Deep Learning based Medical Image Classification

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Abstract*—With the advancement of the Computer Technology classification of Medical Images has become more viable. Use of the traditional features has made the system to lose the ability to represent the higher-level domain problem. Deep Learning models had paved a way for the development of a generalization ability even for the poor models. Medical Images have high resolution and availability of the dataset are also small, making these Deep Learning models deteriorate from various limitations and huge computational costs. In this paper a model is proposed a profound learning model that incorporates Convolutional Neural Network (CNN), Naïve Bayes, Support Vector Machine (SVM) and Multilayer Perceptron (MLP), which consolidates high level features that are separated from a CNN model and some chosen conventional features. The development of the proposed model incorporates the accompanying advances. To start with, a CNN is trained in a supervised manner and the outcome is that it can program the raw pels of Images into include vectors that address undeniable level ideas for characterization. In the next step, a bunch of chosen customary features dependent on foundation information on medical images are extricated. At last, a proficient model that depends on Neural Networks to intertwine the diverse element bunches acquired in the previous steps is proposed. The datasets used for the evaluation of the model are HIS2828 and ISIC2017. A general classification accuracy of 97%and 96%, separately, which are higher than the current techniques are accomplished.

***Keywords*—Classification, Deep Learning, Feature extraction, Multilayer Perceptron, Naïve Bayes, Support Vector Machine**

I. INTRODUCTION

In general, the Brain Tumor can be divided into two stages primary and secondary. Here primary stage is Benign where it is in the starting stage and the secondary stage is the Malignant stage. This stage is dangerous as in this stage the Cancer has spread to the other parts, and it is difficult to control the disease. Brain Tumor is defined as the uncommon growth of tissue due to the uncontrollable growth of cells [1]. The Tumor can be graded as Grade 1 to Grade IV as per the American Brain Tumor Association and WHO. Grade III and IV Tumor indicates a high-grade Tumor. Grade I and II are the low quality Tumor. If the inferior frontal cortex Tumor is left untreated, it is presumably going to shape into a high-grade mind Tumor that is an unsafe frontal cortex Tumor [2]. Patients with grade II Gliomas require consecutive checking and discernments by alluring Resonation Imaging (MRI) or enrolled Tomography (CT) channel every 6 to a year. Frontal cortex Tumor may affect any individual at whatever stage throughout everyday Life, and its impact on the body may not be a comparable thing for every individual.

The liberal Tumors of low quality I and II Glioma are seen as restorative under complete cautious excursion, while undermining frontal cortex tumors of assessment III and IV class can be treated by radiotherapy, chemotherapy, or a blend thereof. The term compromising Glioma consolidates both grade III and IV Gliomas, which is in like manner implied as Anaplastic Astrocytomas. An Anaplastic astrocytoma is a mid-grade Tumor that displays surprising or inconsistent turn of events and an extended advancement record diverged from other inferior Tumors. Besides, the most compromising sort of Astrocytoma, which is moreover the most raised assessment Glioma, is the Glioblastoma [3]. The uncommon fast advancement of veins and the presence of the defilement (dead cells) around the tumor are perceived Glioblastoma from the wide scope of different assessments of the Tumor class.

Assessment IV Tumor class that is Glioblastoma is for each situation rapidly improving and significantly perilous sort of Tumors when diverged from various assessments of the Tumors. Feature Extraction is a process in which the features are extracted from the Images and these features are used by the classification algorithms to classify the Images. Features are low level such as Edge, Color and Texture are useful in classifying the Images. Feature selection is a process in which the important features are identified so that the classification accuracy can be increased, and complexity can be decreased [14]. High level features extracted from the deep learning models such as CNN and the fusion of these low- and high-level features can help the algorithms for a better classification [33, 34].

