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RESEARCH ARTICLE

Intelligent Mobile Application for Alzheimer's Detection and Patient's Life Management

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ABSTRACT

The defining feature of Alzheimer's disease (AD) is a gradual decline in symptoms over several years. This decline reduces the effectiveness of daily routines and leads to memory loss. Among the challenges posed by memory loss are difficulties in remembering names, faces, locations, and other important details. This study introduces an intelligent mobile application designed to assist in managing a patient's daily life, with an emphasis on routine activities and monitoring episodes of memory loss. Additionally, the application aims to detect Alzheimer's disease (AD) using a proposed deep learning model. The suggested Convolutional Neural Network (CNN) deep learning model is trained on a dataset of 11000 magnetic resonance imaging MRI scan images from Kaggle opensource website and has achieved 98% accuracy in detecting Alzheimer's from MRI scans. This application demonstrates effective performance in the realm of AD's detection, patient life management and reducing the financial strain on the relatives of patients.

Keywords: Alzheimer disease, CNN, AI, Mobile application, Alzheimer's life management, Kaggle, Deep learning in healthcare, MRI classification

Highlights

1. Alzheimer Diagnosing Application.
2. Deep Learning Model.
3. Remote patient monitoring

1. Introduction

Alzheimer's disease (AD) is a neurological disease that primarily impact smemory, thinking, and behaviors. It is characterized by a progressive decline in cognitive function. It is estimated to be theprimary cause of dementia, accounting for sixty to eighty percent

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of cases [1]. However, the progression of the disease may be delayed by improving the patient's quality of life and implementing strategies to enhance cognitive abilities average age of onset for individuals with this illness can vary significantly based on several factors, including the age at which symptoms first appear, overall health, and the disease's progression [2]. The adverse effects of AD on the brain generally unfold in three stages: Mild, Moderate and Severe AD [3]. Currently, there is no definitive treatment for AD; while certain medications may slow its progression, they cannot halt it entirely. Early detection of diseases can provide substantial benefits to healthcare provider [4]

The healthcare sector stands to gain significantly from the integration of artificial intelligence [AI] systems. The application of AI in the diagnostic processes of medical professionals has the potential to enhance patient care and transform the healthcare industry. The existing technological framework utilizes AI to expedite the discovery of critical medical information from diverse sources. These technologies can be customized to meet the individual needs and treatment progress of patients [5]. Deep learning, a subsection of AI, has recently demonstrated remarkable efficacy in various complex tasks, including medical imaging. Among the deep learning algorithms, convolutional neural networks (CNNs) have emerged as particularly powerful tools for classifying images [6]. CNNs excel in recognizing spatial relationships and hierarchical patterns in image s due to their architecture, which mimics the visual processing capabilities of the human brain. This makes them especially suitable for analyzing MRI scans, where manual feature extraction can be challenging [7]. Recently, researchers have developed numerous neuroimaging methods to investigate the human brain, With Magnetic Resonance Imaging (MRI) standing out among these techniques. MRI employs radio waves and magnetic fields to create a three-dimensional image of the brain. This method offers several advantages in the realm of medical imaging including exceptional imaging flexibility, well-contrasted tissue visualization, and the capacity to obtain crucial anatomical information without exposing patients to ionizing radiation [8, 9]. In this paper we utilize MRI alongside of CNN to construct a deep learning model aimed at detecting Alzheimer's disease.

Patients with Alzheimer's disease often experience memory loss, making it challenging for them to remember essential daily tasks or appointments, some individuals may become disoriented after leaving their homes and struggle to find their way back [10]. Consequently, friends and family may spend extended periods searching for the patient without knowing their whereabouts [11]. The advent of smart mobile health (mHealth) technologies has facilitated a significant transformation in healthcare ecosystem, shifting from reactive care to proactive and preventative care that can be delivered more efficiently. mHealth encompasses the integration of mobile computers, medical sensors, and communication technologies to provide healthcare services, including chronic disease management and wellness promotion. The technology includes smartphone- and tablet-based medical applications, sensors for monitoring vital signs and health-related activities and cloud –based platforms for data collection [12].

