IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Alzheimer's Disease Detection Using Machine Learning

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Abstract: Alzheimer's disease is a degenerative brain disorder that impairs cognition and causes brain shrinkage, ultimately leading to the patient's death. Early intervention is crucial to delay further degeneration, and machine learning techniques such as optimization and probability models can aid in its diagnosis. As no single non-amyloid protein has been demonstrated to be able to consistently diagnose AD, a possible ML strategy entails discovering combinations of non-amyloid proteins that can. Our method employs ML techniques to differentiate between normal brain aging and the onset of Alzheimer's disease. Specifically, we propose using a Support Vector Machine Algorithm to detect AD.

KEYWORDS: Deep Learning, CNN, Classification, Feature *Extraction, Image Pre-processing.*

I. INTRODUCTION

A crippling neurological ailment that typically affects older persons, Alzheimer's disease (AD) is a severe condition. However, there is presently no treatment that can stop or stop the disease's growth. The prevalence of AD is expected to continue rising, with reports indicating a steady increase in the number of individuals affected from 2005 to 2030. According to estimates, there are already 40 million Alzheimer's patients globally, and by 2050, there may be 135 million. While Alzheimer's Disease is currently incurable, early detection and appropriate treatment can help manage symptoms and slow neuron degeneration. A promising method for early Alzheimer's disease detection is computer-aided diagnostics, which uses sophisticated image processing and pattern recognition algorithms to locate the Features of Interest or Region of Interest (FOI/ROI) in MRI images. These systems are designed to minimize false negatives while maximizing accuracy, greatly aiding neurologists in understanding the physiological changes in the brain.

Although there is no known cure for Alzheimer's disease, early identification and care can help people live better lives and delay the illness's development.

With continued research and technological advancements in the field of neurodegenerative diseases, there is hope for better treatments and eventually a cure for Alzheimer's Disease.

Recent studies have utilized voxel-based brain MRI feature extraction techniques in combination with machine learning algorithms to predict Alzheimer's Disease. AD causes damage to both the grey and white matter of the brain; therefore, analyzing both of these factors has been found to be more effective in predicting the disease.

The goal of the area of study on Alzheimer's disease and other dementias is to create therapies to delay or prevent the beginning of these illnesses, improve early diagnosis, and discover better ways to manage dementia in conjunction with other chronic ailments.

Deep learning, a cutting-edge machine learning approach, has proven to perform better than traditional machine learning at uncovering intricate structures in complicated, high-dimensional data, particularly in the field of computer vision. The use of deep learning for automated categorization and early diagnosis of Alzheimer's disease has seen a marked increase in interest in recent years due to the quick development of neuroimaging techniques and the production of enormous amounts of multimodal neuroimaging data as a result.

A Convolutional Neural Network (CNN) trained using magnetic resonance imaging (MRI) scans of the brain can be used to detect Alzheimer's disease.

The CNN algorithm scans different areas of the brain for characteristics like atrophy that are associated with Alzheimer's disease. The algorithm can be improved to precisely predict the existence of Alzheimer's disease by using a huge collection of labelled brain MRI data. This approach has shown promising results and might help with the early diagnosis and treatment of Alzheimer's disease

II. LITERATURE SURVEY

[1] "FAZAL UR REHMAN FAISAL, Goo-Rak Kwon Automated Detection of Mild Cognitive Impairment and Alzheimer's Disease Using Whole Brain MRI."

The goal of this work is to develop a deep learning model that can quickly diagnose Alzheimer's disease using neuroimaging. The main emphasis is on using structural magnetic resonance imaging (SMRI) to identify relevant biomarkers for Alzheimer's disease and divide brain pictures into Alzheimer's disease, mild cognitive impairment (MCI), and cognitively normal (CN) groups. Convolutional neural networks (CNNs) were modified and trained utilising brain SMRI images from ADNI datasets that were accessible in internet sources in order to do this.

[2] "SUHAD AL-SHOUKRY 1,2, TAHA H. RASSEM 1, (Senior Member, IEEE), AND NASRIN M. MAKBOL,Taha H. Rassem Alzheimer's Diseases Detection by Using Deep Learning Algorithms: A Mini-Review".

The treatment of Alzheimer's patients, particularly in the early stages of the illness, depends on an early and precise diagnosis. This is so that patients can receive preventive care before suffering from irreparable brain damage. The majority of machine detection techniques are constrained by innate observations, despite the fact that computers have recently been utilised in experiments to diagnose Alzheimer's illness. Alzheimer's disease can be identified, but it cannot be anticipated in its early stages because prediction can only be made before the disease shows symptoms. A well-liked method for the early identification of Alzheimer's disease is deep learning (DL).

[3] "Alzheimer Disease Detection Techniques and Methods" by Sitara Afzal, Muazzam Maqsood, Umair Khan, and Irfan Mehmood.