The Technological advancement in the Computer Science has paved way in making many sectors dependent on it. Machine Learning [22, 26] algorithms has helped to solve many complex problems and has a wide application in all sectors. Autism is a disorder effecting many Children in many Countries screening this disease is a difficult process and there is no proper treatment for this disorder is available, so early screening will help to control the effects due to the disorder. Machine Learning [29, 31] algorithms are helping the Doctors and Practitioners in diagnosing the disease at the early stage [4]. Other applications include Facial expression [5], Student's performance [6], Heart Disease prediction [7, 10], Personal care [8], Effort estimation in projects [9, 13], Soil Structure Interaction [11], Thyroid Disease Prediction [12] and also in other fields. Using the Deep Learning model [32] to identify the features and using these features a better classification model is built. IoT has made a great leap by inducing itself into different applications and helping in the medical imaging for a better Health care [36]. The Biomedical Image Segmentation process is very difficult as the important information should not be lost as compared to other images so semantic segmentation is used on these images for a better result [37]. In this paper an attempt is made for the Image Classification which is an important need as there is a large amount of data in the databases and classifying them is a very high difficult task with a good accuracy.

II. PROPOSED METHOD

In this proposed model the Image is taken as Input, and this is general called as a CBIR model in which the Input is an Image and Output also an Image [15]. The Input Image is taken and the channels are separated from the Image. As it is known that the Digital Images are made up of pixels, grey scale images are made up of White and Black pixels and it does not contain any colors comprising of one channel. In the case of standard Camera an Image will have three channels namely Red, Green and Blue. In the case of an RGB Image, each channel will have 8-bits, a total of 24 bits as it has three channels in it. In the case of a Gray scale image, the formula Gray = 0.2989 * r + 0.5870 * g + 0.1140 * b is used. The following Fig. 1 will give an overview of the implementation process flow. Each step will help to understand the process in a detailed way.

Noise Ejection is part of the Pre-Processing stage, and it should be possible to do so via a variety of Spatial Channels, both Direct and Nonlinear (Median channel). Various antiques, such as content, have had various Morphological manipulations performed on them. RGB to dim conversion and reshaping are also performed. It has a center channel for commotion evacuation. The chances of clamor appearing in a current MRI examination are slim. It could have appeared because of the warm effect.

Image Smoothing applied on an image while also saving a lot of data [20, 25]. The goal is to reduce disturbance or pointless intricacies while providing as little mutilation as possible to better the examination. The next process is the Feature Extraction process in which the features must be extracted from the Image [26, 30]. The traditional features such as Edge, Flat is extracted using the local binary pattern. Edges are focuses where two images' places meet at a point [16]. An Edge can take on almost any shape and may include junctions. In practice, Edges are defined as groups of focuses on an Image that have a consistent slope gradient.

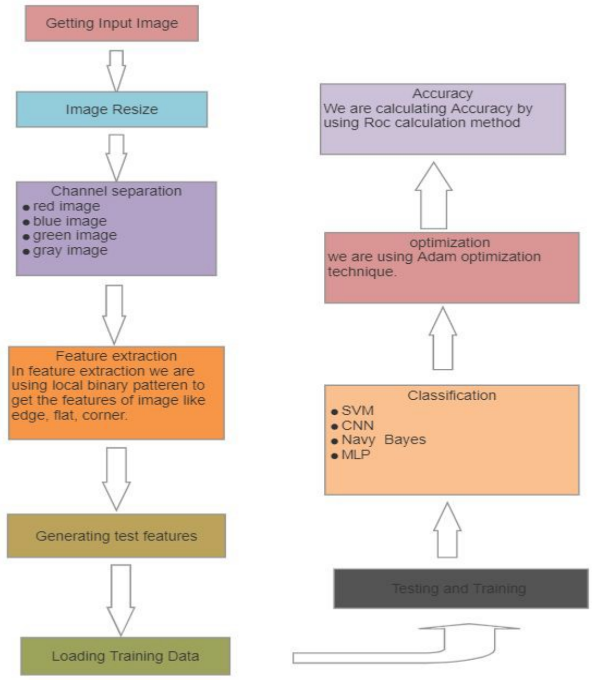


Fig. 1. Flow diagram of Proposed Method

The enormous number of variables in these large datasets necessitates a lot of computational resources to process. To address these concerns about traditional methods versus deep models, a novel deep model is proposed in which it combines traditional features; this model can not only take full advantage of existing Doctors' experiences, but it can also use deep architectures to extract high-level features for Classification automatically with the aid of CNN for Feature Extraction.

