Alzheimer's Disease: Classification and Detection using MRI Dataset.

Suhaira V P, Sita S, Joby George

Abstract: *Alzheimer's disease (AD) is a hereditary brain condition that is incurable and progresses over time. Patients with Alzheimer's disease experience memory loss, uncertainty, and difficulty speaking, reading, and writing as a result of this condition. Alzheimer's disease eventually affects the portion of the brain that controls breathing and heart function, leading to death. This framework proposes the OASIS (Open Access Series of Imaging Studies) dataset, which contains the existing MRI data set, which is comprised of a longitudinal sample of 150 subjects aged 60 to 96 who were all acquired on the same scanner using similar sequences. This paper uses a combination of brain MRI scans and psychological parameters to predict disease with high accuracy using various classifier algorithms, and the results can be compared to improve performance.*

Keywords: Alzheimer's Disease, Support Vector Machine, Dementia, OASIS.

I. INTRODUCTION

Alzheimer's disease is a chronic neurological brain disease that is incurable. It kills brain cells, causing people to lose their memories, mental skills, and desire to go on with their everyday activities. Alzheimer's disease affects the part of the brain that governs language and memory at first. Alzheimer's disease should be diagnosed early, which can assist with recovery and reduce brain tissue damage. Alzheimer's disease starts by affecting short-term memory, then progresses to affecting the areas of the brain that regulate breathing and heart function, finally leading to death. Alzheimer's disease is categorized into three stages: mild, moderate, and extreme. Alzheimer's disease cannot be correctly identified until the patient has advanced to the intermediate stage of the disease.

Automatic and accurate preclinical prediction of genetically influenced neuropsychiatric conditions such as Alzheimer's disease would be highly beneficial to doctors prescribing medications for high-risk AD patients. Magnetic Resonance Imaging (MRI) is useful for detecting image patterns and determining the underlying condition that is associated with such anomalies. To identify and track a patient's deterioration, the Mini-Mental State Examination

(MMSE) is used in conjunction with the Clinical Dementia Rating (CDR) and caregiver interviews. Each point on the CDR scale corresponds to a different stage of dementia. MRIs from the OASIS MRI database We then put our qualified neural network to the test on the entire collection of 457 MRIs from the OASIS dataset to ensure that our system is accurate in its diagnosis. Our findings show that AD diagnosis and classification are nearly 90% accurate. The Open Access Series of Imaging Studies (OASIS) dataset has been subjected to numerous experiments.

II. RELATED WORKS

The model predicts the patient's condition and distinguishes between cognitive disability and dementia. Alzheimer's disease has a specific pattern of progressive brain tissue injury. Figure 1 shows several MRI images of the brain that depict various phases of Alzheimer's disease. For automatic Alzheimer's Disease diagnosis, some remarkable research has been carried out. For example, dimensionality reduction methods were used by Aversen et al. [7]. Gupta et al. [10] developed a sparse auto-encoder model, while Brosch et al. [9] developed a broad belief network model. Figure 1 displays a normalized slice of four MR images from the OASIS dataset with varying amounts of AD.
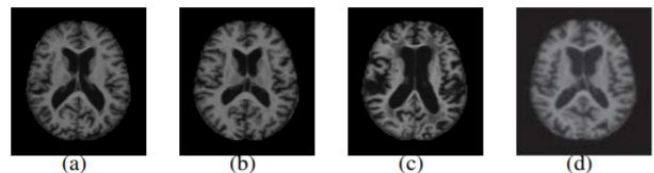

Figure 1 : Example of different brain MRI image presenting different AD stage a) Non Demented; b)Very Mild Dementia; c) Mild Dementia ; d) Moderate Dementia

III. PROPOSED METHOD

Many different approaches are used within the planned framework. Classification denotes an information analysis task, i.e., a system or model for defining and separating information categories and ideas. On the definition of a coaching set of information containing observations and whose classes membership is known, classification is the downside of distinguishing to that of a group of classes, subpopulations, to which a new observation belongs. It's a two-step procedure that goes like this:

a) Learning Step (Training Phase):

Different algorithms are used to construct a classifier by allowing the model to learn from the training set available.

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For accuracy prediction, the model must first be educated.

b) Classification Step:

Model is used to forecast category labels and look at building a model on test data to estimate the classification rules' accuracy.

c) Feature Extraction Process:

There are two ways to exhaust feature extraction for texture analysis,

- All of the voxels that are of interest are collected and merged, and then entirely different textures are computed.
- Textures are calculated at three different axes (sagittal, coronal, and axial) and averaged for each voxel of interest

