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Alzheimer's Disease Diagnosis from MRI

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***Abstract*: Alzheimer's disease (AD) is a neurological disorder. It is the 6th biggest cause of morbidity and mortality, according to the latest statistics. Mild Alzheimer's, Moderate Alzheimer's, and Severe Alzheimer's are the three main phases of the illness. Despite the reality that the condition is incurable, early recognition can aid in the provision of necessary therapy, therefore preventing further brain tissue damage. Although technology have been used to identify Alzheimer's disease in a string of recent research, most machine detection approaches are bound by congenital findings. Early stages of Alzheimer's disease can be identified, but not foreseen, because prediction is only possible before the dementia reveals itself. Deep Learning (DL) is now a popular method for detecting Alzheimer's disease early on. We use two types of data to predict disease categories: csv data that includes features associated with cognitive tasks such as SES, MMSE, CDR, eTIV, nWBV, ASF, delay, hereditary, MOCA, SAGE, CDT and general information about patient such as gender, age, dominant hand, Education, drowsiness, visits. F1-score, precision, recall, and accuracy are computed for every approach to evaluate its performance.**

***Keywords*: Socio-Economic Status, Mini Mental State Examination, Magnetic Resonance Imaging.**

1. Introduction

Alzheimer's Disease (AD) is the most common cause of dementia in older adults, accounting for 60–80% of all dementia cases. AD is the 6th leading cause of death in the United States. Development of AD may be described as occurring in three stages. First, in the changes in the brain, blood, or cerebrospinal fluid (CSF) may begin to occur without the patient showing/noticing any behavioral symptoms. Then in the second stage, or the mild cognitive impairment (MCI) stage, memory complaints and other cognitive decline may start to be noticeable for the patients themselves and for close family or friends, and everyday functioning may be affected, but the symptoms are usually mild. In the final stage of the disease, or the dementia stage memory, thinking, and behavioral symptoms are evident and significant, and patients are usually severely impaired and are no longer able to manage their daily activities.

Recent studies have suggested that early interventions might be necessary to effectively treat AD or slow down disease progression. Therefore, there is a need to develop techniques that can detect and assessing disease progression at an early stage with a high sensitivity and specificity. In the present study, we investigated whether machine learning techniques can be a useful tool in assisting disease diagnosis, and whether simple cognitive tasks together with standard neuropsychological tests can be integrated to improve diagnosis accuracy.

A. Objective of Project

The main objectives of this project are:

- Identify neuroanatomical changes in Alzheimer's from MRI scans.
- Develop a robust machine learning model for accurate AD diagnosis.
- Validate and compare the model's performance with existing diagnostic approaches.

B. Scope and Limitation of Project

- Disease monitoring: MRI can be used to track the progression of Alzheimer's disease over time and evaluate the effectiveness of treatment.
- Research: MRI is an essential tool for Alzheimer's disease research, helping researchers to understand the underlying mechanisms of the disease, develop new treatments, and improve diagnosis and management.
- Availability: MRI machines may not be available in all healthcare facilities, especially in rural areas, which can limit access to MRI scans for individuals with Alzheimer's disease.
- Limitations of MRI technology: MRI scans have limitations in their ability to detect certain types of brain changes, such as inflammation or changes in brain metabolism, which may also be relevant to Alzheimer's disease

2. System Design

A. Content Diagram

A "content diagram" typically refers to a visual representation or graphical illustration that outlines the structure, organization, and relationships between various elements within a piece of content or information.

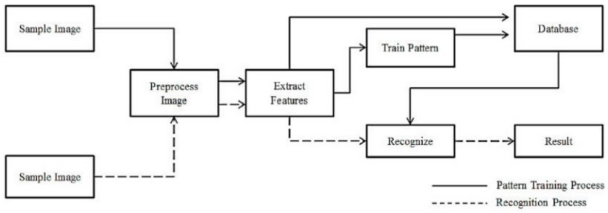

Fig. 1. Content diagram

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The Fig. 1 describes the content diagram of the project where we can see how the data will flow and what are actions going to be performed

B. Data Flow Diagram

It is a graphical representation used to depict the flow of data within a system or process. It illustrates how data moves from one component to another and how it is processed, stored, or transformed along the way.

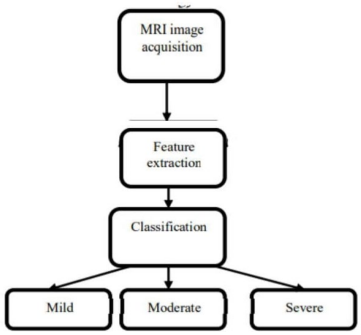

Fig. 2. DFD diagram

The above diagram fig. 2, describes about the DFD diagram of the system. DFD means it explains the detailed information of the system. Firstly, the image will be ready for acquisition and then they make the features after the features extracted it will be classified and the makes the result in which stage it will be present.

