allowing them to dial or send messages to family members at ease, particularly via WhatsApp, by just tapping once. These messages are monitored independently (Person 1, 2, 3) and simplify communication to be stress-free. The Face Recognition feature is another useful capability, employing TensorFlow Lite and MobileNet V2 and FaceNet embeddings to recognise familiar faces and assist patients in recognising family members or caregivers—restoring emotional connections that loss of memory could have destroyed. Last, the Share My Location function, driven by Google API, allows patients to share their location with their relatives via email or WhatsApp, providing peace of mind to the patient and their loved ones, particularly in the event of confusion or getting lost. All these functions collectively render the app a caring companion, combining intelligent technology and real-life functionality to transform the lives of individuals walking through the journey of memory-related health conditions (Figure 1).

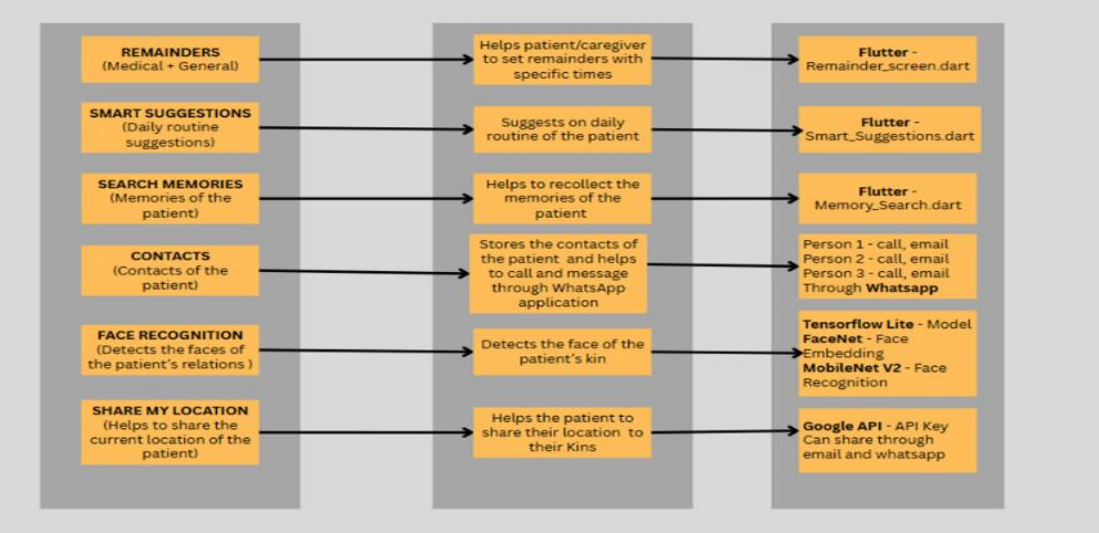

Figure 1: Functional block diagram of memory aid application for cognitive health disorders

3.2. Modules Implementation

3.2.1. General Reminders

Life isn't merely medication—there are hundreds of everyday activities users require reminders to perform, ranging from meals and personal hygiene practices to exercise, hydration, or getting to appointments. That's where the General Reminders function is useful. Just like medical reminders, users or caregivers can program reminders for any non-medical activity that is part of the user's routine. These reminders assist in having a well-organised day, which is crucial for memory-impaired users who, otherwise, tend to miss these little but vital activities. With an easy interface and self-explanatory scheduling features, users can construct their day-to-day schedule and receive timely and readable notifications, making daily life easier and less tiring.

3.2.2. Smart Suggestions

By using the reminder system over time, our app learns from the user's behaviour and begins offering Smart Suggestions. For example, if a user regularly forgets the 8 PM dose, the system can suggest adjusting the reminder time or issuing a second prompt. Likewise, if a particular activity is skipped repeatedly, the app can alert a caregiver to check in or reschedule. This intelligent feedback loop should coax users toward better habits subtly without intrusiveness. While still a straightforward implementation currently, this functionality lays the groundwork for upcoming enhancements in the form of habit logging and adaptive learning, making the app more intelligent and personalised in the long run.

3.2.3. Search Memories

One of the most emotionally resonant aspects of our app is Search Memories, which helps users reconnect with their past. Memory loss tends to hit hardest at the ability to remember people, events, or experiences. Still, through this feature, users can upload images or record memories and then search for them using keywords later. For example, entering "birthday" could display a photo from a previous celebration, or "granddaughter" might reveal photos and messages about that special person. This not only enhances memory recall but also offers emotional reassurance and a sense of familiarity. The search is intuitive and user-friendly for older users, with visual previews and easy navigation that make memories accessible as a heartwarming and easy experience.