Many studies have been done on Alzheimer's disease. Efforts in literature have been made to address the challenge of detecting AD disease. As pointed out by the authors in [13] the authors used three configurations and three experiments in their research. They divided the data in experiment 1 into 80% training and 20% testing. In experiment 2, they divided the data into 30% testing and 70% training; the best average accuracy of training results, 99.95%, is obtained at 32 batch sizes and without dropout. In contrast, 99.99% is obtained at a 32-batch size and without dropout. The effectiveness of the VGG16 model with various optimizers and transfer learning was examined in the third. 97.44% was the best accuracy. After 64 batch sizes and 512 epochs, this outcome was attained. According to [14] a ResNet50, ResNet101, ResNet101V2, and ResNet50V2 deep CNN-based models

were built to classify Alzheimer's disease from MRI scans into multiple categories. Their reports indicated that the accuracy of the deep learning model varied from 80 to 90%. In [15]the authors have suggested using the Inception v2 model, which uses LSTM, one of the RNN-type classifiers, to solve the Alzheimer's classification challenge and displayed an accuracy score over 90 percent. In [16] the researchers evaluated their strategy on 420 individuals—210 with normal brain function, 210 with mild cognitive impairment—using data from the OASIS database, which is dedicated to analyzing Alzheimer's MRIs. Most of the patients are in the 18–96years age range. Normal Control (NC) and individuals with MCI are distinguished by the proposed architecture. The classification with the ResNet50 network gives a 96.8% accuracy rate. The authors of [17]utilized CNN for picture training, whereas Artificial Neural Networks (ANN) uses error-back propagation (EBP) as a classifier to identify different stages of AD. The accuracy of their suggested system is 90% for ANN and 95% for CNN.

Technology developments and support systems based on smartphone applications are publicized. New developments in technology and mobile assistance have presented a good chance to assist families or relatives. Researchers have discovered that phones may be used as helpful tools [18]. Another paper [19] presented "AlzDiagnostics" App of AD, merging established clinical tools, state-of-the-art machine learning techniques, and numerous diagnostic approaches. Furthermore, the application seeks to analyze the effectiveness and accuracy of the Mini-Mental State Examination (MMSE) test, machine learning models trained on MRI images, as well as ones developed on clinical data, evaluating their contributions to boost early diagnosis. Numerous classification experiments were conducted using a large MRI dataset that was acquired through Kaggle, which included 6400 scanned images; a model with an accuracy rate of 98% was found as a result of these tests, which included the investigation of different parameter configurations. According to [20] the indicated application "AlzAI" of this work was to assist individuals with Alzheimer's disease in remembering their everyday activities. The application's dependability is ensured by evaluating it using a variety of testing methodologies.

The primary goal of this paper is to create a mobile application that detects Alzheimer's disease through MRI scans and supports patients with this condition. Key features of the proposed mobile application include real-time location tracking, cognitive function monitoring, and daily task reminders. These functionalities are designed to provide caregivers with essential information while helping Alzheimer's patients maintain their independence for as long as possible. To protect patient confidentiality, the application ensures complete data privacy within the server's database.

2. Proposed Alzheimer detection mobile application

The aim of our research is to minimize the time required for the confirmation of disease diagnostics and facilitates the daily routines of AD patients by a system. This section explains the suggested deep-learning model for Alzheimer diagnosis and Alzheimer's life management mobile application. The separate sections in this part are meant to give anyone reading it a full understanding of the idea behind the developed application.

2.1. Detection CNN model

The dataset used in this work comes from the open-source Kaggle website [21]. By knowing the stages of Alzheimer's patients and Symptoms of each stage, we'll focus on mild to moderate stage due to it's the most manageable stage. There are two distinct classes in the directory structure of the data collected for this work: Demented (mild to moderate)

and Non-Demented. Two datasets are collected from Kaggle website, the first dataset [21] involved 11k sample of MRI for the two Alzheimer classes distributed between 80% for training and 20% for validation and the other dataset [22] contained 3500 MRI utilized for testing the proposed model. Visual studio with python as a framework is utilized to build the model based on the CNN algorithm with some different layers as showed in Fig. 1