The words corners and interest emphases are used interchangeably to refer to point-like highlights in a photograph with a local two-dimensional structure. The term "Corner" came up because early calculations first performed edge discovery and then dissected the edges to find fast changes in course. The Local Binary Pattern (LBP)Code for each pixel is computed, and the LBP highlight is constructed from the histogram of Local Binary Pattern Codes. To determine the Local Binary Pattern Code, the 8 neighbors of the main pixel are contrasted for each pixel p, and the pixel p and the neighbors x are assigned a value of 1 if $x \geq p$. Four algorithms are used for Classification which are

- Support Vector Machine (SVM)
- Naive Bayes
- Multilayer Perception (MLP) and
- Convolutional Neural Network (CNN).

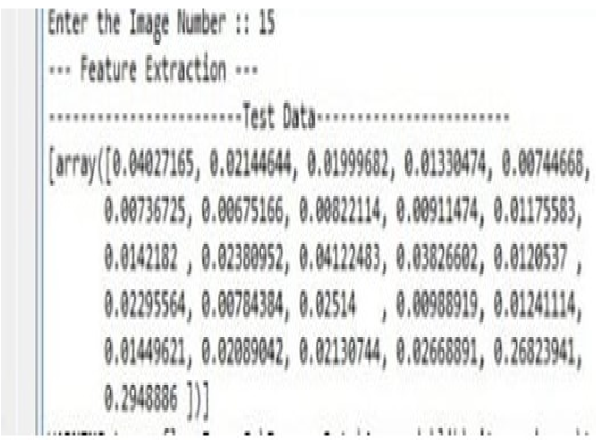
A linear kernel is used in the SVM classifier. A 2D Convolutional Neural Network in the CNN classifier, and the kernel size is (196, 196, 3) by using Relu's activation function is used. Also, utilizing an optimization technique like Adam to get a more precise number at this time. Also, a Gaussian Naive Bayes in the Naive Bayes classifier is utilized. Multilayer perception is the final classifier utilized in this study; with the hidden layer size is (150, 100, 50), the maximum iteration is 300 and the activation function is Relu and Adam optimizer is used. The hidden layer size used is of 150 x100 x50. Matrix size is of 300 and using an activation function of Relu. The standard Multilayer Perceptron (MLP) is a course of single-layer perceptron's. There is a layer of info hubs, a layer of yield hubs, and at least one halfway layer. The inside layers are now and then called "covered up layers" since they are not straightforwardly recognizable from the framework's sources of info and outputs. Hidden layers consider the capacity of a neural organization to be separated into explicit changes of the information. It uses a sigmoid activation function [21].

III. RESULTS & DISCUSSION

In this model the Image database is created with different Brain Images and the Brain Tissues are divided into Grey matter, Cerebrospinal liquid, White matter and Images with Tumor contaminated. The Model is used for Classification of Image and also it identifies the Tumor in the Image. The first step is to jot down the picture number (Eg: 15). After printing the picture number, we'll get an array containing the Image's pixel values. See the graphic below for a better understanding. The flat and vertical estimations of a picture communicated in pixels are known as pixel measurements. The pixel measurements can be manipulated by multiplying the width and height by the dpi.

