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Detection of Alzheimer's disease using Deep Learning Techniques

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ABSTRACT:

Alzheimer's disease (AD) is considered a major public health problem and It is a severe neurological brain disorder that usually affects old people. It destroys brain cells, primary symptoms are memory loss, mental functions, and slowly losing the ability to continue daily activities. AD is not curable, but detecting it early can help with improving symptoms. Therefore, early detection of AD has emerged as an energetic research area in current years. Many research state Statistical and machine learning techniques to diagnose AD. In this paper, we propose Deep Learning Techniques for the detection of AD. Here we classify brain images into normal brain and brain with AD. It involves two main steps. The primary step is based on the partition of the images into separate blocks to extract the part that contains the hippocampus of the brain. The secondary step is classifying images using deep learning techniques. Here convolutional neural network (CNN) and Fine-Tuning are used. CNN helps in extracting characteristics from MRI images of the brain and later classifies them from normal brain and AD brain. On the other hand, Fine Tuning helps in the classification of the images. We have assessed the proposed method through dataset. The obtained results show that the classification of images using Fine Tuning with 70% outperformed the CNN's classification rate.

KEYWORDS: Alzheimer's disease, Region of interest, Classification, Convolutional neural network, Transfer Learning, Alexnet.

1.NTRODUCTION:

Medical imaging is a vital region of medicine. It has recently developed via its usefulness in assisting with diagnosis and treatment. magnetic resonance imaging (MRI), ultrasound, X-ray scanner, radiology are the most common image techniques in present days. These strategies are complementary and every one of them has its personal characteristics. They provides detailed information about the human body like the brain. For example, MRI is taken into consideration as a completely beneficial examination for buying a photograph of the mind with excessive contrast. It is always used to stumble on abnormalities in a given organ, blood clots, brain tumor. Also, it could be used to stumble on issues in extraordinary components of the mind, inclusive of AD [1]
Alzheimer's disease (AD) is a brain degenerative disorder that usually impacts the aged individual and may be led to dementia. The AD has a few signs along with the decrease of human cognitive competencies consisting of remembrance, language competencies, and hassle solving These symptoms can intervene in the day by day activity of an individual. According to Alzheimer's Disease International [2], in 2015 there are about 46. eight million human beings with dementia with inside the international and 22. nine million in Asia. The variety is anticipated to grow two times every 20 years Although there may be no suitable remedy for AD, early detection of AD is an effective manner to prevent, gradually, and prevent AD [1]. Early detection of AD may be carried out through reading the neuroimaging data.[2]

Currently, much research on the early detection of AD had been done [5]. The structural MRI facts were utilized by numerous research as a good way to carry out the AD category [3], [4]. [6]-[10], in which structural MRI is used to decide mind atrophy. The measured atrophy of the structural MRI is an effective biomarker to decide the ranges and depth of neurodegenerative pathology [11]. Several research has used characteristic extraction of structural MRI records, primarily based totally on the AD category of the morphometric method [12], the area of interest (ROI) [13], and the volumetric pixel (voxel) of grey matter (GM) on automated segmentation of the image [10]. Other research blended numerous modalities, inclusive of structural MRI, positron emission tomography

(PET), and cerebrospinal fluid (CSF) to enhance the category. accuracy, Despite the improvement of strategies that integrate a couple of modalities to enhance accuracy, detection of AD with the aid of using the usage of the simplest one modality consisting of structural MRI stays a challenge [3]. Therefore, this has a look that makes use of structural MRI information to carry out AD detection

At the start of AD, people may also turn out to be moderate cognitive impairment (MCI), an intermediate level among the anticipated cognitive decline of regular growing old and the more the critical decline of dementia. It way that the mind has a moderate cognitive and reminiscence impairment, however it does not have an effect on the individuals' everyday functioning and might hardly be detected in medical practice.[3]

Recent strategies on computer vision and image classification the use of CNN functions have impressively advanced the accuracies and outperformed traditional techniques the use of hand-crafted characteristic extractors, inclusive of Local Binary Pattern [3], K nearest neighbour [4], or covariance descriptors [5] [6]. Deep learning has been discovered to be beneficial for image classification which is invariant to various factors inclusive of scale and rotation. Motivated with the aid of using this performance of deep learning, we practice and examine in this newsletter the performance of deep learning primarily based totally strategies for detection of AD namely: the CNN and t Fine tuning with inceptionV3. The relaxation of the paper is organized as follows: In Section 2, we present a few associated works. In In section 3, we describe the proposed method. The experimental consequences are offered in following sections and the belief ends the paper.