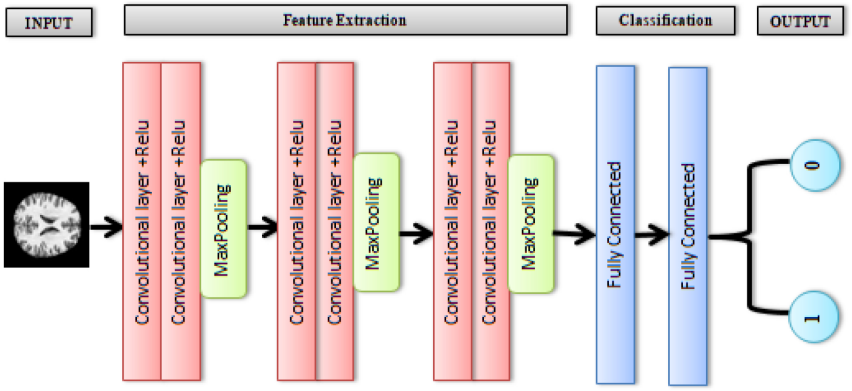


Fig. 1. The process for building CNN detection model.

The algorithm itself is known to set up and update the network parameters (bias numbers and weights), but there is a problem with the hyperparameters setting that could boost model performance if chosen correctly for example we increased the number of convolution layers to feed the model with more features for training. Table 1 provides a clarification of the model hyperparameters that were established following multiple attempts.

Table 1. The proposed CNN detection model architecture.

1st layer	Input	(256,256,1)
2nd Layer	2*Convolution layer	(Conv2D) (Filter = 16)
	MaxPooling Layer	(MaxPooling2D) + ReLU
3rd Layer	2*Convolution layer	(Conv2D) (Filter = 32)
	MaxPooling Layer	(MaxPooling2D) + ReLU
4th layer	2*Convolution layer	(Conv2D) (Filter = 128)
	MaxPooling Layer	(MaxPooling2D) + ReLU
5th layer	Dense	(512) + ReLU
	Dense	(1) + Sigmoid
Compilation	Optimizer	Adam
	Learning Rate	0.0001

The model is next evaluated on a collection of new MRI scans (not previously seen) [22] to check its efficacy. Training and validation datasets feature labels that clearly identify the type of image—Dementia and Non-Dementia—that an image belongs to, whereas testing dataset is label-free. The trained machine learning model retains significant features that were taken from the training images. With this information, it can predict the category of any new or unknown data with accuracy.

2.2. Proposed intelligent mobile application

A mobile application named “Alzheimer ai” was developed to ease the communication between the caregivers and the patients and give the caregivers access to real-time data.

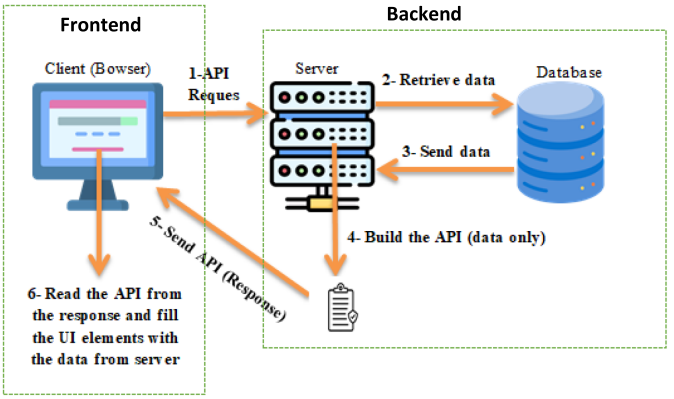


Fig. 2. The architecture of proposed mobile application.

The system must notify the caregivers of the Alzheimer's whereabouts, mental health, and other routine tasks. The suggested AD mobile application can be utilized on both mobile and PC platforms because it was developed using the same steps and stages. There are two components to the structure of any mobile application:

Frontend and Backend, Fig. 2; explains the suggested mobile application architecture, The proposed mobile application's frontend is developed using the Flutterflow software environment [23], which allows the developers to create and publish mobile apps for iOS and Android with little to no code.

The backend forms the core of the application; it handles application data, login credentials and performs the necessary tasks.additionally, the backend does the required functions and manages login information and application data. Vultr [24] was set up space as virtual server to house the backend of the suggested application.To build the backend, we needed two essential components:

1) Flask is a Python-based backend development framework.
2) SQLite is employed in the suggested mobile application as a database.

