Detection of Brain Tumor on MRI Images

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***Abstract*—Brain Tumor is the coagulation of abnormal cells in the brain. The Brain Tumor could lead to brain damage hence eventually to death. Detection of tumours at an early stage can save the life of millions of people. MRI images can be used for detection of tumour/cancer cells through Vision techniques. Good feature-selection and Feature Extraction Technique can validate and increase the accuracy by applying Machine Learning. Previous research has given good results in the tumour classification using image segmentation and morphological operations are applied and then finally, the tumour region is obtained using image subtraction technique. Various classifiers are used by applying feature selection. Our researchers have improved the model accuracy to some extent. We have decreased the computation cost by applying PCA, FDA. Various advanced Feature selection technique and advanced vision Techniques are used such as HOG transform, SIFT transform, SURF transform, KAZE transform. Machine Learning Techniques are applied such as RandomForest, SVM, XGBoost classifiers. This has improved the cross-validation accuracy of the model from previous works. We have also applied Deep Learning Techniques such as Feed Forward Neural Network and Convolutional Neural Network. CNN works on images well. We have used various Architectures of CNN mod-els such as VGG-3 and VGG-5 architecture. Dropout techniques, Batch Normalization techniques, Early Stopping, are used.CNN models are fine-tuned models with some hyperparameters tuning. Adam and SGD optimizers are used for compiling. Activation Functions used are relu for all Convolutions layer and max-pooling are performed with a kernel size of (3,3) and max pool size of(2,2) . This CNN model has given us good results. Accuracy, score, precision, recall are compared for various techniques. This is a binary classification problem so output used is sigmoid or tanh . These techniques used outperformed the previous methods and results on classification of the tumour. Leading researchers in this field have developed good techniques. We have achieved the accuracy of approx 90 per cent. Others techniques can be also applied and further improvements can be performed on it.**

***Index Terms*—Feature Selction HOG [10], [16], SIFT [12],SURF [18],KAZE [13], CNN [8] models ,VGG-16 [9] CNN [8] model**

I. Introduction

Brain Tumor is the collection or coagulation of abnormal cells in the brain and is one of the most common diseases among various other types of cancers. The Brain Tumor could lead to brain damage which could result in death as well. Only certain techniques such as biopsy and spinal tap methods can help to determine if the patient's brain tumor is cancerous or not. If detected before, at least the lifespan of the patient can be increased to a certain extent if it can't be completely treated. One of the techniques for the diagnosis is to take MRI(magnetic resonance imaging) scans of the patient's brain and then analyze it. So MRI images are used for detection of Brain tumor at an early stage which can save millions life annually.

Natarajan et al. [1] proposed brain tumor detection method for MRI brain images. The MRI brain images are first preprocessed using median filter, then segmentation of image is done using threshold segmentation and morphological operations are applied and then finally, the tumor region is obtained using image subtraction technique. This approach gives the exact shape of tumor in MRI brain image. Joshi et al. [2] proposed brain tumor detection and classification system in MR images by first extracting the tumor portion from brain image, then extracting the texture features of the detected tumor using Gray Level Co-occurrence Matrix (GLCM) [19], [20] and then classified using neuro-fuzzy classifier. Amin and Mageed [3] proposed neural network and segmentation base system to automatically detect the tumor in brain MRI images. The Principal Component Analysis (PCA) is used for feature extraction and then Multi-Layer Perceptron (MLP) is used classify the extracted features of MRI brain image . The average recognition rate is 88.2% and peak recognition rate is 96.7%. Sapra et al. [4] proposed image segmentation technique to detect brain tumor from MRI images and then Probabilistic Neural Network (PNN) [17] is used for automated brain tumor classification in MRI scans. PNN [17] system proposed handle the process of brain tumor classification more accurately. Suchita and Lalit [5] proposed unsupervised neural network learning technique for classification of brain MRI images.

There were many limitations in the previous research done ie applying median filter and segmenting images are good feature detection . But in advancements of Computer Vision Techniques these features selection are more combined and some excellent feature selection techniques are developed . Hog [10], [16], SIFT [12], SURF [18], ORB [11] and mamy more computer vision techniques are used which can help the classification of brain tumor more accurately and precisely.With less True negative rate this types of selection can help us. many Research's are done in this field which shows the more advancement of selecting particular features from images with more Precision. Development of Convolutional Neural Netwok gave an excellent results on images. Feed Forward Neural Network and CNN [8] with different

architectures have done major advancements in classsifiaction of Brain tumor without much knowledge of vision techniques. Selecting feature selection and extraction are tedious tasks and can be overcomes by CNN [8] model. It has power of selecting good features from images with the help of Convolutions and MaxPooling.

Our Proposed approach to overcome this limitations are using Deep Learning Techniques on images . Using modern developed features such as Image Data Generator, CNN [8] ,CNN VGG-16 [9] and many more architectures. We have also improved upon existing approach by applying HOG [10], [16] transform as feature selection Technique . Using Hybrid approaches for selecting features has good improvements as it can help to get insights of images more accurately. We have applied Random Forest Classifiers, SVM [14] and XGBoost [15] classifiers by doing proper Feature Selection . Principal Component Analysis and Linear Discriminant Analysis are used for selecting top k features for use of classifaction .This methods reduces the overall Computations required in training and testing and reduces training time . Some Good architectrues of CNN [8] are used that can improve upon existing models more efficiently and increases the validation accuracy.