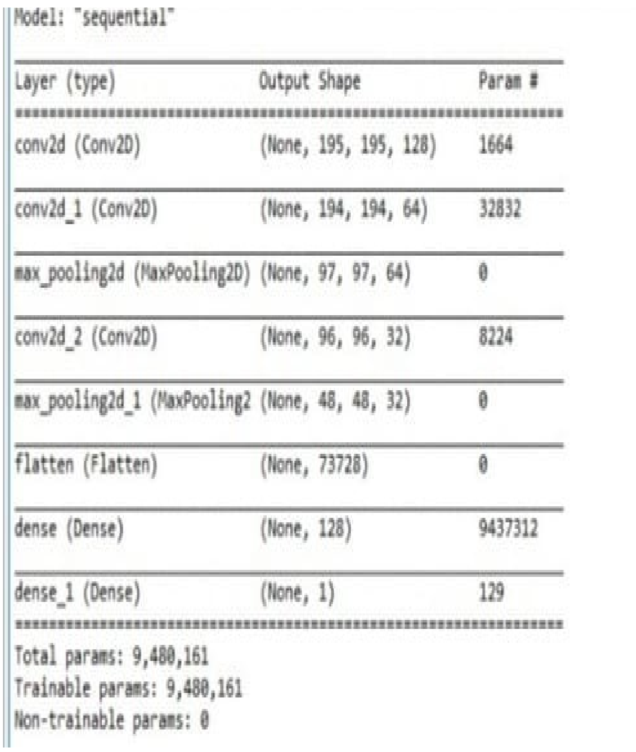
The Feature Extraction table is calculated as the following output. CNN [23, 24] approach is utilized to extract features. A Conv2DNetwork is used with an out shape of (195,195,128) and a max-pooling 2D of (195,195,128). (97, 97, 64). A density of 128, and a flatten of 73728 is used. The total amount of params obtained is 9480161, with 9480161 trainable params being used [35].

The reason for distinguishing grey photos from other types of shading pictures is that each pixel should have less info. The brilliance of a pixel is represented by the grey level or grey worth. The default level of grey is 0. The most severe dark level is determined by the image's digitization depth. It is 255 for an 8-digit profound picture.



```
Enter the Image Number :: 15
*** Feature Extraction ***
************************Test Data************************
[array([0.04027165, 0.02144644, 0.01999682, 0.01330474, 0.00744668,
       0.00736725, 0.00675166, 0.00822114, 0.00911474, 0.01175583,
       0.0142182 , 0.02380952, 0.04122483, 0.03826602, 0.0120537 ,
       0.02295564, 0.00784384, 0.02514   , 0.00988919, 0.01241114,
       0.01449621, 0.02089042, 0.02130744, 0.02668891, 0.26823941,
       0.2948886 ])]
```

Fig. 2.Features extracted from Input Image



Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 195, 195, 128)	1664
conv2d_1 (Conv2D)	(None, 194, 194, 64)	32832
max_pooling2d (MaxPooling2D)	(None, 97, 97, 64)	0
conv2d_2 (Conv2D)	(None, 96, 96, 32)	8224
max_pooling2d_1 (MaxPooling2	(None, 48, 48, 32)	0
flatten (Flatten)	(None, 73728)	0
dense (Dense)	(None, 128)	9437312
dense_1 (Dense)	(None, 1)	129

Total params: 9,480,161
Trainable params: 9,480,161
Non-trainable params: 0

Fig.3 CNN Characteristics

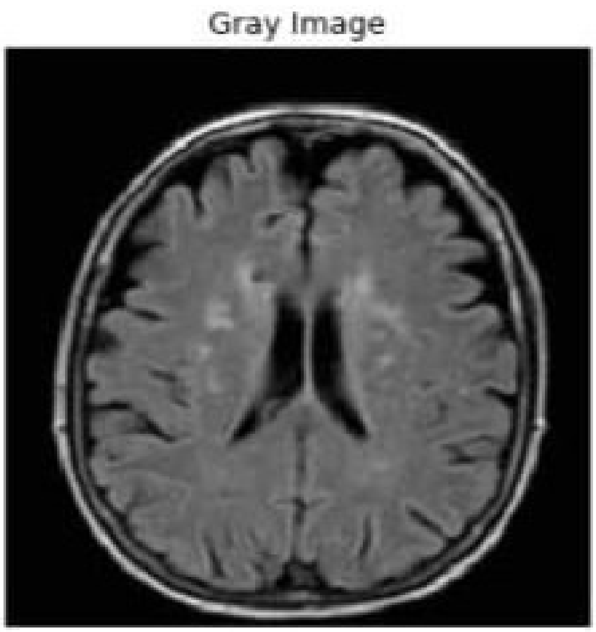


Fig.4. Sample Images used in Database

In classification, SVM, CNN, MLP, Naive Bayes algorithms are used. The accuracy of these algorithms for the non-tumor brain image [17, 18, 19] is calculated using the formula.