Following the completion of the backend organization, the proposed deep learning model is uploaded to the server. Finally, a particular function in python was used to connect with the DL model, allowing us to incorporate it into the mobile application and receive prediction results through APIs [25, 26].

The proposed android application's design took into consideration the difficulties that Alzheimer's patient deals with. The following Fig. 3 explains the developed mobile application block structure and demonstrates the application's processes in the two levels: Alzheimer's diagnosis and patient life management.

The smartphone application's beginning stage focuses on diagnosing the disease's presence. As illustrated in Fig. 4.

The first page is the registration screen. In order to detect for Alzheimer, the user must click on the "signup" button to import MRI images from the phone gallery. After that, we can click the "upload photo" button to evaluate the photo by the proposed CNN model. The whole

The second stage of the proposed mobile Application starts after Alzheimer's has been proven to be existent. As shown in Fig. 5 the user should create an account by filling out some essential details about the AD's patient. There is a special box for the patient's blood type, which is a drop-down list for easy selection.

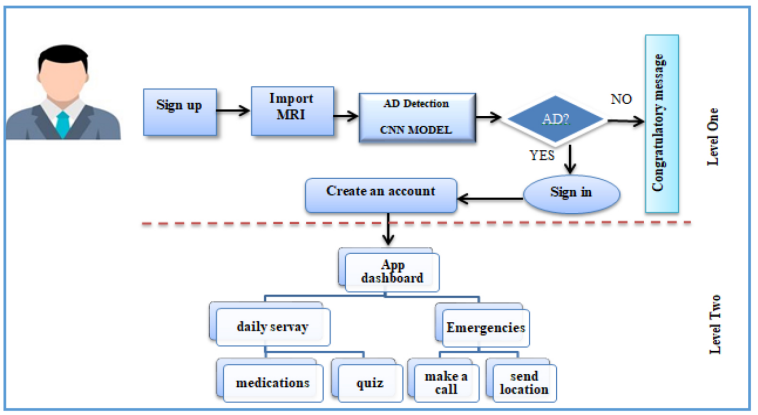


Fig. 3. Workflow of proposed mobile application.

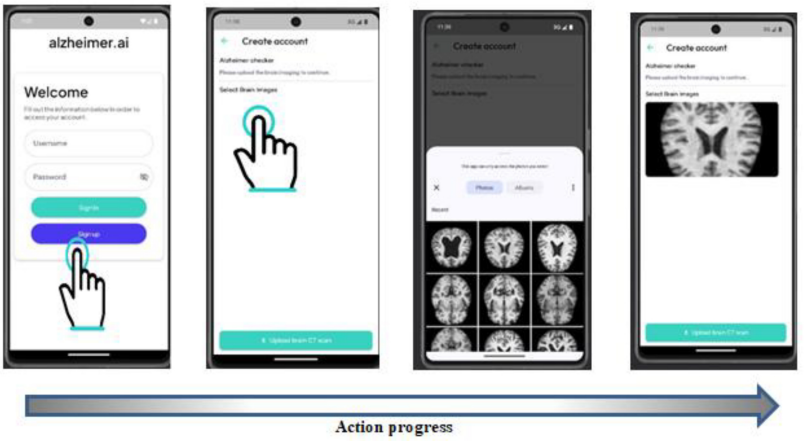
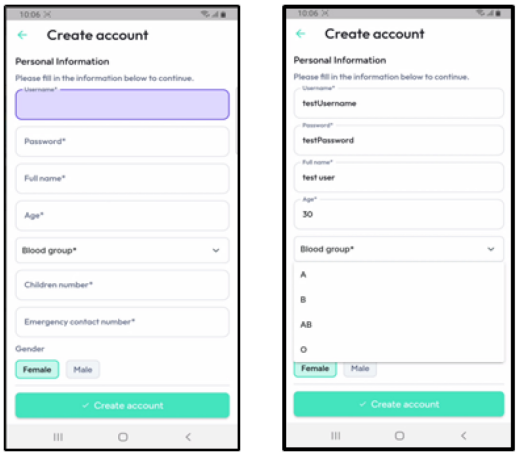


Fig. 4. The process of MRI selection to be detected in the proposed mobile App.



(a) (b)

Fig. 5. The information required for registration. (a) Create a profile for the patient. (b) Patient's blood type selection.