PROBLEM STATEMENT:

In this project, we work on the prediction of Alzheimer's disease (AD). Different algorithms can be used for the detection of disease. Here in this paper, we used Fine-tuning method for the detection of AD. In this work, we used the data set that provided the extracted features.

2. EXISTING SYSTEM:

The existing model they used machine learning algorithm with psychological parameters like age, number of visit, MMSE and education make use of this they created model. Existing system used SVM, Decision Tree algorithm for classify the Alzheimer. But they achieve low accuracy.

Deep Learning (DL) has emerged as a common approach for the early analysis of AD. Here, they evaluate a few essential pieces of literature on AD and discover how DL can assist researchers to diagnose the disorder at its early stages. Only detection processes of AD is done. There is a lack of disease area segmentation and classification. In deep learning neural networks Conventional neural network(CNN) is a class mostly used for image recognization. Mostly CNN processes is done without proper segmentation They're maximum usually used to analyze visual imagery and are often running backstage in photograph classification. By using image processing techniques Alzheimer's region can be obtained by a combination of denoising, segmentation, feature extraction, and classification techniques Here we review the current state of AD detection using deep learning. Through a systematic literature review of over few articles, we set out the most recent findings and trends. Specifically, we review useful biomarkers and features such as, personal information, genetic data, and brain scans, the necessary pre-processing steps.

3. LITERATURE REVIEW:

- In order to diagnose this disease, numerous sets of the art methods were conducted, for instance, we mention: Nair and Mohan [4] used the Gaussian Mixing Model for grey depend segmentation (this version is used for the classical type hassle in addition to the problem of estimating the density). Partial Least Squares algorithm is used for extraction of essential features and Support vector machine is used for classification.
- Classification of SPECT images of ordinary topics versus images of Alzheimer's disease sufferers through Stoeckel et al [5] used voxel intensities of the brain volume. In order to reduce the small pattern length problem, they decreased the quantity of functions the use of decreased decision equivalents of the authentic image, which had been computed through smoothing with an average filter, accompanied by a sub-sampling step.
- In 2008 Duchesne [6] used SVM to categorize MRI images, however in place of using the voxel intensities, this additionally covered local shape information. In the research done by Gorriz et.al [3] issue primarily based totally SVM algorithm the use of SPECT images turned into proposed ie, the authentic volumes had been divided into numerous smaller areas after a sub-sampling step and for every place a distinct SVM classifier was used and the technique received extra accuracy in comparison to the existing methods
- A group of neurological professionals led by Gorriz et.al [7] [8] have made widespread contributions toward the detection and of Alzheimer's disease classification. In 2010, the group added a CAD system for Alzheimer's Detection primarily based totally on Partial Least Squares (PLS) and random forest SPECT image classification [9].
- In 2011, a Gaussian Mixture Model-based SPECT for diagnosis of AD image classification was introduced[10]. This density estimation version automatically selects areas of interest and decreases the dimensionality of the problem. The Gaussians acquired from this model are built based on the maximum likelihood criterion of the usage of the Expectation-Maximization (EM) algorithm. Later in 2012, a study on characteristic extraction techniques the usage of the ADNI database that compares GMM based methods and PLS method for AD type changed into added [11].
- Amiri, Ben Rabeh, and Benzarti [12] presented a categorized technique based on segmentation by the Level Set. Before retraining 4 mastering samples, our technique starts by locating the nearest to the new input with the use of four distances. This technique leads to categorizing the images using the Bayes theorem.
- To gather the three mind tissues (the white matter, the grey matter, and cerebrospinal fluid)Angkor, Purnama, and Purnomo [13] used the image segmentation technique based on Voxel morphometry. Then, they used the Kolmogorov-Smirnov distance approach to extract the capabilities so as to classify the images by the use of a returned propagation neuron community. Other techniques use deep structure

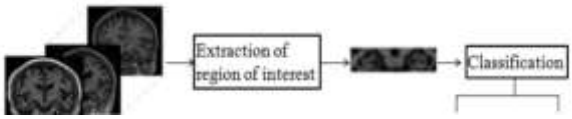
specifically CNN so as to stumble on the AD.

