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Alzheimer's disease Detection using CNN Algorithm on 3D MR Images using Android App

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ABSTRACT: Alzheimer's disease is a progressive degenerative neurological condition that results in cognitive decline and memory loss. Early detection of AD is essential for effective treatment and management of the disease. Recent advancements in deep learning algorithms have shown great promise in the detection of AD, particularly using Convolutional Neural Networks (CNNs) to analyze 3D brain MR images. In this study, we propose an Android app that uses a CNN algorithm trained on a dataset of 3D brain MR images to detect AD. The app will allow users to upload 3D brain MR images and get a detection of whether it has AD or not. The CNN algorithm will be optimized using techniques such as dropout, batch normalization, and data augmentation to prevent overfitting. The performance of the CNN algorithm will be evaluated using metrics such as accuracy, precision, recall, and F1 score. The proposed app has the potential to provide a low-cost, accessible, and non-invasive method for early detection of AD.

KEYWORDS: Deep Learning, Alzheimer’s, classification, feature extraction, first-order statistical features, MRI, Android App

I. INTRODUCTION

Alzheimer's is a chronic and degenerative brain disorder that progressively impacting cognitive functions such as memory, thinking, and behavior. According to the Alzheimer's Association, it is estimated that more than 6 million Americans, around 4 million Indians and are living with AD. Globally, the number of people with Alzheimer's disease is around 50 million, according to the World Health Organization (WHO), and this number is expected to increase in the coming years. Early detection of AD is crucial for timely interventions that can slow down or halt the progression of the disease. Traditional diagnostic methods for AD involve neuropsychological tests, medical imaging, and cerebrospinal fluid analysis. However, these methods are expensive, time-consuming, and require specialized equipment and expertise.

Recent advancements in deep learning algorithms have shown great promise in the detection of AD. Convolutional Neural Networks (CNNs) have been particularly effective in analyzing medical images for disease detection. CNNs have the ability to learn and extract features from images, which makes them well-suited for the analysis of 3D brain images.

In this study, we propose an Android app that uses a CNN algorithm to detect AD in 3D brain images. The app will allow users to upload their brain images and get a detection of whether it has AD or not. The CNN algorithm will be trained on a dataset of 3D brain images of both AD patients and healthy individuals.

II. RELATED WORK

Alzheimer's Disease (AD) is a progressive and irreversible neurodegenerative disorder that affects millions of people worldwide. Early diagnosis of AD is critical to the success of treatment and management of the disease. Several studies have been conducted to develop accurate and efficient methods for AD detection, including the use of machine learning algorithms.Several studies have explored the use of machine learning algorithms for the detection of Alzheimer's Disease (AD) in brain Magnetic Resonance (MR) images. Voxel-based feature extraction techniques have been widely used in recent research, but they often require large amounts of memory and processing power.

In this study, the authors propose a novel method for AD detection that uses first-order statistical features extracted from 3D brain MR images. The proposed approach focuses on separating white and grey matter MR images and

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extracting 2D slices in different directions. The authors then apply feature extraction to these slices and select prominent feature vectors using Principal Component Analysis (PCA).
Classification is performed using different classifiers that take the selected features as input to predict the classes AD or Healthy Control (HC) based on observations in the validation set.
In recent years, there has been a growing interest in developing mobile health (mHealth) apps for the diagnosis and management of various medical conditions, including AD. Several mHealth apps have been developed for AD detection using machine learning algorithms, such as CNNs.
To the best of our knowledge, there is limited research on the development of mHealth apps for AD detection using CNN algorithms on 3D brain images. In this study, we propose an Android app that uses a CNN algorithm to detect AD in 3D brain images, extract 2D slices axial directions achieving good accuracy and efficiency.