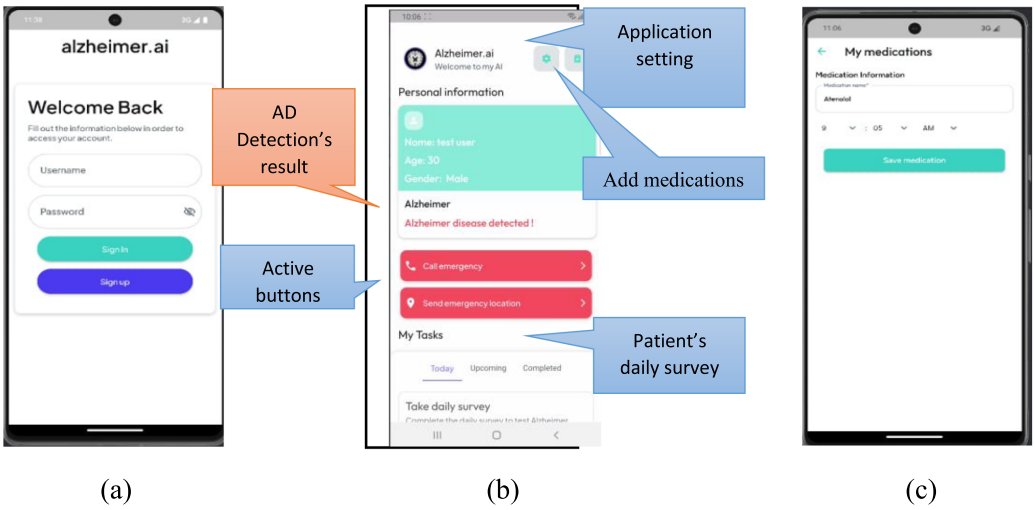


Fig. 6. The main features of proposed mobile application. (a) Registeration page. (b) Application dashboard. (c) Adding a new medication.

The registration screen (as shown in Fig. 6*(a)*) appears again for the user to enter his username and password once he had completed setting up his personal account, and by pressing on "sign in "button the dashboard page appears.

the dashboard screen includes tabs, mentioned in Fig. 6*(b)* Like:

- **Add medication:** as shown in Fig. 6 *(C)*, Almost every patient with Alzheimer's is taking medicine to help them fight the illness. These can include various medications in the day that can make it difficult for the patient to know when to take each of them. The purpose of this service is to remind the patient to take all of their medications throughout the day. After adding a medication, the user gets a notification notice him to take it at a specified time. The interface has been designed to make it easy for the user to use and to clearly display the time and name of the medication.
- **Setting:** Pressing this button opens up an interface with four selections, each of which relates to a different aspect of the application.as presented in Fig. 7*(a)*. These options are:
  1. About Alzheimer ai: as shown in Fig. 7 *(b)*, Includes copyright for authors.
  2. Edit profile: assists the user in updating a few crucial details on his personal account. As shown in Fig. 7(c).
  3. Quizzes History: includes the patient's mental test answers.
  4. AI Predication: This section includes the percentage of DL models that diagnose AD.
- **Emergency call**: this button enables the patient to call the caregiver if he loses the name or phone number of the person in responsible for his care.
- **Send current location**: In the case of the patient leaves his home and becomes confused, this option provides the caregiver with Alzheimer's patient current locations.
- **Daily survey**: this section of the dashboard contains two units
  A. The patient's medication schedule. as shown in Fig. 8(a)
  B. Unit for Evaluating Cognitive Tests: It is an essential element of the diagnosis. Users must respond to a series of questions that are presented to them. Depending on how many right answers the user gave, their performance is evaluated and they are either marked as "fail to pass" or "passed successfully" which is subsequently noted in their personal profile. As shown in Fig. 8(b). The mental test page; as presented