- For example, Song et al. [14] used graph convolutional neural networks (GCNN) classifier. They are primarily based totally on a structural connectivity input with inside the shape of graphs. This community carries 11 layers (9 convolutional layers and completely linked layers) permitting the classification of people of AD into four classes.
- D. Chitradevi, S. Prabha and K.Sakthidasan," Brain Hemisphere Analysis using Genetic Algorithm and Fuzzy Clustering in Alzheimer Disease", International Conference on Communication and Signal Processing, vol. 18, pp. 901-905, April 2018.
- A. Raut and V. Dalal, "A Machine Learning Based Approach for Detection of Alzheimer's Disease Using Analysis of Hippocampus The region from MRI Scan", IEEE International Conference on Computing Method
- [15]Another approach has been proposed with the aid of using Padole, Joshi, and Gandhi [14]. They used the GCNN classifier based at the idea of graph signal processing while the extraction of the traits is done the use of the Graph Fourier Transform. The most important contribution of this paper is to analyze the performance of deep studying for the detection of AD.

4. PROPOSED METHOD:

Our method contains two steps: Extraction of the region of interest and classification of the images.

These two steps are complementary to each other to achieve the classification rate as presented in (FIG. 1.



CNN Fine Tining

(Fig-1)

4.1 *Classification*

Image classification consists of grouping different objects into distinct classes according to different classification criteria by a classifier. In our case, we have two classes (normal brains and AD brains).

Then, once the blocks have been extracted, the classification phase will be carried out with two classification methods, namely CNN and fine-tuning methods in order to make a comparison between the classification rates.

4.11 CNN :

CNN is a structure of multi-layer network evolved through the traditional neural network method, called multi-layer perceptron. It is composed of two distinct parts: the first part is the convolutional part which acts as an image feature extractor. The image is passed through a succession of filters creating new images called convolution maps. Some intermediate filters reduce the resolution of the image by a maximum local operation. Next, the convolution maps are concatenated into a feature vector. This vector is linked to the input of a second part, it is the classification part composed of completely connected layers (multilayer perceptron) which allows the classification of the images into two classes

The convolution level: This level consists of moving a filter by dragging it over the entire image and performing a convolution (a matrix product) of this filter with the underlying image. At the

beginning of the convolution, the filter will be placed at the top left of the image, then it will move a number of boxes (the pass) to the right. Arrived at the end of the image, it will go down a step to deduce until the filter has traversed the whole image. The purpose of this method is to bring out certain characteristics of a given image and the path of the filter on the image. *Pooling Layer:* reduces image size while preserving relevant features. The most widely used method is 'Max Pooling'. It consists in reducing the image while keeping the largest values of pixels. To do this, a tile moves (like a filter) on the surface of the image. At each position of the tile, the highest value is extracted. This produces a new image with only the impressive image values.

The correction layer: To improve the efficiency of processing by inserting a layer between the processing layers which will perform an activation function on the output signals. This function forces neurons to return positive values.

Flattening: This operation consists of putting all the arrays of images into a single vector. This vector will allow the creation of the first layer of entirely connected neurons (each of the values of this vector will be connected to the neurons of the first layer of the network

The completely connected level: After several levels of convolution and levels of max pooling, the classification reasoning is performed through completely connected levels. The neurons of this level have connections with all the neurons of the previous level. The outputs of this level are processed by the Soft max function to obtain the probability distribution vectors. This function returns a vector of size N, where N is the number of classes in our image classification problem. Each element of the vector indicates the probability that the input image belongs to a class.

4.12 Fine Tuning:

When appearing characteristic extraction we haven't re-train the original CNN. Instead, we handled the CNN as an arbitrary characteristic extractor after which trained an easy machine learning version on the top of the extracted functions. Fine-tuning Remove the absolutely related nodes on the cease of the community (i.e., in which the real class label predictions are made). and Replace the absolutely related nodes with freshly initialized ones. after that, it Freezes earlier CONV layers earlier with inside the community Later it Starts training, however only trains the FC layer heads. Optionally unfreeze a number of the CONV layers with inside the community and carry out the second one by skip of schooling. Fine-tuning with Keras is an extra superior approach with masses of gotchas and pitfalls so as to ride you up alongside the way. From there we'll assess the dataset we're using for fine-tuning. Once we've got a great cope with the dataset we'll then switch to imposing fine-tuning with Keras. Using this option extractor, we ahead propagated our dataset of images thru the community, extracted the activations at a given layer (treating the activations as a characteristic vector), after which stored the values to disk. But there's some other kind of switch getting to know, one that may clearly outperform the function extraction technique. This technique is referred to as fine-tuning and calls for us to carry out "network surgery". First, we take a scalpel and reduce the very last set of absolutely related layers (i.e., the "head" of the community in which the elegance label predictions are returned) from a pre-trained CNN (normally VGG, Res Net, or Inception). We then update the pinnacle with a brand new set of absolutely related layers with random initializations. From there, all layers below the head are frozen so their weights can't be updated We then train the community the use of a very small learning charge so the new set of completely related layers can learn patterns from the previously learned CONV layers in advance with inside the network — this technique is referred to as permitting the FC layers to "warm-up". Optionally, we might also additionally unfreeze the relaxation of the community and retain training. Applying fine-tuning allows us to make use of pre-trained networks to apprehend classes that have been not originally skilled on. And furthermore, this technique can result in better