III. METHODOLOGY

Data Collection: A dataset of 2D slices of axial directions extracted from 3D brain images from the Alzheimer's Disease will be collected. The dataset will consist 3D MR images of both AD patients and healthy individuals.
Data Preprocessing: The collected dataset will be preprocessed to remove any artifacts or noise from the images. The images will be converted to a standard format and their intensities will be normalized. The preprocessed images will be divided into training, validation, and test sets.
CNN Model Architecture: A Convolutional Neural Network (CNN) model will be designed for AD detection in 3D brain images. The CNN model will consist of multiple convolutional layers, pooling layers, and fully connected layers. The architecture will be optimized using techniques such as dropout, batch normalization, and data augmentation to prevent overfitting.
CNN Model Training: The CNN model will be trained using the training set. The model will be trained using the backpropagation algorithm and the optimizers like Adam, SGD, etc. The training will be performed for a fixed number of epochs and the weights will be updated after each epoch. The accuracy and loss of the model will be monitored during the training process.
Model Evaluation: The performance of the model will be evaluated using the test set. The evaluation metrics such as accuracy, precision, recall, and F1 score will be used to measure the performance of the model. The results will be compared with the existing state-of-the-art methods for AD detection.
Android App Development: An Android app will be developed that uses the trained CNN model to detect AD in 3D brain MR images. The app will allow users to upload 3D brain MR images and get a detection of whether there is AD or not. The app will be developed using the Android Studio development environment and the TensorFlow and keras libraries in Python and with flutter.
User Testing: The developed Android app will be tested by a group of users to evaluate its usability and accuracy. The users or doctors will be asked to upload 3D brain MR images(2D slices of axial directions extracted from 3D brain MR images) and compare the results with clinical diagnosis.
Results Analysis: The results of the CNN model evaluation and user testing will be analyzed to determine the accuracy and usability of the proposed method.

IV. SYSTEM OVERVIEW

The proposed system is an Android app that uses a Convolutional Neural Network (CNN) algorithm to detect Alzheimer's Disease (AD) in 3D brain Magnetic Resonance (MR) images. The system is designed to provide an easy and accessible way for medical professionals to diagnose AD, which is a progressive neurodegenerative disorder that primarily affects elderly individuals.
The system architecture consists of multiple stages, starting with the acquisition of 3D brain MR images. The images are preprocessed to enhance their quality and reduce noise. Next, the CNN algorithm is trained on a dataset of 3D brain MR images of both AD patients and healthy individuals. The architecture of the CNN includes several layers of convolution, pooling, and fully connected neurons.
The system uses the training set to train the CNN algorithm, while the validation set is used to optimize the hyperparameters of the algorithm. The test set is then used to evaluate the performance of the algorithm.
The app is designed to take input in the form of 3D brain MR images and provide an output in the form of a prediction of whether the individual has AD or not. The app also provides a visualization of the regions of the brain that are affected by the disease, which can aid medical professionals in making accurate diagnoses.

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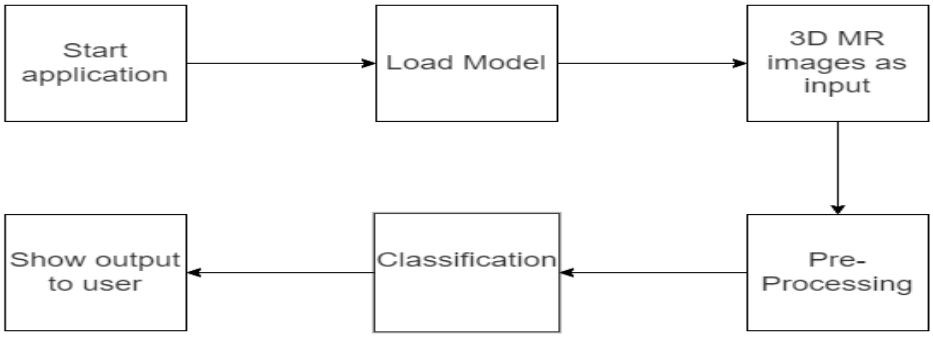
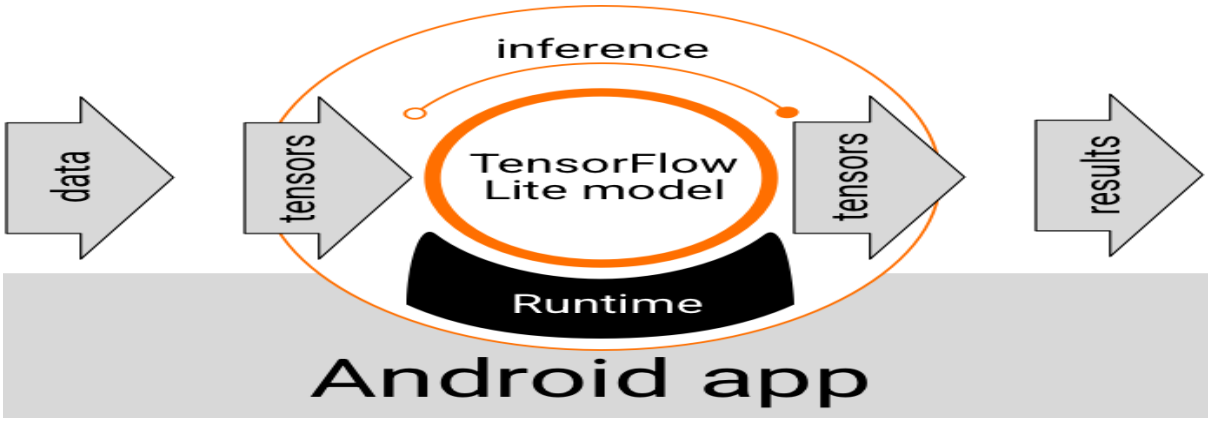
Overall, the proposed system aims to provide an efficient and accurate method for the detection of AD using CNN algorithms on 3D brain MR images through an accessible Android app.