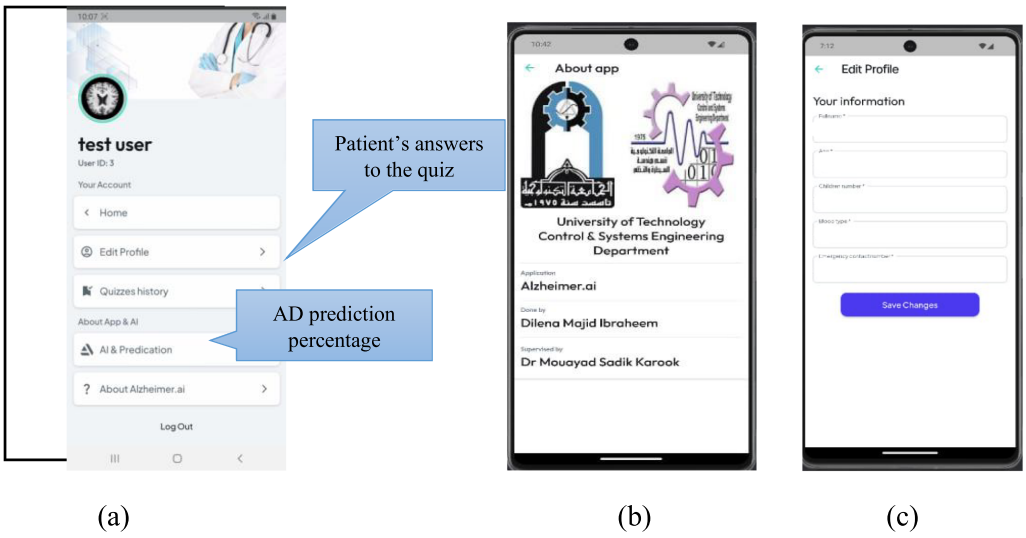


Fig. 7. The features of setting button. (a) Application setting. (b) Rights of the proposed mobile application. (c) Edit profile.

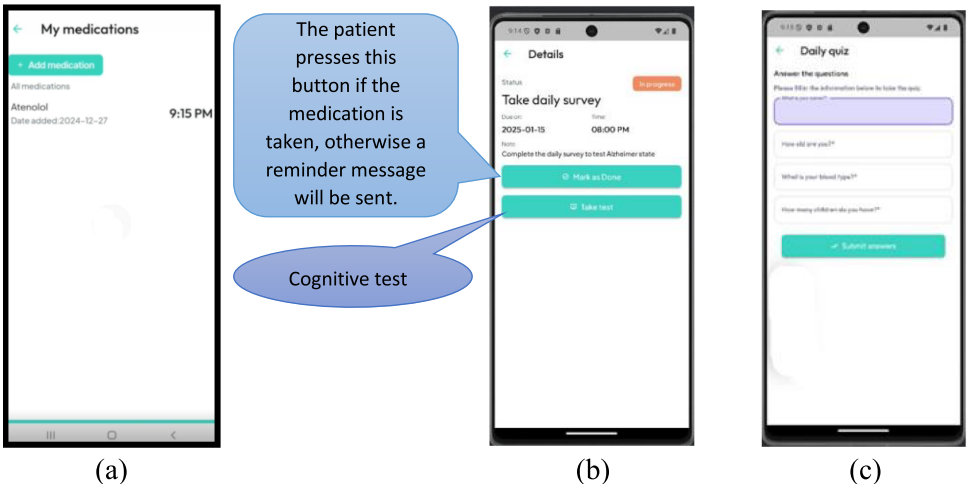


Fig. 8. Daily survey features. (a) Schedule of patient's medications. (b) Patient's daily tasks. (c) Mental test.

in Fig. 8(c) contains various questions that must be answered before while creating a personal account.

3. Results and discussion

3.1. Proposed CNN model

The aim of this research was that CNN model with extremely high object detection and image classification capabilities (over 90%) can be produced utilizing the deep learning methods available today. As clarified in further detail, as demonstrated in Fig. 9 the built model was trained for 20 epochs and achieved 98% accuracy, which is high enough to be deemed useful.