The centre slice image of all axes is extracted first, since it provides the best visibility of all regions. Figure 2 ((a),(b),(c)), ((d),(e),(f)), ((g),(h),(i)) depicts the middle slice of all axes with ROI blocks containing at least one statistically important texture
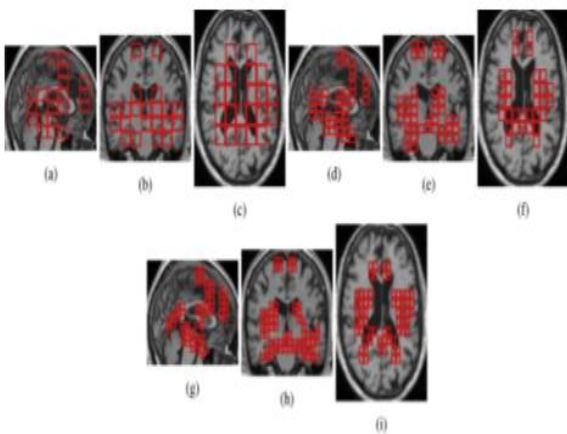

Figure2: Center Slice of Axes

Feature selection:

Feature selection, from the standpoint of machine learning, eliminates overfitting of a classifier on higher dimensional data by eliminating redundant or irrelevant features. Since the number of features obtained through the RROI process is larger than that obtained through conventional ROI analysis, a good feature selection process is needed to remove unwanted features. As a result, the fisher, elastic net regularization, and SVM recursive feature elimination algorithms' performances are compared.

Figure 3 portrays two pictures of elderly patients, one for a nondemented patient and the other for a moderate Alzheimer's disease patient. (a) depicts a 73-year old subject who is free of dementia. (b) portrays an 83-year old man suffering from moderate dementia.
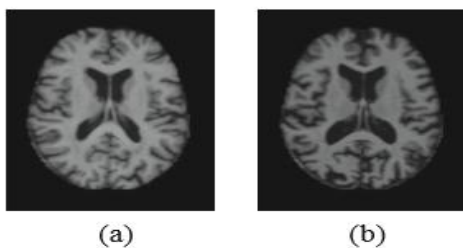

Figure 3: Images of nondemented and demented patients

IV. RESULTS

The method performs texture analysis after extracting features from specified areas of interest. To deal with the complication of higher dimensional features, techniques like fisher ranking, elastic net regularization, and SVM recursive feature elimination are used to pick the textures. Finally, the features are tested using multiple classifiers and their results on various AD classifications. Each feature has been evaluated separately to determine its performance, and the accuracy of all classifiers has been checked using those features.

Each characteristic has been compared between the Demented and Nondemented classes. Figure 4 (a), (b), and (d) show that the Demented group has a far higher ASF, eTIV, and nWBV ratio than the Nondemented group, and (c) shows that the Demented group has a lower MMSE amount.
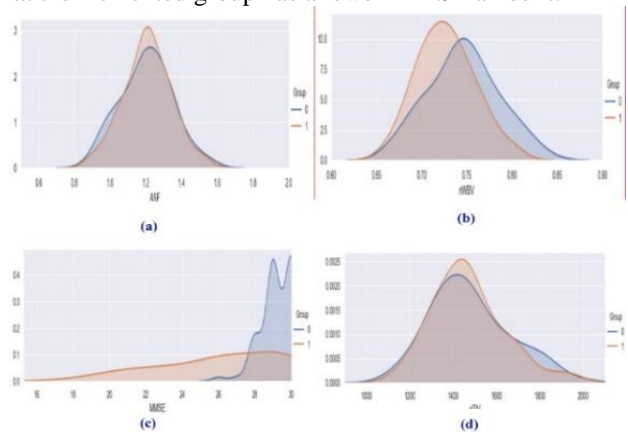

Figure 4: Feature wise comparison

The system's performance assessment shows that one of the four classifiers has the highest accuracy of the four, and that classifier is used to conduct identification for a single test case that yields demented or nondemented results.

Support Vector Machine, K-Nearest Neighbor, Random Forest, and Naive Bayes' classifiers are used in this study to predict Alzheimer's disease. We can get different accuracies for different classifiers by using a random collection of samples, for example. Figure 5 illustrates this. Random Forest has reached the highest degree of accuracy in this situation.
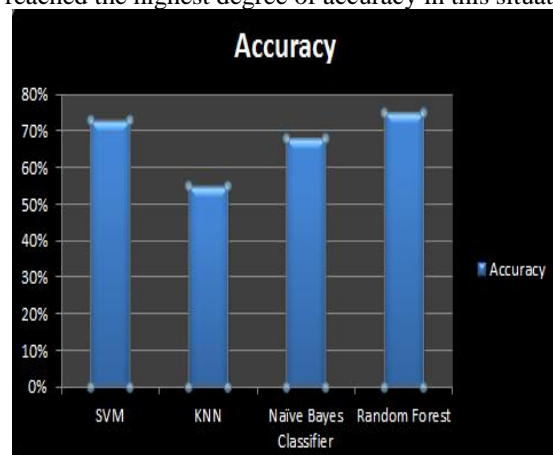

Figure 5: Accuracy of different classifiers

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V. CONCLUSION

Early detection of Alzheimer's disease may help to halt or delay the disease's progression. Using brain MRI data analysis, we demonstrated an important tool for diagnosing Alzheimer's disease. Future study may include a proposal to test the proposed model against various Alzheimer's disease datasets, such as ADNI [11], as well as other neurological condition diagnoses.

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