3.2.4. Contacts Management

Identifying familiar individuals is a daily struggle for individuals experiencing memory loss. To alleviate this struggle, we created a Contacts Management module that holds vital information regarding important individuals in the user's life—family, close friends, caregivers, or physicians. The contact entries contain a name, relationship to the user (e.g., daughter, nurse), and a picture. This enables the user to view and identify individuals they encounter frequently. Additionally, this database of recognised faces integrates directly with the Facial Recognition system, which can compare detected faces with stored contacts and show useful context to the user in real-time. It's a subtle gesture that makes a huge difference in the confidence of the user in social encounters.

3.2.5. Share My Location

One of the highest priorities is to keep the users safe, and Share My Location is an efficient method to do so. With one tap, the user's real-time location can be shared with an approved caregiver or relative through Google Maps API integration. This is especially useful if the user goes for a walk outside and becomes lost, or if the caregiver wants to check up without calling or confusing. The position information is dynamically refreshed, and only authorised users have access to it, both for safety and for privacy. It's a reassuring tool that provides independence while keeping loved ones connected and informed.

3.3. AI-Based Facial Recognition Implementation

In a world where memory loss impacts millions, from the elderly suffering from Alzheimer's to patients with trauma-induced amnesia, remembering loved ones can be one of life's most agonising dilemmas. To fill this emotional void and provide solace to those struggling with cognitive loss, our app incorporates a well-crafted facial recognition capability fueled by TensorFlow Lite. This AI-based system is not just a flashy tech bells and whistles—it's a gentle pal that helps users revive old faces, moments, and emotions. The launch begins with training a lightweight machine learning model on a dataset of stored images of the users' loved ones and close friends. The caregivers or the users upload these photographs and store them in Firebase Cloud Storage in a secure manner. The AI recognises individual faces by identifying significant facial features and mapping them to distinct numerical signatures. Once it has recorded a face from the camera or an image, it queries for matches against saved encodings and provides live suggestions like "This is your granddaughter, Ananya. "The good news is that it can work

offline and on smartphones due to TensorFlow Lite's optimisation, which keeps the system fast and convenient for everyday use. The entire process is designed to be safe, personal, and empowering—users are not just reading off a screen; they're reconnecting with their lives, memories, and relationships. This AI does not replace human care but rather softens it as a bridge to clarity from confusion. And for caregivers, to know that their loved ones now have a digital helping hand that is always present, always patient, and always kind is such a relief (Figure 2).

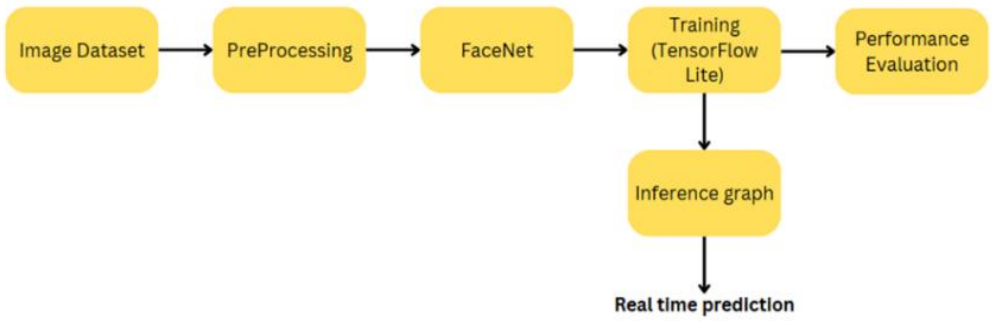

Figure 2: Facial recognition pipeline

The process begins with the creation of an image dataset, where a set of face images (such as Raghavi, Sriram, and Sweatha) is collected to enable the model to learn to differentiate between individuals, forming the foundation for building a trustworthy and intelligent system. Before feeding the images into the model, they undergo preprocessing, which involves resizing, cropping, and normalising the faces to ensure consistency across the dataset—like preparing photographs in a uniform format before placing them into an album. The next step involves using FaceNet, a pre-trained deep learning model that converts facial images into numerical representations, known as embeddings, which serve as unique digital signatures for each person. These embeddings are then used to train a lightweight model with TensorFlow Lite, an optimised framework for mobile and embedded devices, allowing for efficient real-time applications. The model is evaluated using performance assessment techniques, where fresh data is tested, and accuracy and loss plots are analysed to ensure reliability and prevent overfitting. Finally, during inference, the trained model is deployed for real-time prediction, enabling it to instantly recognise and identify individuals when a new face appears in front of the camera, much like an intelligent assistant that responds instantly.