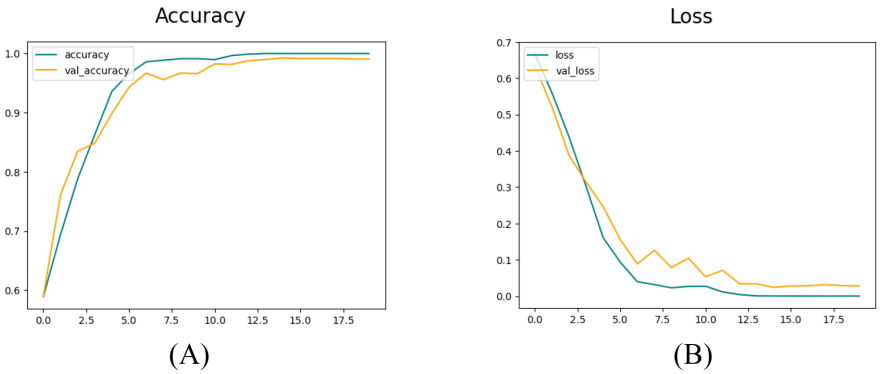


Fig. 9. Validation Graph of (A) Accuracy (B) Loss.

A variety of the proposed model's performance evaluation factors, including accuracy, recall, precision, and F1 score [12], are taken into consideration in Table 2. With a high precision rate, the model reliably predicts if AD is having an impact on a person's brain. While a high recall indicates that the DL model can accurately depict a large number of brain illnesses.

Table 2. The evaluation's outcomes for the suggested model.

	Precision	Recall	F1-score
Non_Demented	1.00	0.96	0.98
Demented	0.98	0.95	0.96
accuracy			0.97

The proposed model is a helpful diagnostic tool for AD since it is easy to use, efficient, and highly accurate. With a 98% accuracy rate, the results exceed those of earlier research that has been written about in the literature as illustrated in Table 3.

Table 3. An overview of the literary works.

Author	Dataset	Model	Accuracy %
[15]	Kaggle	the Inception V2 model	above 90%
[16]	OASIS (Open Access Series of Imaging Studies)	(AlexNet, VGG16, ResNet18, ResNet50 and MobileNetV2)	96.8%
[27]	Kaggle website	Enhanced Xception architecture	99.14%
[28]	the dataset from ADNI –(Alzheimer's Disease Neuroimaging Initiative database)	CNN inspired by VGG19	91.38%
[29]	the Kaggle platform	the ResNet-50	95%
[30]	Kaggle	Residual Network-50-pretrained CNN model	80.14%
[31]	ADNI and Kaggle	CNN andvision transformertechniques	92.46%
[32]	ADNI	Support Vector Machine (SVM)	70%
Our model	Kaggle	CNN	99%

3.2. Proposed mobile application

The main features and functionalities that the suggested application offers Alzheimer's patients were noted in the section above. We present the findings of our system in this section.

3.2.1. Registration and diagnosing approach

This diagnostic module uses our machine learning model that has already been trained to handle MRI scanning and analysis. The user needs to use their phone's gallery to upload the medical image (MRI) and send it to the server via the mobile application in order to start the analysis. As shown in Fig. 9, the user receives the result after the model finished evaluating the medical image. To make sure the application was reliable, we examined two scenarios. First, In Fig. 10(a) we upload a brain scan with Alzheimer Disease to the server as an API request, the proposed CNN model in the server checked the MRI status and return an API response as "Alzheimer Disease detected in the uploaded brain image" and activate two buttons for the user:

A. Create Account: Helps the patient or the caregiver to create an account as mentioned eailer in Figure V in the developed application to organize his tasks.
B. Go Home: return back to registration page.

In the second scenario, as in Fig. 10(b) where the brain is normal and free of Alzheimer's, the mobile application should display a congratulatory message such as "Alzheimer disease not detected in the uploaded brain image" as an API response when the MRI scan is uploaded to the server. The "Go Home" button then becomes active, bringing you back to the registration page and out of the current page.

