ALZHEIMER'S DETECTION AND CLASSIFICATION USING SVM

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ABSTRACT

Alzheimer's disease (AD) is the leading cause of dementia in older adults. In Alzheimer's disease, the brain is affected by neurodegenerative changes. As our aging population increases, more and more individuals, their families, and healthcare will experience diseases that affect memory and functioning. These effects will be profound on the social, financial, and economic fronts. In its early stages, Alzheimer's disease is hard to predict. A treatment given at an early stage of Alzheimer's disease (AD) is more effective, and it causes fewer minor damage than a treatment done at a later stage. The paper proposes a technique based on Support Vector Machine that identify the best parameters for Alzheimer's disease prediction. Predictions of Alzheimer's disease are based on Magnetic resonance imaging (MRI) data, and performance is measured with parameters like Precision, Recall, Accuracy, and F1-score for ML model. The proposed classification scheme can be used by doctors to make diagnoses of these diseases. It is highly beneficial to lower annual mortality rates of Alzheimer's disease in early diagnosis with this Machine Learning(ML) algorithm.

Keyword: - Alzheimer's disease, Machine Learning, SVM

1. INTRODUCTION

Alzheimer is from a family of diseases that can develop dementia, specially in elderly people. Dementia is a loss of memory and/or other mental disability that can cause physical damaged to the brain. Although Alzheimer is the most common type of dementia but there are different types of dementia such as vascular dementia, Lewy Body disease, frontotemporal dementia, alcohol related dementia and HIV associated dementia, etc. The most common type of dementia after Alzheimer's disease is vascular dementia which can happens after stroke. In addition, some of the causes of dementia are reversible such as thyroid problem and vitamin deficiencies. The dementia is not just a disease but its associated risks such as decline in the memory significantly reduces a person's ability to perform daily tasks.

Dementia with Alzheimer's is classified into three categories:

- a. Very Mild Dementia: Individuals suffers from memory loss as they age.
- b. Mild Dementia: Symptoms which includes lack of memory, Behavioral changes, inability to perform routine tasks.
- c. Moderate Dementia: The day to day life becomes complex for the individuals with moderate dementia, where the patients require extra care and support.

It is expected that the number of people affected from dementia will increase over the time. The early detection can not only help doctors to precisely make decision on the treatment but also help preventing the complications. It is important to develop a system that can help in early detection of dementia. The Alzheimer's disease has number of symptoms, especially in the elderly people that can cause problems to perform daily tasks due to memory loss. Although the Alzheimer is not normal due to aging, its risk factor increases with the aging. Most of the people who suffer from Alzheimer are aged 65 or above.



Fig -1: Statistics of Alzheimer's Disease

Fig 1 shows the statistics of Alzheimer's Disease. However, it not uncommon to have this disease in the people younger than 65. For instance, more than two hundred thousand American aged less than 65 suffers from Alzheimer disease. Fig 2 shows the difference between the normal brain and Alzheimer's brain. It can be noticed that the brain of the Alzheimer's disease in not only significantly smaller than the normal brain but is affected severely from neurological disorder and dysfunction. Additionally, Fig 3 presents some of the common symptoms of the Alzheimer's disease. The most common types of symptoms are loss of memory, changes in the behaviour difficulty with everyday task and confusion in familiar environments.



Fig -2: Difference between a normal brain and a severe Alzheimer's Brain

Practically, no effective cure to treat Alzheimer's disease exist to date. However, there exist ways that can temporarily slow down the process of Alzheimer's symptoms and improve the quality of the life of the patient. To this end, significant research efforts are dedicated to find the effective ways of treating the Alzheimer's disease with a focus on preventing the disease from progressing over the time. It is suggested that ML algorithms, which have proven their significance in various fields, can help solve the problem of early detection of Alzheimer's disease clearly, ML methods have their applications in various domains, including but not limited to sentiment analysis, speech enhancement, cyber-security, image classification, energy efficiency, travel detection, posture detection, and atrial fibrillation etc. Therefore, the ML techniques including support vector machine (SVM), logistic regression,

multi-layered perceptron and deep learning classifiers. This paper proposed a novel approach, based on ML method with Support Vector Machine(SVM) to detect and classify Alzheimer's disease. The obtained results from ML algorithm (SVM) are compared. The rest of the paper is structured as follows. Section 2 presents the motivation to our project. Section 3 provides the state of-the-art in Alzheimer detection. Section 4 presents the proposed methodology. Section 5 provides the experimental results of the proposed Alzheimer detection and discussion .Section 5 concludes the paper, and finally section 7 provides the references.