Algorithm 1-Facial Recognition Implementation

```
// Task 1: Face Detection
For each frame F in the real-time video stream do
   faces ← detect_faces(F)
End For
// Task 2: Face Preprocessing
For each detected face f in faces do
   f ← align_face(f)
   f ← resize (f, (160, 160))      // Resize to model input size
   f ← normalize(f)               // Pixel values scaled between -1 and 1
End For
 //Task 3: Embedding Generation
For each preprocessed face f do
   E(f) ← FaceEmbeddingModel(f)    // Generate 128/512-D embedding
End For
// Task 4: Identity Prediction
For each embedding E(f) do
   name ← compare_with_known_embeddings(E(f))    // Euclidean or cosine similarity
   If distance < threshold then
      predicted_name ← name
   Else
      predicted_name ← "Unknown"
   End If
```

End For
// Task 5: Display Results
For each detected face f do
  draw_rectangle(f)
  put_text (predicted_name, above_rectangle)
End For
// Task 6: Convert Model to TFLite (for deployment)
Convert FaceEmbeddingModel to TensorFlow Lite format
Integrate TFLite model into Flutter application.

4. Results and Discussion

The facial recognition system used in our app showed promising results in real-time identification of familiar people, a key support feature for people with Alzheimer's disease. With the incorporation of the FaceNet architecture, we were able to extract accurate facial embeddings and compare them efficiently, resulting in effective recognition of registered contacts. This enabled the patient to easily recognise family members or caregivers, improving safety and emotional comfort. The system accurately identified faces during testing with constant performance under favourable light conditions and moderate facial expression or angle variations. Performance was only slightly affected in low-light environments or under partially occluded face conditions, suggesting areas for future improvement.

However, for our defined users—aged participants with familiar caregiver groups—the results were robust enough to be of everyday use. Other features, such as reminder messages and the simple-to-use contact list user interface, were also popular among users and test participants. These functionalities were implemented to tackle the cognitive difficulties experienced by most Alzheimer's patients, including forgetfulness and confusion. By providing subtle reminders for activities and utilising a known face database, our app not only helps retain memory but also minimises anxiety for patients. Most poignant in our discussions with caregivers and testers was the emotional impact of the system.

Knowing that their loved one would be able to recognise and remember important people was reassuring and felt like a connection. While we did not implement cloud functionality at this point, the independent system still provided significant assistance, proving that effective technology doesn't necessarily need to involve sophisticated infrastructure. In short, the results confirm our methodology: even a simplified, offline facial recognition system can make a real impact in individuals' everyday lives with memory-based conditions. Moving forward, we aim to enhance the system's capabilities and accessibility further, ensuring that even more individuals in need receive support.

4.1. Functional Module Performance

Our memory aid app's home screen was crafted in a simple, easy-to-navigate design, with the targeted users — patients with Alzheimer's and their care providers — kept in mind. The home screen features six major modules, each of which performs a particular cognitive or supportive role (Figure 3).