accuracy than transfer learning through function extraction.

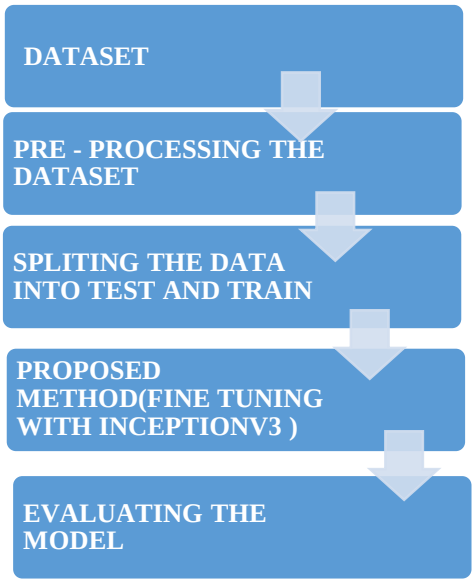
4.13 InceptionV3:

Inception v3 has vast usage in image recognition projects that have been proven to acquire more than 78% accuracies at the ImageNet dataset. This version is the end result of many thoughts advanced through a couple of researchers over the years. This version itself is made from symmetric and uneven constructing blocks, which include convolutions, average pooling, max pooling, concatenations, dropouts, and fully connected layers. Batch normalization is used considerably at some stage in the version and carried out to activation inputs. Loss has computed with the usage of Soft max. The version has been effectively-skilled on v2-8, v2-128, and v2-512 configurations. The version has attained over 75% accuracy in approximately 160 + epochs.

The contemporary implementation of Inception v3 is at the threshold of being input-bound. Images are retrieved from the record system, decoded, after which pre-processed. Different sorts of pre-processing levels are available, starting from mild to complicated. If we use the maximum complicated of pre-processing tiers, the training pipeline can be pre-processing bound. one can gain an accuracy more with the use of a reasonably complicated pre-processing stage.

4.14 Methodology

In this project, the methodology which contains the modules are shown in the below figure.



4.3 DATASET

The first module which is collection of dataset, we gathered the data from the Kaggle website. The dataset contains approximately 6300 images in JPG format. It is further classified into two types, they are Demented and Non-Demented. The image's which describes about the brain part of the human being.

PRE - PROCESSING THE DATASET

Pre-processing method is the second module, first of all we will read the path of the data by using glob library. And then performs some operations like

- Resize the shape of the image into 229 X 229 dimension, why because all the images are not in the same shape which effects our model performance.
- Convert the image into RGB format and
- Normalizing i.e., scaling the values of the image in the range of 1 to 255.

SPLITING THE DATA INTO TEST AND TRAIN :

In this module we will spilt our data into train and test dataset in the ratio of 0.3 which means 70% of data is used to the train model and 30% of the data is used to test the model performance.

We applied Label Binarizer method which helps to encode the categorical value into numpy array. And then we applied to_categorical method which is

used to convert the numpy array into binary values and has columns which is equal to number of unique categorical values.

PROPOSED METHOD(FINE TUNING WITH INCEPTIONV3):

The process of fine-tuning a network is based on the principle of transfer learning. In our proposed method at first we will load the base model which is pre-trained algorithm called InceptionV3 trained on ImageNet dataset and then freeze the top layer of the InceptionV3 algorithm.

And then we added the dense layers with 1024, 512 neurons each with an activation function Relu and then applied the dropout layer of 0.4 which helps to prevent overfitting on the training data and added the final output layer with the activation function soft max which predict a probability distribution. Thereafter we will freeze the all layers in inception model.

Data argumentation, the process of applying and complex transformations like flipping, rotation to the data. It acts as a regularizer and helps to reduce the overfitting when training a model.