C. Use Case Diagram

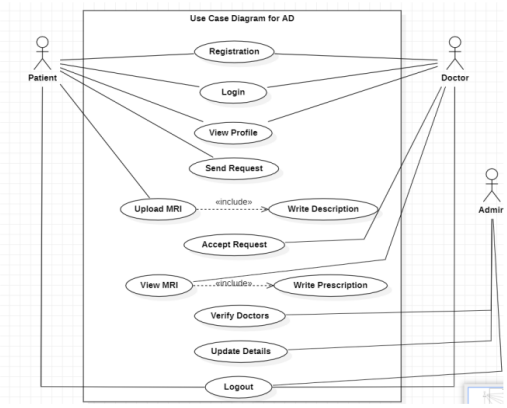

Fig. 3. Use Case diagram

The fig. 3 describes the functions that a system performs to achieve the user's goal. It describes how the actor(user) interacts with the system.

D. Class Diagram

Class diagram shows a collection of classes, interfaces, associations, collaborations, and constraints. It is also known as a structural diagram.

The fig. 4 describes the class diagram of the system. It shows the attributes and operations of various classes and it shows the dependency and multiplicity among different classes.

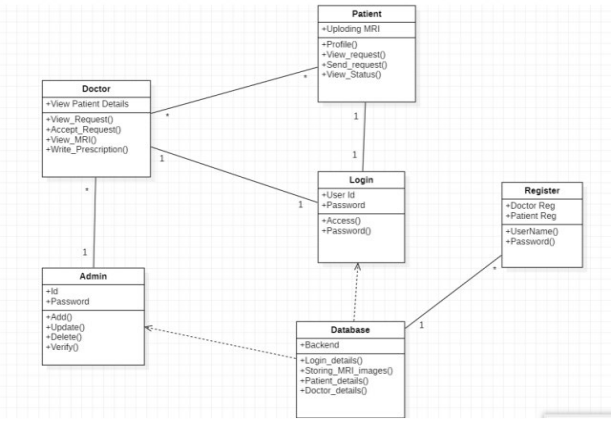

Fig. 4. Class diagram

E. Sequence Diagram

The sequence diagram represents the flow of messages in the system and is also termed as an event diagram. It helps in envisioning several dynamic scenarios. It portrays the communication between any two lifelines as a time-ordered sequence of events, such that these lifelines took part at the run time. In UML, the lifeline is represented by a vertical bar, whereas the message flow is represented by a vertical dotted line that extends across the bottom of the page. It incorporates the iterations as well as branching.

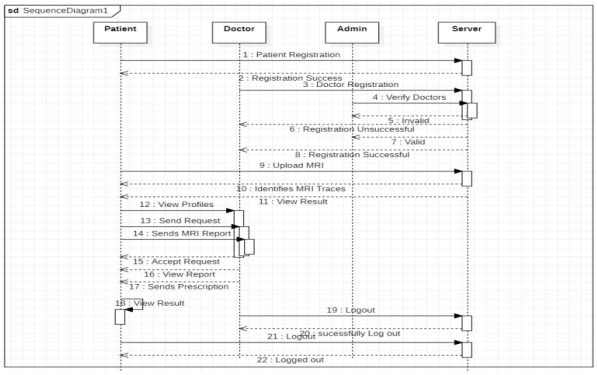

Fig. 5. Sequence diagram

The above fig. 5 depicts the sequence flow included with the time and it describes how the system interacts with the user.

3. Implementation

The method of implementation deals with how the system being implemented, the technologies involved in developing the software and executing the software. The implementation phase comprises of several activities. The required hardware and software acquisition is carried out. The system may require some software to be developed. For this, programs are to be written and tested. The user can then change over to his new fully tested system and the old system is discontinued.

A. Technologies Used

The technologies that are used in the project are:

- Python

- MySQL
- ML
- HTML

B. Algorithms

1) Support Vector Machine (SVM)

A Support Vector Machine (SVM) is a supervised machine learning algorithm used for classification and regression tasks. In the context of classification, SVM is primarily designed to find an optimal hyperplane that best separates data points belonging to different classes in a high-dimensional space. The hyperplane acts as a decision boundary, maximizing the margin (distance) between data points of different classes, which allows SVM to make accurate predictions for new, unseen data.