Dementia is a term for a decline in mental ability severe enough to interfere with daily life. Alzheimer's is the one type of dementia. Alzheimer's is the most serious yet common neurodegenerative disease that initially destroys cells of the part of the brain. It's responsible for language and memory resulting in memory loss of the patient and also the ability to perform regular tasks. As there is no cure for Alzheimer's disease, it's better to detect as early as possible to slow down the severity of the disease. Usually to diagnose the disease radiologists use manual methods such as previous medical history, continuous monitoring of the patient to detect the various stages of AD, however these manual methods may lead to errors.

Herewith mentioning the key contributions of this paper:

- 1) Implementing Machine Learning algorithm (SVM) efficiently to detect and identify the stage of the Alzheimer's disease patient.
- 2) Analyzing the various performance metrics of the machine learning algorithm.

2. MOTIVATION

Under the current conditions, human instinct and standard measurements do not often coincide. In order to solve this problem, we need to leverage innovative approaches such as machine learning, which are computationally intensive and non-traditional. Machine learning techniques are increasingly being used in disease prediction and visualization to offer prescient and customized prescriptions. In addition to improving patient's quality of life, this drift aids physicians in making treatment decisions and health economists in making their analyses. Viewing medical reports may lead radiologists to miss other disease conditions. As a result, it only considers a few causes and conditions. The goal here is to detect and identify the Alzheimer's disease based on ML framework with SVM.

3. RELATED WORKS

Alzheimer's disease is a fast-growing disease occurring worldwide. It mostly affects the aged population. Alzheimer's disease is incurable and is a neurodegenerative disease that mostly affects the brain. People are facing problems associated with Alzheimer's disease due to a lack of early diagnosis due to no or minor symptoms in the early stages of the disease.

Gaudiuso et al.(2020) [6] proposed a technique using machine learning integrated with Laser-Induced Breakdown Spectroscopy (LIBS). Micro drop plasmas were diagnosed for patients having Alzheimer's disease and healthy controls (HCs). The classification was also performed using machine learning algorithms. The dataset used for the evaluation of the model had 31 patients who are having Alzheimer's disease and 36 HCs. The proposed technique successfully diagnosed late-onset Alzheimer's disease, with a better diagnosis for patients greater than 65 years of age. The total classification accuracy between Alzheimer's disease and healthy controls was 80%.

Early detection of this disorder is being researched to slow down the abnormal degeneration of the brain, reduce medical care cost reduction, and ensure improved treatment. In some other Existing system machine learning algorithms are used to predict the Alzheimer disease using psychological parameters like age, number of visit, MMSE and education. Different modalities are used for AD study include MRI, Positron Emission Tomography (PET), and genotype sequencing results. It is time-consuming to analyze different modalities to take a decision. Furthermore, the patients can encounter radioactive effects in the modalities like PET. Previously researchers performed 3D tissue segmentation of white matter, gray matter, and cerebrospinal fluid from MR images after skull striping using FSL tool, calculate the surface fractal dimension from segmented brain tissue. From the survey , Numerous techniques exist for AD classification using machine and deep learning. However, the high model parameter and class imbalance in the multiclass AD classification is still an issue.

Disadvantages in existing systems

A few points needed to be addressed, with some under examination, as discussed below.

- Efficient and accurate early diagnosis of AD is needed to provide early treatment options. Automatic techniques are required to handle the large volume of patients' medical image data.
- Currently, there is no disease therapy, and there is a need for a solution for large volumes of image data to treat a large volume of patients.