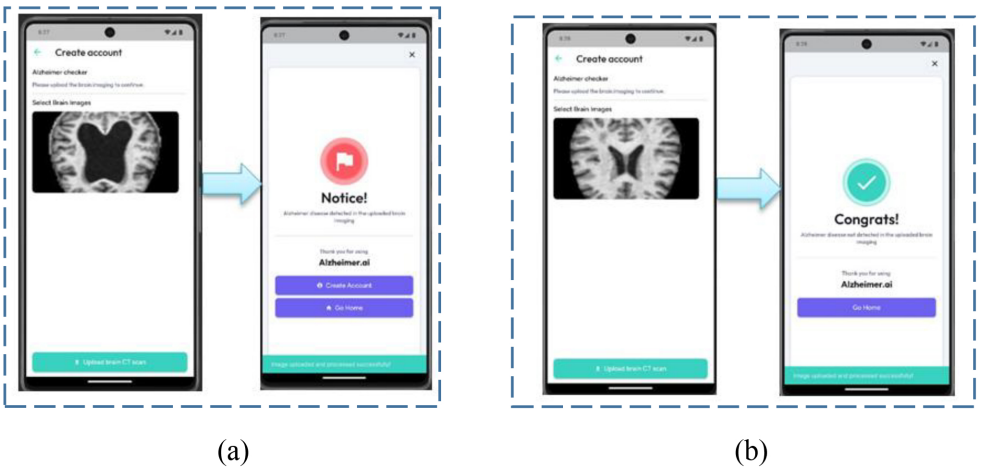
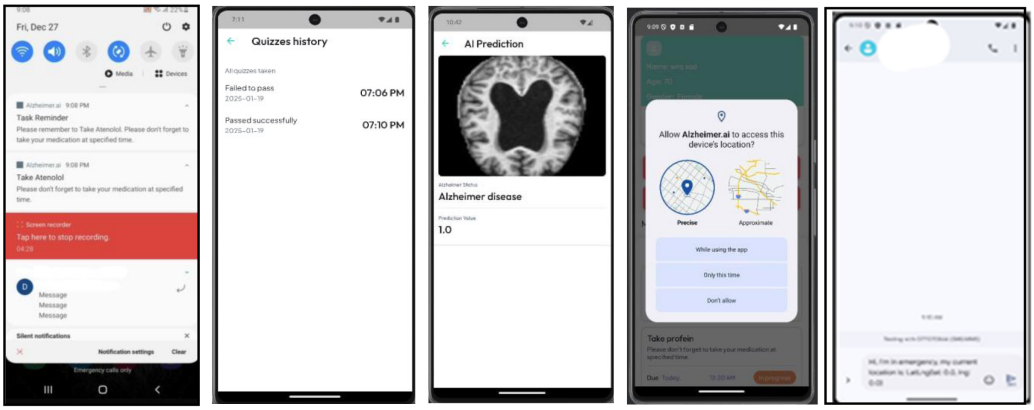


Fig. 10. Two case studies (a) AD case, (b) A case without Alzheimer.

3.2.2. AD patient life management

We started by classifying the App's features according to the beneficiary, which is an Alzheimer's sufferer or caregiver. The outcomes of this phase are displayed in Fig. 11

- Medication reminder: the notification generated by the medication reminds system aids patients' knowing about medication schedules and increases their medication tolerance. Additionally, it decreases the workload for caregivers. As shown in Fig. 11(a)
- Quizzes history: Patients and caregivers can view a history of their previous test results with the time of doing it to keep an eye out for any cognitive problems. As display in Fig. 11(b).
- The percentage of predication: We examine the percentage of brain disease diagnoses based on our deep learning model on this page. As shown in Fig. 11(c).



(a) (b) (c) (d)

Fig. 11. Results of proposed mobile application. (a) medication reminder (b) history of quiz results (c) prediction percentage. (d) send location.

- Location sharing: Fig. 11(d) shows how the patient can send his current location to the caregiver.

According to early user reviews, caregivers found the app's location monitoring and medicine reminders to be quite useful for overseeing their patients' everyday schedules.

4. Conclusion

This work proposes a system for basic medical diagnosis driven by supervised machine learning algorithms. The CNN classifier model achieved an accuracy of 98% based on the results from applying the algorithms to the dataset. For the selected dataset, the CNN classifier provides more accurate predictions according to the accuracy scores. The Android app, developed after an extensive literature review, includes a section for diagnosing Alzheimer's, navigation tracking, a daily survey, and a medication reminder to assist patients with Alzheimer's disease. The user interface was designed with the user's convenience in mind. This app aims to enhance the quality of life for individuals with dementia by addressing cognitive issues such as forgetfulness and confusion. Additionally, it may alleviate financial and mental stress for caregivers. Typically, mobile phone apps can help people with mild-to-moderate dementia become more independent and engaged in society during the early stages of the disease. Future work will focus on expanding the app's features to include voice-based cognitive training exercises and integrating with healthcare provider systems for more comprehensive patient management.

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Conflict of interest statement

There is no conflict of interest.

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