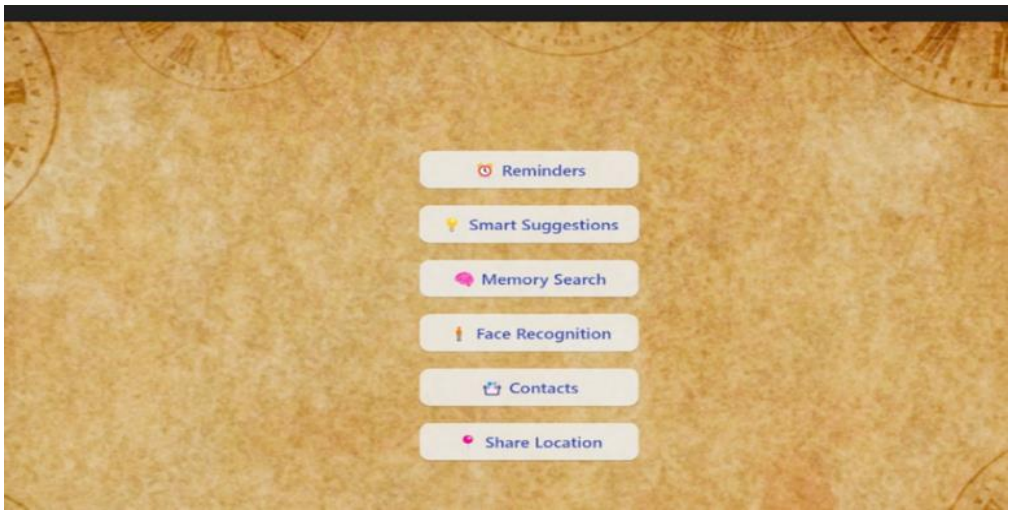

Figure 3: Memory aid application- home screen

4.1.1. Reminders

This module assists users in setting and receiving timely reminders for medical and general activities (Figure 4).

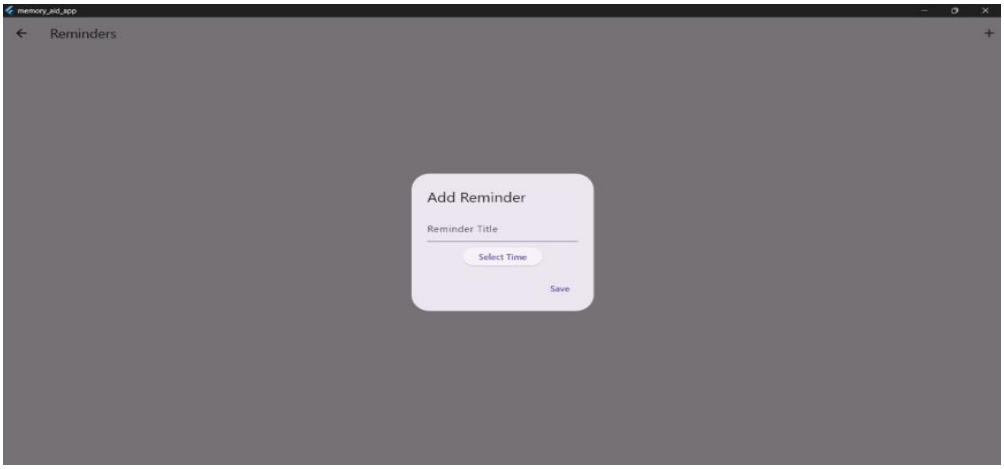

Figure 4: Reminder screen

Figure 5 helps users maintain their daily routines independently.

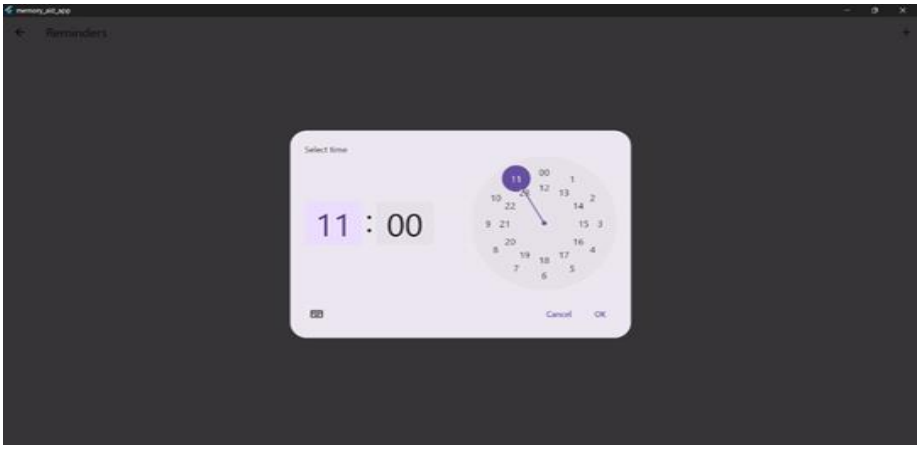

Figure 5: Reminder screen

4.1.2. Smart Suggestions

Directed by user behaviours and preferences, this module provides personalised suggestions such as reminders for hydration or reminders for tasks to promote healthy conduct and proactive care (Figure 6).