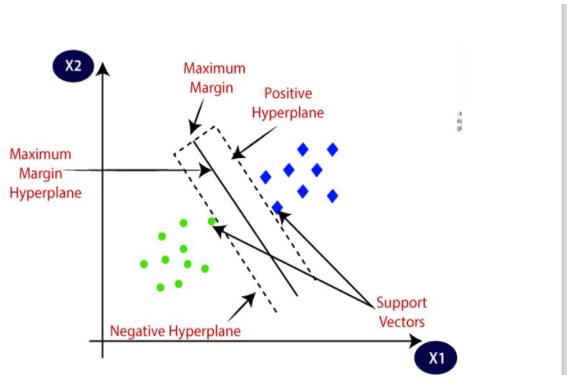

Fig. 6. Decision boundary or hyperplane is used to classify two separate categories

2) Random Forest (RF)

Random Forest is a classifier that contains several decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset. Instead of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output. The greater number of trees in the forest leads to higher accuracy and prevents the problem of overfitting. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model.

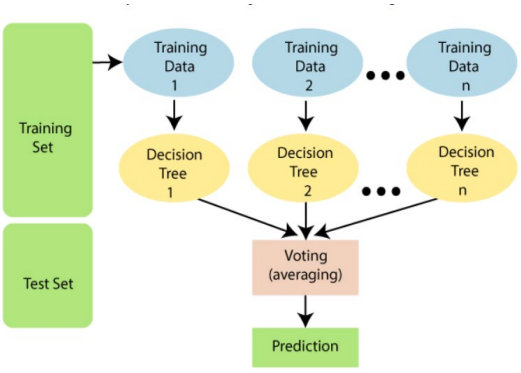

Fig. 7. The working example of the random forest algorithm

4. Result

A. Home Page

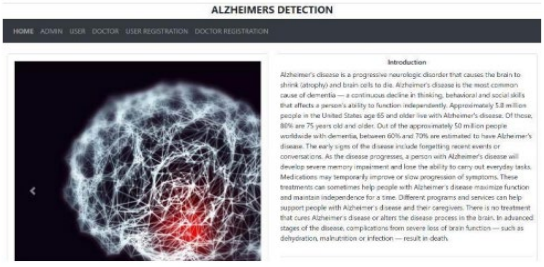

Fig. 8. Home page

B. User Registration Page

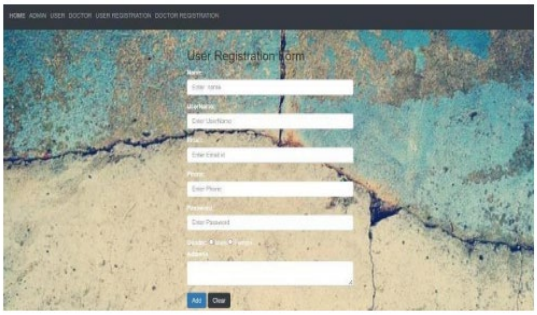

Fig. 9. User registration page

C. User Login Page

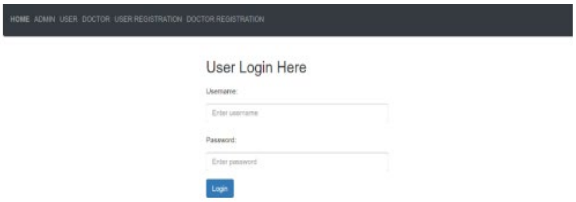

Fig. 10. User login page

D. User Home Page

Fig. 11. User home page

E. Models

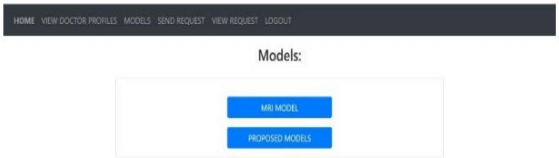

Fig. 12. Models

F. User Result

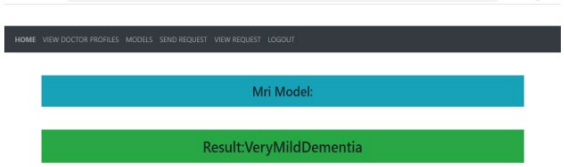

Fig. 13. User result

G. User Send Request Page

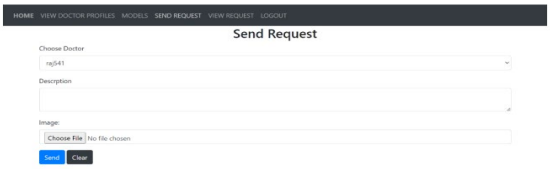

Fig. 14. User send request page

H. Doctor Registration Page

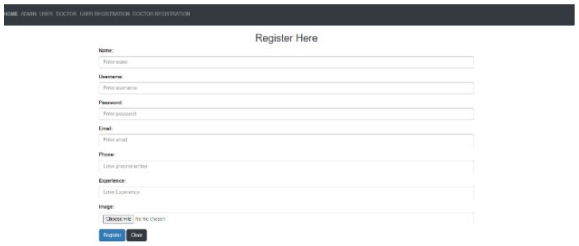

Fig. 15. Doctor registration page

I. Doctor Login Page

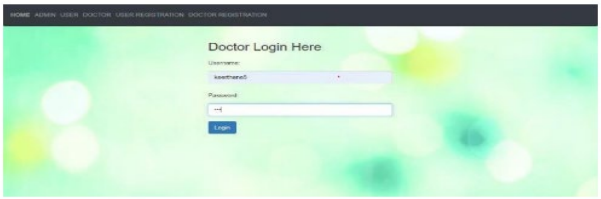

Fig. 16. Doctor login page

J. Patients Request Page

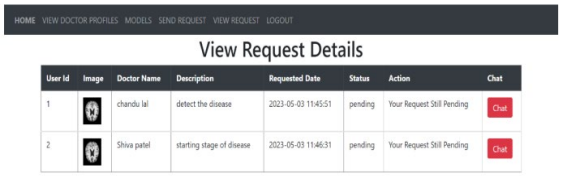

Fig. 17. Patients request page

K. Doctor Prescription Page