$$Accuracy = \frac{TP+TN}{TP+FP+TN+FN} \quad (1)$$

The accuracy is defined as appropriate predictions done on the test data [20].

Table 1. Showing the Classification Accuracy of different Algorithms

S.No	Algorithm Used	Accuracy
1	CNN	97.5%
2	Naïve Bayes	97.3%
3	MLP	98.92%
4	SVM	97.79%

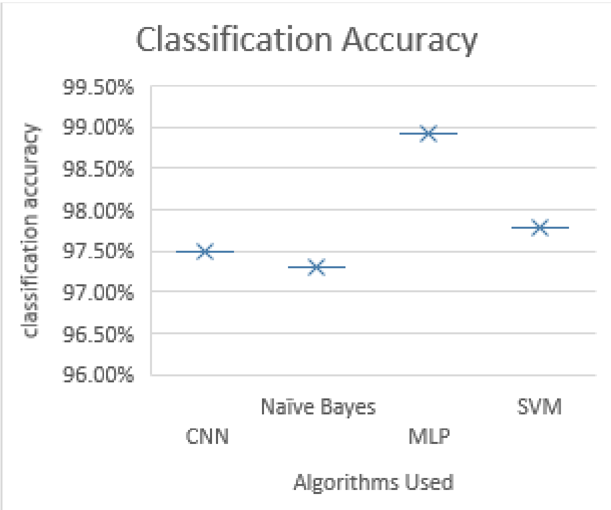


Fig.5. Classification of Accuracy of different Algorithms

IV. CONCLUSION

Brain Tissues were separated into conventional tissues such White matter, Grey matter, Cerebrospinal liquid (foundation) and Tumor-contaminated tissues in this experiment using MR images of the Brain. This research was helped by fifteen individuals who were infected with a Glial Tumor at various phases of development. Preprocessing was used to increase the Sign-to-Clamor Ratio and eliminate the effect of unwanted commotion. To optimize the Skull stripping execution, a limit strategy-based skull stripping in calculation. In addition, Berkeley Wavelet Transformation is used to split the images and supporting Vector Machine to arrange the Tumor stage by breaking down highlight vectors and Tumor region.

An investigation was done on Surface-based and Histogram-based highlights using a commonly perceived classifier for the Classification of Brain Tumors from MR Cerebrum images in this study. When compared to the manual discovery conducted by Radiologists or Clinical Experts, the examination for Cerebrum Tumor Recognition is rapid and precise, according to the trial findings produced on distinct Images. The many exhibition elements also demonstrate that the proposed computation improves specific limits such as Mean, MSE, PSNR, Precision, Affectability, Explicitness and Dice Coefficient, resulting in a superior outcome.

The first findings suggest that the proposed method can aid in the accurate and ideal detection of a Cerebrum Tumor, as well as the identification of its precise location and the suggested method is crucial for detecting Brain Tumors from MR Images. The test results were accurate to 98.92%, demonstrating the validity of the proposed approach for identifying everyday objects and unusual tissues from MR pictures. Obtained Outcomes lead to the end that the proposed strategy is appropriate for coordinating clinical choice emotionally supportive Networks [21, 27, 28] for essential screening and analysis by the Radiologists or Clinical specialists. Later on work, to improve the Exactness of the order of the current work, the Research is focused on the particular plan of the Classifier by consolidating more than one Classifier and highlight determination procedures.

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