Alzheimer's disease (AD)-related brain alterations can be measured via neuroimaging. Through categorization frameworks that offer diagnostic and prognostic tools, these parameters have recently been incorporated into AD signatures. This thorough analysis of published publications on AD focuses on computer-aided diagnosis. The review covers imaging techniques such positron emission tomography (PET), amyloid-PET, diffusion tensor imaging, functional magnetic resonance imaging (fMRI), and magnetic resonance imaging. The results show that classification methods based on characteristics have shown promise for identifying AD and promoting therapeutic development.

[4] **"PERSONAL ASSISTANCE FOR ALZHEIMER'S PATIENT"** by Kalpana Devi. S1, Amirtha Varshini D2, Anbukani RS3, and Bhavatha Ranjanni S4.

Alzheimer's disease is an incurable degenerative brain ailment that slowly erodes one's capacity for memory and thought. Discussion boards, behaviour tracking, and path identification are examples of current methods. The creation of a patient-specific personal assistance application is one suggestion for resolving this problem. facial identification, wandering and fainting detection, home-finding aid, daily task and memory reminders, job organisation and planning, and

facial recognition are all included in the app. This can be done by keeping an eye on the patients' movements and detecting them using the sensors and GPS capabilities of cellphones.

[5] **"H. M. Tarek Ullah, Zishan Ahmed Onik, Riashat Islam, and Dr. Dip Nandi**," "Alzheimer's Disease and Dementia Detection From 3D Brain MRI Data Using Deep Convolutional Neural Networks."

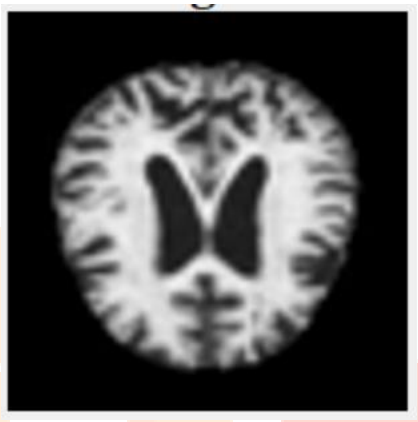
Over 5 million Americans already have Alzheimer's disease, and by 2050, that figure is projected to rise to 16 million, according to the Alzheimer's Association. In the US, this neurodegenerative condition is the sixth biggest cause of death, and in 2017 it cost the economy of the country $1.1 trillion. Surprisingly, Alzheimer's

or another form of dementia kills 1 in 3 seniors, making it more lethal than breast and prostate cancer put together. As of the writing of this paper, the conventional method of detecting Alzheimer's requires brain imaging reports and expert analysis, making it both time-consuming and expensive, with a high risk of error.

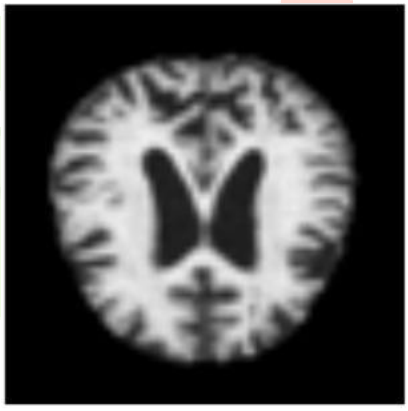
III. METHODOLOGY

Here, we outline the rigorous procedure we followed to find out what people's opinions were on the Indian farmer protests. Gathering data from Twitter is the first step in the process, which is then followed by a few critical procedures like cleaning and preparing the data to make it computer intelligible. The following stage is to ascertain and classify a user's sentiment based on two factors. Additionally, the way people feel about certain situations can be studied using visualization approaches.

1)Data Collection: A full and accurate picture of a subject of interest may be obtained by data collection, which is the systematic gathering and measurement of data from a number of sources.



a). MRI Image



b) Grey Image

c) Binary Image

2) Data Mining: - Data mining is a valuable tool for transforming raw data into meaningful insights. In the case of analyzing MRI brain images, the initial step is to preprocess the data by converting the images into grayscale format. This process eliminates any irrelevant information from the images. To utilize the CNN algorithm for further analysis, the images must be in binary format. So, in order to make it easier to extract important elements from the data, the grayscale brain pictures are converted into binary images.

3) Evaluation Method:- The binary representation of the data is used to evaluate it. The Convolutional Neural Network (CNN) technique is used to analyze data from images and forecast results. The output of the analysis of data is evaluated on the basis of the features of the binary image. The swelling or shrinkage of brain walls, the amount of cavity in the brain image and the measurement of brain walls plays the role of features which is used for the prediction of output. The training data set has various brain images having multiple output scenarios. The machine is trained to find the highlighting features which are crucial for the categorization of brain images into different categorized outputs. Based on the distinct features, the output is categorized into four groups namely –

i) Very mild
ii) Mild
iii) Moderate
iv) None

When the brain image is uploaded for the prediction, the machine will process the image and evaluate it by performing feature extraction and categorize the output into any of the four categories based on the range and similarities of the features between the trained data and the data that has to be tested. Basically, the process of classification is been done for the categorization of the output.