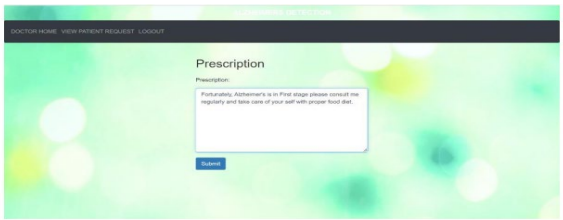

Fig. 18. Doctor prescription page

L. Admin Login Page

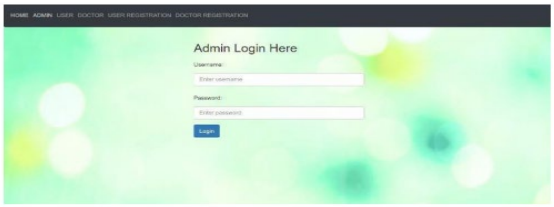

Fig. 19. Admin login page

M. Admin Verification Page

Fig. 20. Admin verification page

N. MRI Results

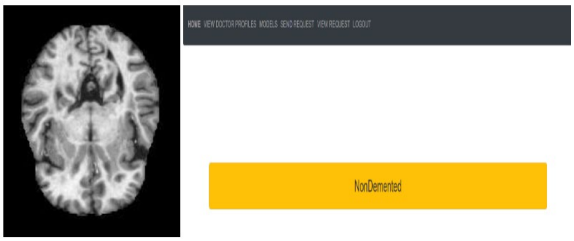

Fig. 21. Non-Demented detected

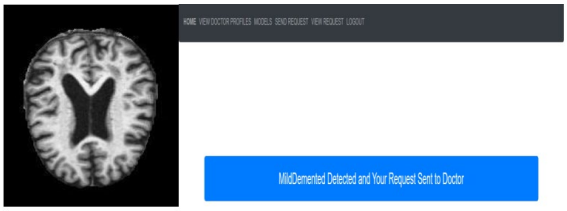

Fig. 22. Mild demented detected

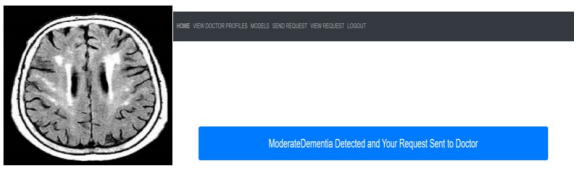

Fig. 23. Moderate dementia detected

5. Conclusion

In this work, the publicly available brain MR image data set OASIS is used for detection. An effort has been made to study the brain MR image slices for AD diagnosis. The proposed method shows90.9% accuracy has been achieved in detection AD. For the data analysis Four classification methods, logistic regression, Naive Bayes, SVM, and Random Forest have been used to study the performance of the proposed algorithm. The experimental results show that maximum accuracy has been achieved.

6. Future Enhancement

In order to get the more accuracy, we need to train the machine learning model more accurately with the accurate MRI scan reports. We need to do more data cleaning and consider the image vector which is being neglected during the feature extraction. So, using the future deep learning methods we should train the model so that we get more than 90% accuracy for detecting the Alzheimer's Disease Using the Structural MRI.

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