Hyper parameters that are used in our proposed model,

- Activation Function - Relu
- Learning Rate = 1e-4
- Optimizer =Adam
- Loss function = Binary cross entropy
- Epoch =30, Batch_size = 64

EVALUATING THE MODEL

In this study, we assessed the proposed model's efficiency using a variety of metrics: accuracy, confusion matrix, precision, recall, and f1-score, which is defined in relation to true negative (TN), false negative (FN), true positive (TP), and false positive (FP) and Auc Curve.

Dataset :

The study's data came from the kaggle website and the author is HARIPRAKASH K 18CSR053.

It contains approximately 6330 MRI images which are in the format of JPG. It consists of two directories one of the directory is named as Demented which is example of a person who is suffering from Alzheimer disease and the other directory is Non- Demented which is example of person not having Alzheimer disease. It describes the image of the brain of human being. And around 4000 MRI images were used for the training dataset whereas around 2000 MRI images were used for the testing or validation dataset.

The datasets demographic data

	Demented	Non-Demented
No.of subjects	1	1
Total No.of Images	3136	3200
Format	JPG	JPG

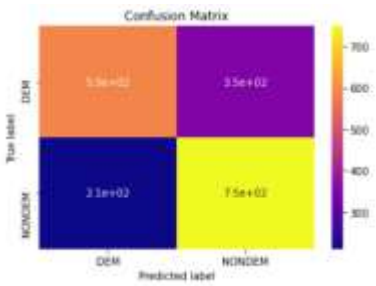
5. Results:

Classification Report:

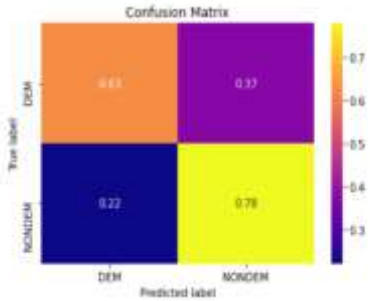
	precision	recall	f1-score	support
0	0.74	0.63	0.68	941
1	0.68	0.78	0.73	960
accuracy			0.70	1901
macro avg	0.71	0.70	0.70	1901
weighted avg	0.71	0.70	0.70	1901

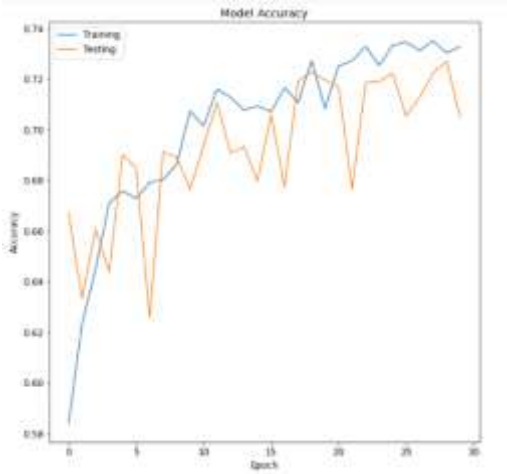
Confusion Matrix

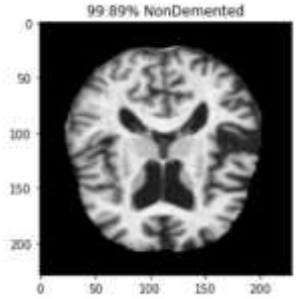
without Normalization

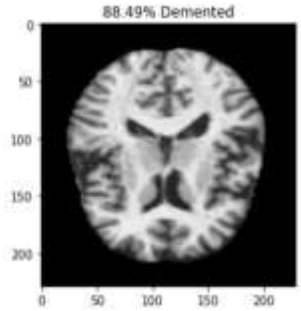


with Normalization









6. Conclusion:

In this paper, we carried out exceptional techniques for the detection of AD: CNN and Fine-tuning. The proposed approach includes major steps (extraction of the area of interest and category). The first step divides the image into blocks that allow you to hit upon the element that consists of the hippocampus of the brain. In the second step, we assessed CNN and Fine-tuning techniques. The received results display that the category of images & the usage of Fine-Tuning offers a greater green end result fee in comparison to CNN. High category charges have received the usage of the carried out techniques and outperformed trendy techniques following the equal protocol. As a perspective of our work, we study the application of the proposed technique for the study of different illnesses that infect the brain which includes brain cancer. Moreover, we intend to use the deep quantization approach on CNN that allows you to reduce the wide variety of its parameters which includes Bag of features paradigm.

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