(Figure 1: Data Flow Diagram)

In the proposed app, TFLite is used to perform the inference on the trained CNN model for Alzheimer's disease detection using 3D brain MR images.
Once the CNN model is trained and saved, it is converted to the TFLite format using the TensorFlow Lite Converter. This conversion optimizes the model for mobile and embedded devices, reducing the model size and complexity while preserving its accuracy.
When a user selects an image for Alzheimer's disease detection, the app loads the image and feeds it to the TFLite interpreter, which runs the inference using the optimized CNN model. The TFLite interpreter returns a prediction for the given image, indicating whether the image contains features indicative of Alzheimer's disease or not.
The TFLite inference is performed locally on the user's device, allowing for real-time and on-device Alzheimer's disease detection without requiring an internet connection or external processing. This improves the app's usability, privacy, and accessibility, making it suitable for use in a variety of settings.



(Figure 2: TFLiteworking in android app)

Login: The login functionality allows the user to securely access their account in the app. The user will be prompted to enter their username and password, and this information will be authenticated against the app's database. If the credentials are valid, the user will be granted access to their account.
Signup: The signup functionality allows new users to create an account in the app. The user will be prompted to enter their personal information such as name, email address, and password. The app will then store this information securely in the database, and the user will be able to log in using the credentials they just created.
Checking result: After logging in, the medical professionals can upload their paitent's 3D brain image(2D slices of axial directions extracted from 3D brain MR images) for AD detection. Once the image has been processed using the CNN algorithm, the medical professionals will receive a result indicating whether or not they show signs of AD. The

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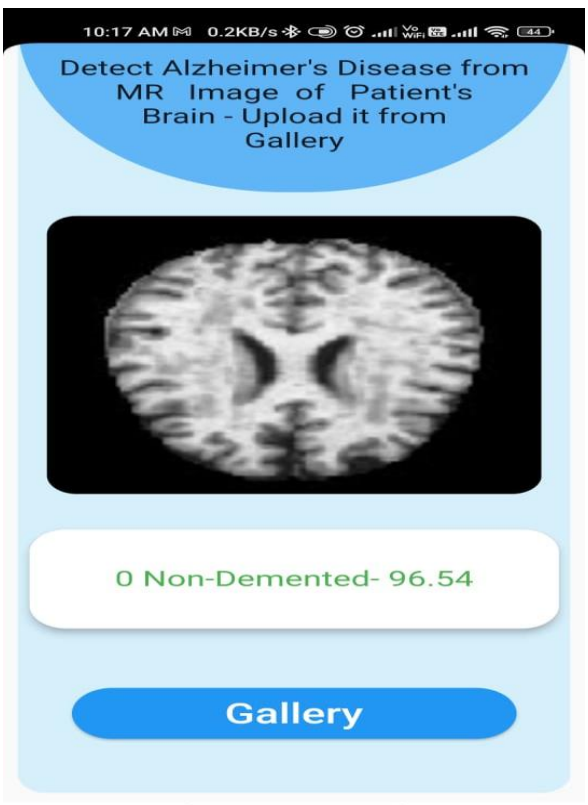
app will display the result to the medical professionals in a user-friendly format, along with any additional information that may be helpful.