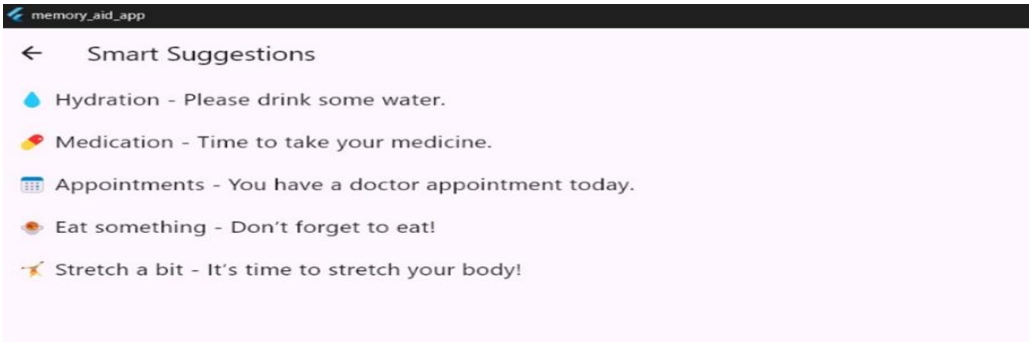

Figure 6: Smart suggestions screen

4.1.3. Memory Search

A helper tool for remembering memory, this application enables users to query stored memory — in the form of text entries, images, or sound — via plain keyword or tags (Figure 7).

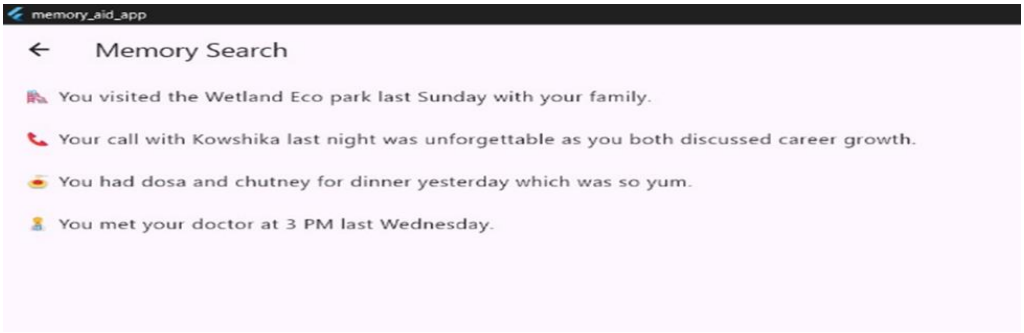

Figure 7: Memory search screen

4.1.4. Contacts

A simple contacts manager with secure storage for important people such as loved ones, carers, or doctors. Its clean design allows users to add their loved ones and call them immediately when needed (Figure 8).

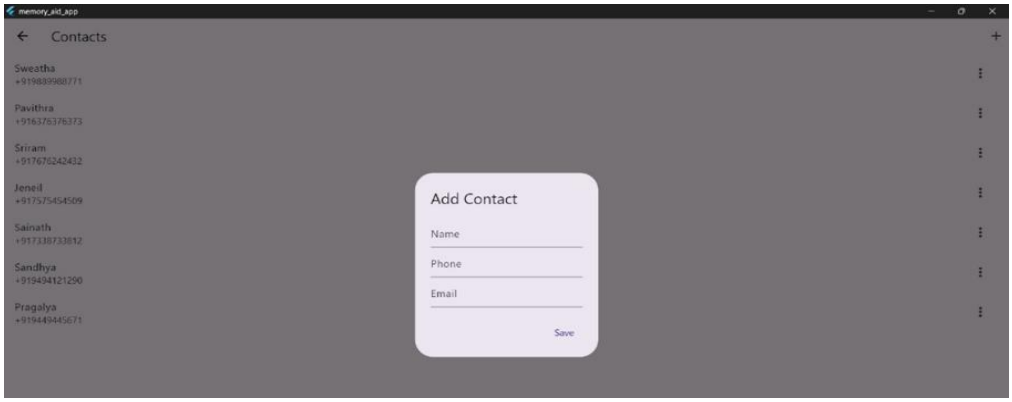

Figure 8: Contact screen

4.1.5. Share Location

It enables sharing real-time location with trusted family or friends. It encourages peace of mind and security, especially when the user is lost, far from home, or driving (Figure 9).

