Review of the literature on deep learning methodologies for Alzheimer's disease identification

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ABSTRACT: Alzheimer's disease-related dementia is an important healthcare concern as the population of most nations ages prematurely. Dementia is ranked seventh as one of the main reason of death among all diseases and one of the main reasons why elderly people around the world become disabled and dependent. Dementia affects those living with it physically, subjectively, socially, and in terms of business. It also negatively affects their families, communities, and careers. Dementia is frequently misunderstood and neglected, which leads to stigma and obstacles to treatment and diagnosis. It is possible to treat senility symptoms even though there is currently no cure. Early identification is important to the effectiveness and success of treatments. The neuroimaging offers one of final potential domains for treating the Alzheimer's disease. Using magnetic resonance imaging (MRI), deep learning techniques are being used to identify and extract valuable biomarkers for Alzheimer's disease. These techniques are also being used to classify the input into various stages of the disease.

KEYWORDS: Deep Learning, Dementia, Neurological disorder.

I. INTRODUCTION

Alzheimer disease relate to a type of dementia which is a progressive neurologic disorder characterized by the shrinking of the brain cell and make the cells die. The key significant contributor to dementia is Alzheimer's disease. It is characterised by the persons cognitive and social skills gradually deteriorating, which hinders their capacity for carrying out action on their own. Forgetting prior encounters or occurrences is one of the diseases' early symptoms. A person with Alzheimer's disease will have significant loss of memory and lose the capacity to carry out basic tasks as the health deteriorates. There are few, if any, medications for Alzheimer's disease which can stop the illness development inside the brain. In later event of the illness, consequences from a considerable reduction in brain function, also including exhaustion, or infection, may ensue and lead to the patient's death.

The neuropsychiatric symptoms of Alzheimer's disease, which can manifest in varied degrees during the phase of the disease, involve apathy, depression, aggressiveness, agitation, disturbed sleep, and hallucinations. Due to the neuropsychiatric characteristics of Alzheimer disease patients, which negatively affect the interaction between the patient and caregiver and result in feelings of tension, burden, and lack of social support, not only the patient but also the family will be affected. Since informal carers are so important in the care of AD patients, it is critical to implement effective management techniques that include strategies for addressing the independent functions of each caregiver.

Detection of Alzheimer disease in early stage will prove to be boon for many patients and their family members. Due to the rapid advancement of neuroimaging techniques, there has been a noticeable increase in interest in the use of machine learning for automated segmentation and

timely identification of Alzheimer disease in past few years. Due to the rapid advancement of neuroimaging techniques, there has been a greater increase in interest in the implementation of machine learning for automated categorization and Alzheimer's disease detection and cure in recent years.

II. LITERATURE SURVEY

The authors of the paper [1] have proposed a 12 layer Convolutional Neural Networks (CNN) consisting of five steps namely: (1) Convolutional layer selection- here they have used Conv2D, which helps produce a tensor of outputs. (2) Pooling layer where they have made use of Maxpooling2D. For each of Conv2D layer, they implemented the Maxpool2D layer. (3) Flatten Layer was processed after the implementation of pooling layer. The purpose of flatten layer was used to flattening the whole connected network system. (4) Dense Layer was utilized as a fully connected layer. (5)The Activation Function of the proposed system have made use of three functions named Sigmoid function ,ReLU function and Leaky ReLU activation function which has improved the accuracy of the system. When the system was implemented on Open access series of imaging studies has yielded greater accuracy then the previous trained CNN models.

The offered study [2] have created a twin interest multi-example deep mastering networks for the prodromal level of mild cognitive impairment and Alzheimer's disease early diagnosis. They used sMRI scans of 1689 people from the Australian Imaging, Biomarker and Lifestyle Flagship Study of Aging and the Alzheimer's Disease- Neuroimaging Initiative, special datasets, to discover ability biomarkers of Alzheimer's disease. The proposed, is split into 3 sections: The Patch, an interest multi-example mastering pooling operation, which aids in balancing the relative contribution of every patch and might offer a worldwide distinct weighted average. Nets with spatial interest blocks, which resource in pre-processing the acquired set of statistics to acquire discriminative statistics in every MRI patch even as strengthening the capabilities of abnormally mutated precision withinside the cerebrum. An interest-conscious everyday classifier is a 3rd classifier this is used to classes times of AD with the aid of using mastering extra approximately the critical capabilities.

In the paper [3], the scientists employed a neuroimaging on structural magnetic resonance image (sMRI) from the left and right hippocampi to derive slice-wise volumetric characteristics for diagnosing Alzheimer's disease. They employed a 6-layered DNN model to analyses the data from the cortex and left and right hippocampi. Using a DNN model and the collected slice-wise hippocampal volumetric characteristics, the probability score for the AD sample class and the non-AD sample class have been computed. The model was modified from the Hough-initial two-stage CNN's network design in order to make the localization model easier. The suggested model's average weighted accuracy values, depending upon those volumetric features allocated to the left and right, are 94.82% and 94.02%, respectively.