IV. PROPOSED SYSTEM

Deep Learning is utilized to interpret and analyze data. By employing data mining techniques, a large amount of raw Alzheimer's disease (AD) data is transformed into meaningful information that can facilitate better decision-making and predictions. The proposed system incorporates Deep Learning algorithms such as CNN, requiring the AD Dataset to be uploaded and trained. The system performs various data processing functions through three modules: pre-processing, feature extraction, and classification, each using a different algorithm. Finally, a model is constructed and evaluated for its effectiveness.

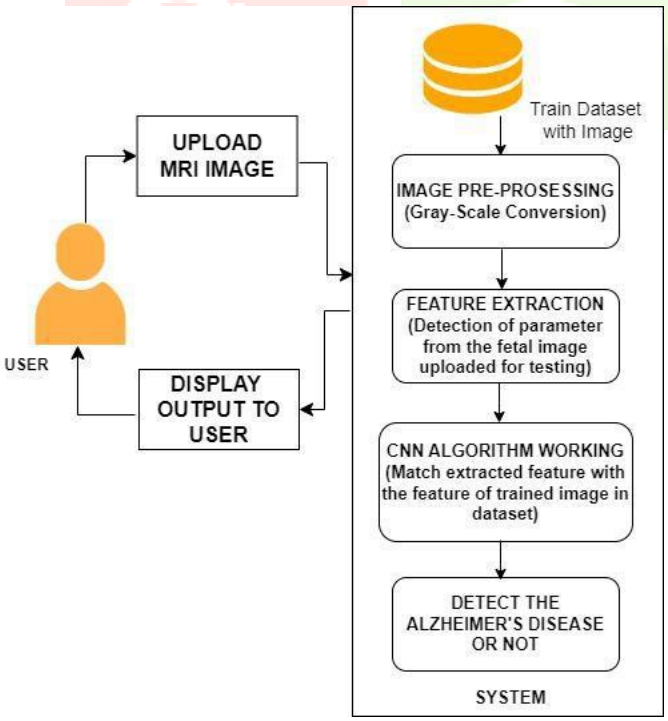


Fig.1. Proposed System Architecture

V. ALGORITHM

Convolutional Neural Networks (CNN), it is a type of artificial neural network used in deep learning and computer vision. It is mainly used for image and video recognition, classification, and segmentation. Neurons are the basic building blocks of CNNs. They receive input from other neurons or the environment and produce results based on that input. Activation functions are used to introduce nonlinearities in the network and allow it to model complex relationships between inputs and outputs.

The output of the ith neuron in the jth layer is given as: Output_ji = activation function (Summation(Weight_kj * Output_i-1k + Bias_j)) where,

Output_ji : output of the ith neuron in the jth layer

Activation function : the activation function used in the layer

Weight_kj : weight of the connection between the kth neuron in the previous layer and the ith neuron in the jth layer

Output_i-1k : output of the kth neuron in the previous layer

Bias_j : bias term of the jth neuron

Summation_k : summation over all neurons in the previous layer.

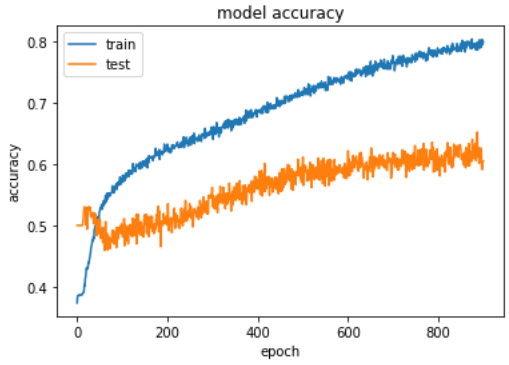


Figure 2: MODEL ACCURACY GRAPH

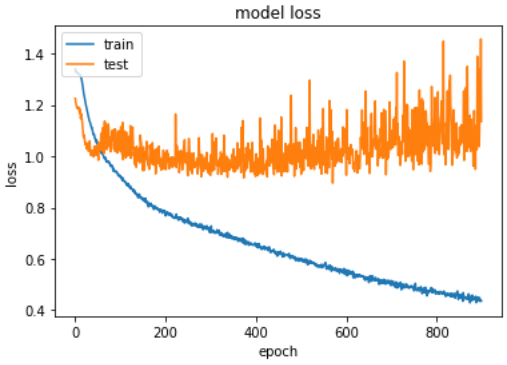


Figure 3: MODEL LOSS GRAPH

VI. CONCLUSION

In this work, we have analyzed 3D brain MRI images to diagnose Alzheimer's disease. CNNs algorithm is used to analyze binary images of the brain and extract relevant features, such as the swelling or shrinkage of brain walls, the amount of cavity in the brain image, and the measurement of brain walls.

The Convolutional Neural Network (CNN) algorithm was trained on a large dataset of labeled brain MRI scans to accurately predict whether a patient has Alzheimer's disease or not. The results showed that the CNN algorithm was successful in detecting Alzheimer's disease and could potentially help in the early diagnosis and treatment of the disease.

VII. REFERENCES

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