4. PROPOSED WORK

This work proposes a novel Alzheimer's detection and classification using ML algorithm (Support Vector Machine).

The two main sections, Alzheimer Detection and Alzheimer Classification.

- Alzheimer Detection: Whether the patient has the Alzheimer or not
- Alzheimer Classifier: Define what stage the patient is in the Alzheimer.

The model is developed from scratch to classify the stages of AD more accurately. The models are evaluated by training them over the MRI dataset from the Kaggle. The dataset comprises four types of dementia such as Mild Dementia (MID), Moderate Dementia (MOD), Non-Demented (ND) and Very Mild Dementia (VMD). Fig 4 presents the picture of the different stage of the Alzheimer disease.



Fig -4: Different Stages of Alzheimer Disease

In particular, the raw data coming from MRI scans is pre-processed before applying ML algorithm (SVM). This project will go through ML model Support Vector Machine(SVM) with kernels starting with linear to radial basis function(RBF) kernel .Detection model SVM will be making judgements about the test data to see whether this person's brain image shows Alzheimer signs. And then, Alzheimer Classification will be done through training the data with different severity for Alzheimer. Fig 5 presents the picture of the proposed workflow of the Alzheimer detection and classification system .Finally various metrics like accuracy, precision, recall, f1 score and confusion matrix are calculated for Alzheimer detection system and accuracy is calculated for Alzheimer's classification system.



Fig -5: Proposed Workflow

5. RESULTS

Table 1. Summary of performance metrics of SVM algorithm to detect Alzheimer using three different kernels.

METRICS	LINEAR KERNEL	2 DEGREE POLYNOMIAL KERNEL	RBF KERNEL
Precision	0.89067	0.84337	0.83203
Recall	0.91211	0.88467	0.79942
F1 score	0.90127	0.86353	0.83846
Confusion matrix	[[636 11]	[[543 104]	[[507 140]
	[15 618]]	[73 560]]	[75 558]]

Table 2. Summary of performance on test data(Accuracy) of SVM algorithm for Alzheimer's detection and classification using three different kernels.

SYSTEM	MODEL	PERFORMANCE ON TEST DATA
Alzheimer Detection	SVM(Kernel: Linear)	90.1% accuracy
Alzheimer Detection	SVM(Kernel: 2-degree polynomial)	86% accuracy
Alzheimer Detection	SVM(Kernel: RBF)	83% accuracy
Alzheimer Classification	SVM(Kernel: Linear)	90% accuracy
Alzheimer Classification	SVM(Kernel: 2-degree polynomial)	83.1% accuracy
Alzheimer Classification	SVM(Kernel: RBF)	77% accuracy

6. CONCLUSION

This study is based on the comparison and evaluation of recent work done in the prognosis and prediction of Alzheimer's disease using machine learning method. Explicitly, the recent trends with respect to machine learning has been revealed including the types of data being used and the performance of machine learning methods in predicting early stages of Alzheimer's. It is obvious that machine learning tends to improve the prediction accuracy especially when compared to standard statistical tools. The proposed model suggests a machine learning based method for detecting and classifying Alzheimer's disease utilizing the support vector machine. Non-Dementia, Very Mild-Dementia, Mild Dementia, and Moderate Dementia were the four classifications of Alzheimer's Disease in this model.

Alzheimer's is a major health concern, and rather than offering a cure, it is more important to reduce risk, provide early intervention, and diagnose symptoms early and accurately. As seen in the literature survey there have been a lot of efforts made to detect Alzheimer's Disease with different machine learning algorithms and micro-simulation methods. However, it remains a challenging task to identify relevant attributes that can detect Alzheimer's very early. The future work will focus on the extraction and analysis of new features that will be more likely to aid in the detection of Alzheimer's Disease, and on eliminating redundant and irrelevant features from existing feature sets to improve the accuracy of detection techniques. And we plan to extend the disease detection with more data sets and use the different measures to detect the system's accuracy.

7. REFERENCES

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