The theories in the study [4] take use of how Alzheimer's disease affects the brain's white and grey material, which are regarded to be potential early warning signs of the disease. Three orthogonal directions—the coronal, sagittal, and axial—are displayed for a specific 3D MR image. One slice is taken after separating the white material and grey material from the 3D brain image. Four classifiers—SVM, Naive Bayes, Adaboost, and Logistic Regression classifier—are selected based on the prominent features selected to assess the presence of Alzheimer's disease just after data has undergone pre-processing. These classifiers are applied separately to data from white material and grey material in the coronal, axial, and sagittal directions. By using a white slice of the coronal view, the inventor of this method was able to achieve accuracy of 90.9% for the OASIS dataset.

Offered paper [5] is grounded on a deep three-D cease- to- cease CNN for biomarker identity obligations with multi-elegance advertisements the use of the complete photograph quantity as input. Model channels correspond of his 3 important sorts mind delivery and normalization, three-D CNN processing, and sphere matching. For mind delivery and normalization, the statistics had been acclimated via way of means of registering the photos to a widespread template. Since analogous systems are predicted to be at more or less the equal spatial locales, the device can reuse the complete photograph promptly and routinely decide essential areas of interest. The writer supported his 4 CNN structure designs videlicet, Le-Net- 5, VGG, GoogLeNetandResNet. To keep away from overfitting, the authors supported regularization via way of means of Level1 and Level2 morals. In Level1 this impact is performed via way of means of minimizing absolutely the values of the weights at the same time as in Level2 it is completed with their squared values. Enhanced he confirmed in CNN becoming that the VGG 512 is graceful and at the CAD Dementia Challenge take a look at set he performed a finesse of52.3.

The document [6] describes automatic Alzheimer's disease kind the usage of structural MRI. In this study, we envisioned effects the usage of the   dataset, which is composed of various protocols. To prize functions from segmented argentine count number towel, we used the Harvard-educated Free Cybersurfer to cipher indigenous cortical consistence(CT) for a couple of anatomical regions. They measured cortical consistence in the usage of the Killiany/ Desikan department atlas. The SVM- grounded retrogression set of rules prognosticated 22 his CT functions withinside the left and proper components. For all checks finished the usage of specific system getting to know approaches, the nonlinear SVM classifier with radial base characteristic kernel confirmed the loftiest particularity, perceptivity, F- score, MCC and kappastatistic ROC AUC, Included an basic delicacy of seventy five of 10xcross-validations.

The litterateur delivered a study on colorful system to descry Alzheimer's complaint in the paper [7]. In this study, the author showed his different styles of detecting Alzheimer's complaint. Brain imaging ways can be used tonon-invasively fantasize brain structure, function, or pharmacology. He has two approaches to it. 2) Positron Emission Tomography (PET) uses amyloid and fluorodeoxyglucose as tracers for announcement opinion. Publications in this area generally concentrate on two main exploration areas biomarkers and neuroimaging. This study reviewed crucial announcement recordings and individual ways associated with and some of the findings. This approach is suitable for his neuro- imaging studies in his early stages.

Machine-learning architecture for Alzheimer's detection techniques in [8] used a 3D-CNN and FSBi-LSTM. They suggested substituting the stacked Bi-LSTM (SBi-LSTM) for the traditional Bi-LSTM in this study. In contrast to conventional SBi-LSTM, which only extracts a subset of the structural brain data, FSBi-LSTM gathers data on every SBi-LSTM cell that is common to and closely connected to the brain structure. Each subject can then use the FC layer to reliably convey this characteristic information. They created a special transfer learning system as a result

of this finding, which uses 3D-CNN and entirely stacked bidirectional LSTM to diagnose AD using multimodal data (FSBi-LSTM). The authors of this work employ 3D-CNN to identify the important traits from inputs from MRI and PET. The SoftMax classifier receives the concatenated learned features from this model in order to diagnose illnesses. They used the FSBi LSTM, which had a 75% accuracy rate, to identify the disease.

A present day approach primarily based totally on device studying version to come across Alzheimer's became delivered in [9]. In the study, researchers used IoT gadgets to acquire speech information from 23 older people. They then used device studying strategies to differentiate among the Alzheimer's disease and healthy-manage groups. By fusing AI era with the subjects' voices, it's far feasible to figure small modifications which might be undetectable with the aid of using human ears. The paintings created a brand new dataset of senior speakers' speech information and created an set of rules to robotically extract spectrograms from audio information. and a device studying-primarily based totally gadget to come across Alzheimer's. The era contains of a wearable Internet of Things machine that constantly captures the user's speech. The authentic speech information is stored at the cloud server, wherein the voice information is sent. In order to become aware of the life of Alzheimer's Disease, the set of rules is as compared to the saved information.

The idea presented in [10] suggested a method to use a CNN deep learning architecture (LeNet) trained on a sizable quantity of data from the dataset of Alzheimer's Disease Neuroimaging Initiative (ADNI) to distinguish data from Alzheimer's Disease from normal control data. It has been cautioned that rs-fMRI gives a non-invasive manner to evaluate modifications withinside the mind and useful mind activity. The technology is able to forecast various Alzheimer's disease stages for various age groups. The suggested method increased the accuracy of classifying data related to Alzheimer's illness from 84% using Support Vector Machine (SVM) to 96.86% using fully advanced preprocessing processes and CNN classification.