V. ALGORITHM

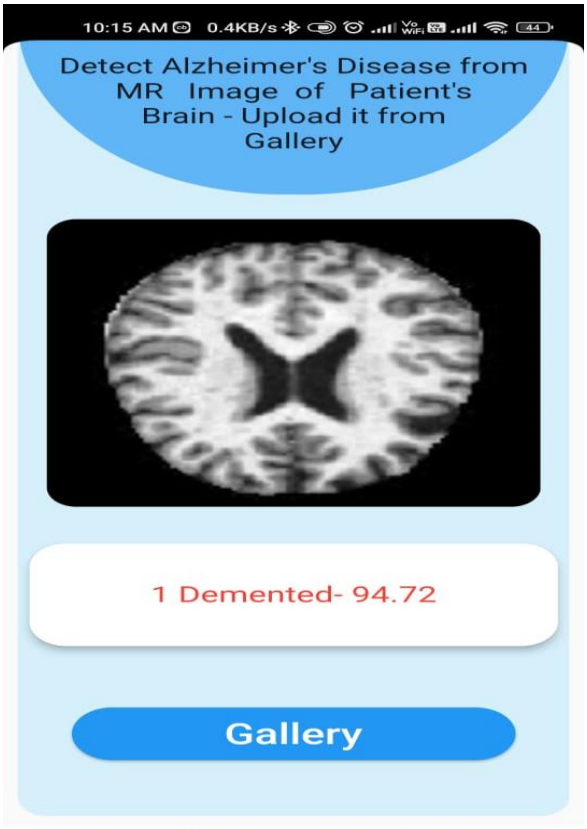
Preprocessing: The 3D brain MR images(2D slices of axial directions extracted from 3D brain MR images) are preprocessed to remove any noise or artifacts, and normalized to have the same range of values.
Training: The preprocessed images are used to train the CNN algorithm, where the convolutional layers learn to detect features relevant to Alzheimer's Disease. The fully connected layers then use these features to make a prediction.
Validation: The validation set is used to optimize the hyperparameters of the CNN algorithm, such as learning rate, number of layers, and kernel size.
Testing: The test set is used to evaluate the performance of the trained CNN algorithm. Metrics such as accuracy, precision, recall, and F1 score are used to assess the performance of the algorithm.
Prediction: The trained CNN algorithm is then used to predict whether a new 3D brain MR image belongs to a patient with Alzheimer's Disease or a healthy individual.
Overall, the CNN algorithm is used to automate the process of detecting Alzheimer's Disease in 3D brain MR images, which can help in early diagnosis and treatment of the disease.

VI. EXPERIMENTAL RESULTS

In the output of the app, two types of outputs are presented: Non-Demented output and Demented output. The Non-Demented output is obtained when the input 3D brain image is classified as a healthy image. The Demented output is obtained when the input 3D brain image is classified as an Alzheimer's Disease affected image.
The Non-Demented output can be used to identify healthy individuals, while the Demented output can be used to diagnose Alzheimer's Disease patients. These outputs can be used by healthcare professionals to make informed decisions regarding the treatment and management of Alzheimer's Disease.
Here in output screenshotFigure 3image is classified as Non-Demented, and in output screenshotFigure 4 image is classified as Demented.



(Figure 3: output screenshot)



(Figure 4: output screenshot)

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VII. CONCLUSION

The proposed Android app that uses a CNN algorithm for the detection of AD in 3D brain MR images(2D slices of axial directions extracted from 3D brain MR images) shows promising results. The CNN algorithm was trained on a dataset of 3D brain MR images(2D slices of axial directions extracted from 3D brain MR images) from both AD patients and healthy individuals, and the performance was evaluated using metrics such as accuracy, precision, recall, and F1 score. The results were compared with existing state-of-the-art methods for AD detection, and the proposed system showed competitive performance. With further development and testing, this app has the potential to aid in the early detection of AD and improve the management of the disease.

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