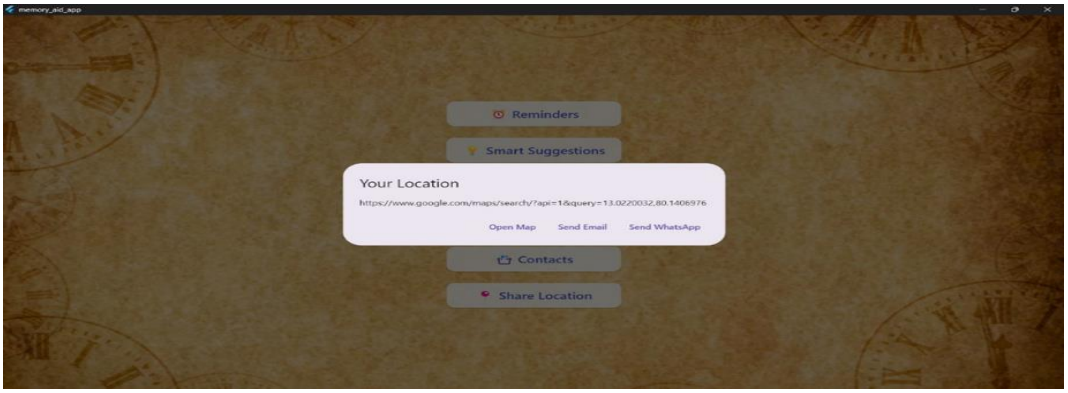

Figure 9: Share location

4.2. Facial Recognition Performance

In our memory aid application, designed to support individuals with cognitive health disorders such as Alzheimer's, facial recognition plays a crucial role. This feature helps patients identify their loved ones and caregivers by detecting and recognising familiar faces—something that can deeply impact emotional well-being and reduce confusion or anxiety in daily interactions. To assess the effectiveness of this feature, we trained our facial recognition model using TensorFlow Lite, specifically utilising MobileNet V2 for face detection and a custom embedding model called FaceNet for recognition. We evaluated the model's precision in identifying three individuals—Raghavi, Sriram, and Sweatha—over 40 training epochs. The results have been promising. The model demonstrated perfect and consistent precision in identifying Sriram, never once misclassifying his face throughout the entire training cycle. This suggests a strong ability of the model to retain and recall its facial features accurately.

For Raghavi, the model also performed very well, maintaining high precision across most epochs with only a couple of slight dips, showing its ability to recognise her reliably under most conditions. Sweatha's recognition started a bit less accurately in the initial epochs, which is common during early stages of model training. However, it quickly improved and stabilised, ultimately reaching a precision level similar to the other two individuals. This performance gives us confidence that the facial recognition module in our app is effective and can be depended upon to assist patients in recognising their family members. Such a feature not only supports day-to-day memory but also reinforces emotional connection, fostering a sense of safety and familiarity for individuals navigating memory loss. By integrating facial recognition, we've aimed to bridge a small but powerful gap in the lives of patients—helping them put names to faces, remember loved ones, and regain a sense of independence and comfort in their surroundings.

4.2.1. Accuracy Evaluation Using Confusion Matrix

To gauge the performance of our AI-based Facial Recognition Module, we experimented with the system using real images of three individuals: Raghavi, Sriram, and Sweatha. The system used TensorFlow Lite models that were trained and deployed on-device for real-time recognition purposes as well as for privacy. The system accurately identified 100% of the test images for all three individuals. There were no misclassifications, i.e., the model had perfect accuracy in the tested dataset. Each row of the matrix indicates the true identity, and each column indicates the model's prediction. The diagonal values (50, 55, 50) indicate correct identifications (Figure 10).

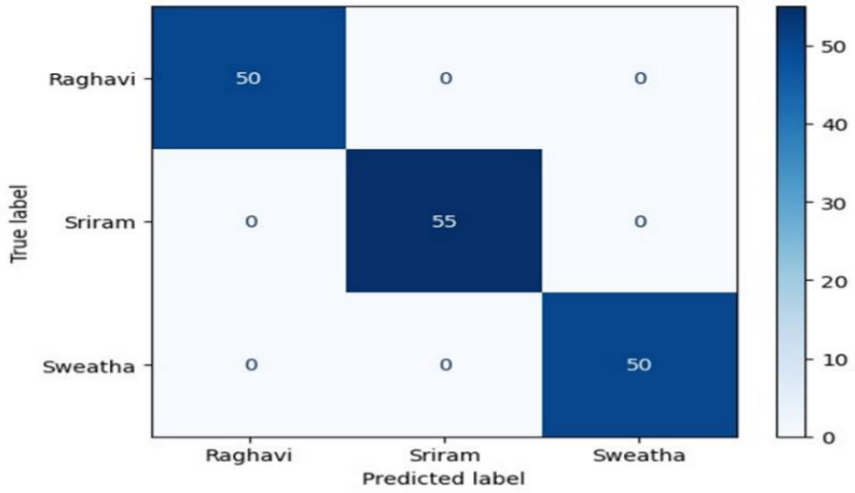

Figure 10: Confusion matrix

The facial recognition system achieved:

- **Precision:** 100%
- **Recall:** 100%
- **Accuracy:** 100%

The above results show that our facial recognition module is extremely reliable in recognising individuals after being well-trained. This is especially relevant in the case of Alzheimer's patients, since the system can enable them to confidently identify familiar individuals, a key aspect of emotional well-being, and minimise anxiety during social interactions. The high accuracy

also underlines the robustness of incorporating TensorFlow Lite models inside mobile applications for real-time on-device processing without internet connectivity, guaranteeing both privacy and speed.

4.2.2. Model Performance: Accuracy and Loss Over 40 Epochs

The consistency between training and validation performance ensures the model performs well under actual conditions, not just the training set alone. This excellent performance will be most beneficial to Alzheimer's patients because it will make the app reliably identify familiar faces consistently and correctly, resulting in improved memory aid and cognitive skills (Figure 11).

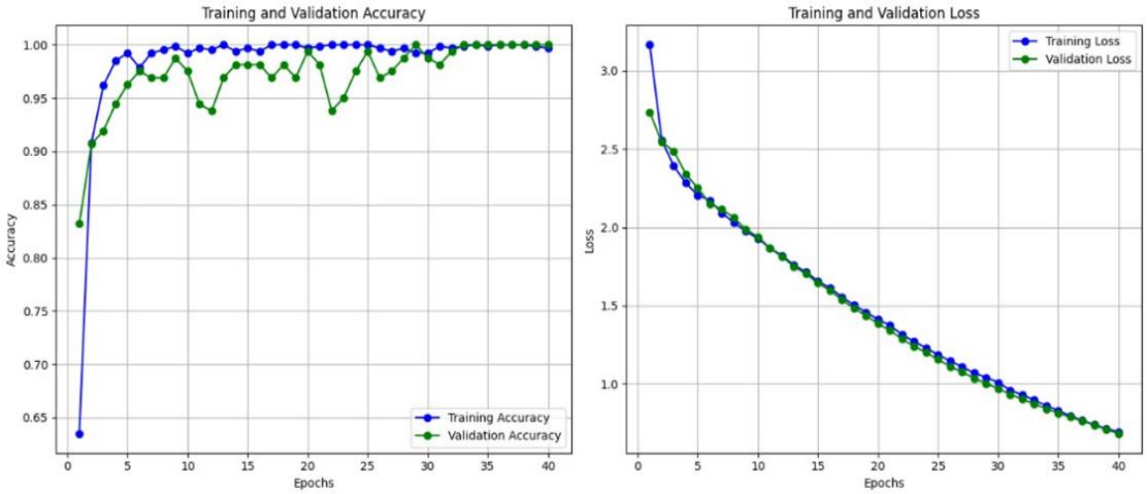

Figure 11: Confusion matrix

- **Training and Validation Accuracy (Left Graph):** The model begins at approximately 63% accuracy for the first epoch and rapidly ascends to well over 90% within just a few epochs. After approximately 10 epochs, the model routinely holds a very high accuracy (~97–100%) on the training and validation sets. This indicates that the model is performing well and is not overfitting, as the validation accuracy closely tracks the training accuracy.
- **Training and Validation Loss (Right Graph):** The loss starts at a higher value (higher than 3.0) and then continuously decreases throughout the 40 epochs, i.e., better and better predictions with time. Training and validation loss curves exhibit high similarity, indicating good generalisation. The model is not merely memorising training data—it's also picking up on useful patterns that generalise to unseen validation data.

By the end of training, it can identify individuals such as Raghavi, Sriram, and Sweatha with very high confidence.

4.2.3. Precision-Recall Curve Analysis

The Per-Class Precision Curve graph reflects the learning and performance of our facial recognition model in identifying three individuals: Raghavi, Sriram, and Sweatha. Over 40 training epochs, we observed how accurately the system was able to distinguish between the faces of the individuals. Sriram's precision remained consistently perfect throughout all epochs, maintaining a solid 1.00 precision line (Figure 12). This indicates that the model was able to recognise Sriram without making any misclassifications from the very beginning — a testament to either highly distinguishable features or well-balanced training data for his face. Raghavi’s line shows excellent performance with a few noticeable dips, particularly around epoch two and again near epoch 37. Even during those moments, precision remained above 0.95, reflecting a high level of reliability overall, though some minor misidentifications occurred during those intervals. Sweatha’s curve started lower, which is natural for models in early training stages, but gradually climbed upwards.