Figure: Table Analysis

SL.NO	Title of the paper	Dataset Used	Methodology/Algorithm	Drawback
1	Deep Learning Based Binary Classification for Alzheimer's Disease Detection using Brain MRI Images.	Cross-sectional image of 416 subjects were collected from Open Access Series of Imaging Studies (OASIS).	12 layer Convolutional Neural Networks (CNN).	Designing of the system architecture is complicated compared to pre-existing 8 layer CNN approach.
2	Dual Attention Multi-Instance Deep Learning for Alzheimer's Disease Diagnosis with Structural MRI	Alzheimer's Disease Neuroimaging Initiative (ADNI) and Australian Imaging, Biomarker and Lifestyle Flagship Study of Ageing (AIBL) where used.	Dual attention multi-instance deep learning network (DA-MIDL).	The system is not optimal for input of non-uniform size of patches and patches of fixed size could not represent various local feature required for detection of biomarkers.
3	Volumetric Feature-Based Alzheimer's Disease Diagnosis From sMRI Data Using a Convolutional Neural Network and a Deep Neural Network	Gwangju Alzheimer's and Related Dementia (GARD) dataset collected from e National Research Center for Dementia (NRCD).	Discrete volume estimation convolutional neural network (DVE-CNN) model.	Volumetric analysis of the MRI image has to be done for both left and right hippocampi which makes the execution time longer.
4	Alzheimer's Disease Detection using Machine Learning Techniques in 3D MR Images	Use of Open Access Series of Imaging Studies (OASIS) dataset is done.	Logistic Regression, SVM, Naive Bayes and Adaboost classifier models are used.	The system does not describe the best suit classifier for detecting the Alzheimer's Disease.
5	Alzheimer's Disease Detection Through Whole-Brain 3D-CNN MRI	Alzheimer's Disease Neuroimaging Initiative (ADNI), AIBL, CADDementia.	ADNet and ADNet-DA models.	Accuracy is very less compared to other methods.
6	Automatic classification of cognitively normal, mild cognitive impairment and Alzheimer's disease using structural MRI analysis	Alzheimer's Disease Neuroimaging Initiative (ADNI) dataset consisting of different protocols named ADNI-1, ADNI-2 and ADNI-GO.	Non-linear SVM classifier using a radial basis function kernel.	The study focused more on the age group between 50 and 90 which may result error in age group below 50.
7	Alzheimer's Diseases Detection by Using Deep Learning Algorithms: A Mini-Review	It has mentioned about dataset like ADNI, Harvard medical school dataset, National health and aging trends study etc.	Recurrent Neural Network (RNN), Deep Auto-Encoder (DAE), Deep Boltzmann Machine (DBM) and Deep Belief Networks (DBN).	Does not specify which approach has to be used on particular data set to yield high accuracy.
8	Deep Learning Framework for Alzheimer's Disease Diagnosis via 3D-CNN and FSBi-LSTM	Alzheimer's Disease Neuroimaging Initiative (ADNI) dataset is used for training the model.	FSBi-LSTM is the approach used to detect the Alzheimer's Disease.	The diagnostic performance of sMCI is limited due to anatomical changes of sMCI
9	A New Machine Learning Method for Identifying Alzheimer's Disease	23 elderly persons' speech data collected through IOT device	Speech spectrogram method	IOT wearable device is very expensive and cannot be worn all the time.
10	Deep Learning-based Pipeline to Recognize Alzheimer's Disease using fMRI Data	Alzheimer's Disease Neuroimaging Initiative (ADNI).	Convolutional Neural Networks (CNN) and Deep Learning.	The system has high algorithm complexity and expensive infrastructure.

III. DISCUSSION

The detailed review has provided a comprehensive insight of the best suited Deep Learning Model for detecting the Alzheimer Disease. The classical Convolutional Neural Networks (CNN) model has showed greater level of accuracy compared to other techniques. The model includes pre-processing of the data collected and classify them into different categories of Alzheimer Disease.

The approach is to use multi layered CNN architecture to segregate the MRI image and identify the potential biomarker responsible for causing the disease and classify the data based on the trained model as image of Alzheimer affected and not affected person.

IV. CONCLUSION

As a social being mental health is one of the key factors which will impact on our daily chores.Due to uneven situations prevailing in present situation and unhealthy lifestyle the mental health havebeen adversely affected. Alzheimer which is a neurologic disorder has been one of the major issueamong the elderly population. As of now there is no permanent cure for it. Due to the behaviouralchanges of the affected person, it may impact on the mental condition of their family members orcaretakers. In order to prevent the disease from spreading, it is crucial to detect it at its earliest stage.

This paper provides detailed summary of various methodologies used to detect Alzheimer Disease which are effective for detecting the biomarkers of the disease. In resent time through the advancement in Machine Learning fields it's been easier for segregation of any data. Appropriate use of these technologies can lead to effective detection of the disease and enhance the chances of access to appropriate medical help.

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