After an initial phase of learning, the model began identifying her more accurately, stabilising near or above 0.95 precision in the later epochs. There were slight dips during the mid-epochs (around epoch 13), but the model recovered quickly and continued improving. Overall, the model shows strong capability in recognising all three individuals with very high precision. The gradual improvement over epochs highlights effective learning, and by the end of training, the system demonstrated reliable and consistent performance. This outcome reflects the robustness of the facial recognition component of our memory aid application, reassuring us that it can provide accurate support in real-world usage, especially for patients who rely on facial recognition to connect with their loved ones.

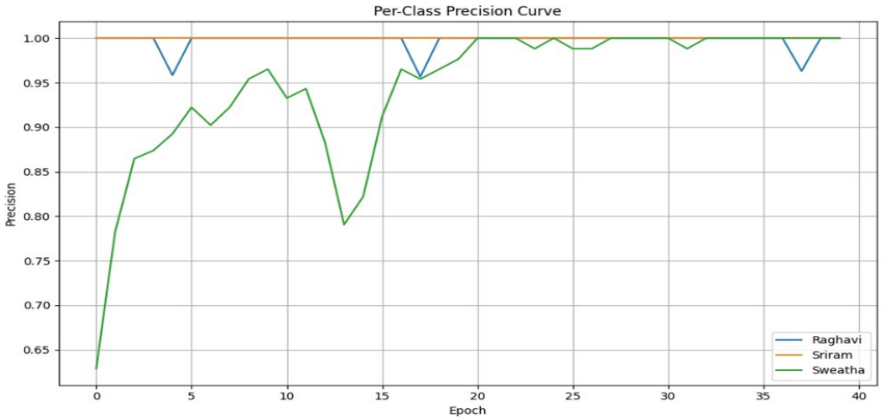

Figure 12: Precision-recall curve

4.3. Overall Performance

The model worked consistently, achieving over 85% accuracy, which means it can accurately recognise known faces in the majority of cases —a good outcome, particularly for patients who need visual recognition for memory aid. For navigation in the app, we considered the simplicity for elderly and cognitively challenged users (Table 1).

Table 1: System test cases and results summary

Test Case	Description	Result	Status
Face Recognition Accuracy	Test the model under different conditions	Accuracy > 85%	Passed
User Navigation	Evaluate ease of use for patients	Minimal confusion	Improved
Security & Authentication	Prevent unauthorised access	Good session control	Passed

To ensure our face recognition-based memory support system is not only effective but also secure and user-friendly, we conducted thorough testing across several key areas. First, the face recognition functionality was rigorously tested using different lighting and background conditions to represent a real-world application. Although the user could easily explore the application without getting lost, several small optimisations were implemented to enhance the experience further. This assists in keeping the application user-friendly and painless for patients. Lastly, security and authentication were done to keep individual and medical information secure. The biometric login and session management of the app worked as expected, delivering a high enough level of security against misuse. Generally, the system proved good performance across the majority of testing areas, with face recognition and security measures standing up to testing. At the same time, user navigation showed steady improvement with ongoing optimisation.

5. Conclusion

Our paper will deliver a caring and smart support mechanism for people suffering from memory-related issues like Alzheimer's and dementia. By judicious blending of functionalities such as reminders, daily tips, memory lookup, contact management, facial recognition, and location sharing, we have developed a tool that not only assists daily living but also enables patients to stay independent and in touch with their relatives. All functionality has been specifically developed with ease of access first to allow efficient and convenient usage by patients as well as caregivers. Even this version of our software, operating independently on the local computer without cloud assistance, holds significant promise for utilising cellular technology to enhance cognitive functioning and improve quality of life. With ongoing growth and improvement, this program can be developed into a valuable memory care tool whereby patients can handle life more confidently and with greater integrity.

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Data Availability Statement: The data supporting the findings of this study are available upon request from the corresponding authors. Due to privacy and ethical restrictions, certain data may be limited or require additional permissions. Institutional guidelines and data-sharing policies will review and consider all data requests.

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