II. Materials and Method

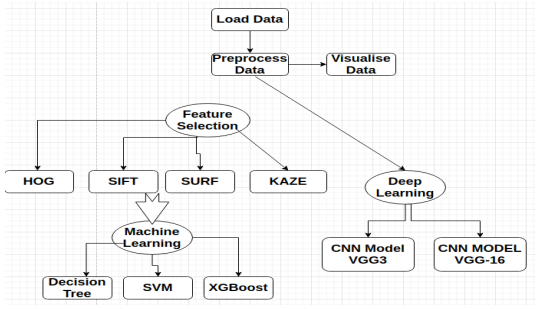

Fig. 1. Workflow of Proposed Architecture.

- Dataset Description :- It is a MRI images dataset which consists of total 253 images of size 300*300. It has 2 labels YES and NO representing Brain Tumor or not . 98 images of dataset has NO label and 155 images of dataset has YES label

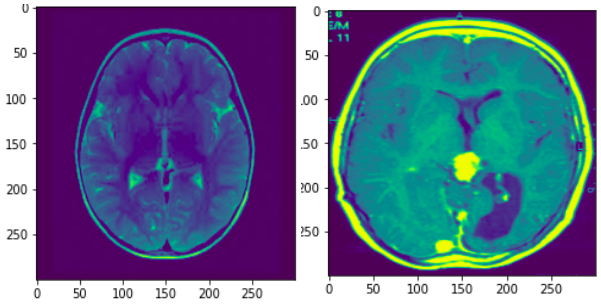

Fig. 2. Brain Tumor Images OF yes and no.

Classifiers	Feature Selection	Training accuracy	Testing Accuracy
Random Forest	Hog	1.0	0.8548
Random Forest	sift	1.0	0.661
Random Forest	surf	1.0	0.774
Random Forest	kaze	1.0	0.758
Random Forest	N/A	1.0	0.919
SVM	Hog	0.9193	0.870
SVM	sift	0.9153	0.580
SVM	surf	0.8306	0.774
SVM	kaze	0.979	0.725
SVM	N/A	0.939	0.838
XGBoost	Hog	1.0	0.903
XGBoost	sift	1.0	0.629
XGBoost	surf	1.0	0.693
XGBoost	kaze	1.0	0.725
XGBoost	N/A	1.0	0.903

TABLE I
Results of Various Machine Learning Models with feature selection techniques

Model	Accuracy
SVM	0.8039
Logistic Regression	0.8235
Gaussian NB	0.6470

TABLE II
Baseline results with median filter

- We Proposed an architecture that consists of apllying machine Learning Techniques such as XGBoost [15] ,SVM [14] ,Random Forest by applying suitable Feature Selection Techniques such as HOG [10], [16] transform,SIFT [12] transform,SURF [18] transform,KAZE [13] transform . These Features selection packages are available in opencv2 library. This are top Feature detection Techniques in the feild of Computer Vision . Hybrid Models of Feature selection are also used which takes mixed features of all techniques. These Techniques are excellent in image matching and features detection and matching . PCA and FDA are also applied to save computation cost and increase the model accuracy. Random Forest has given excellent results on HOG [10], [16] transform and improved training and testing accuracy.
- Deep Learning CNN [8] Model is applied with 2 different architectures. One is CNN VGG2 [9] Block and another one is VGG-16 [9] BLock . Convolutions are performed with filter size of (3,3) with activation function as relu for all layers except output layers where tanh or sigmoid are used. MaxPooling layer is also added of size (2,2) . Different architectures are applied for different results analysis and proper validation. Dropout layers are added for preventing overfitting of the model and proper validation. This architectures used has improved the model accuracy from previous ones as CNN [8] outperformed all others machine learning models.

III. Results

- Table1 shows the training and testing accuracy for Random Forest,SVM,XGBoost Classifiers for differnt Features Selection Techniques such as Hog, Sift,Surf,Kaze and no feature selection. Training accuracy for all the

Model	Accuracy
SVM	0.7843
Logistic Regression	0.7450
Gaussian NB	0.6274

TABLE III
BASELINE RESULTS WITHOUT MEDIAN FILTER

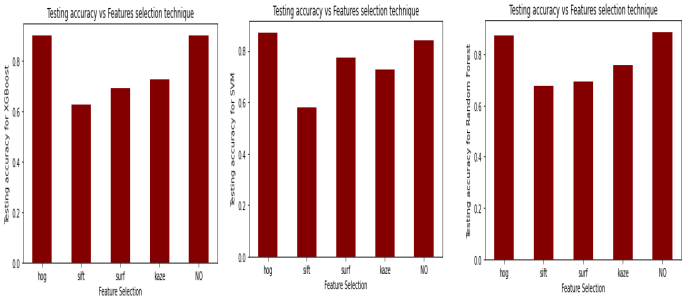

Fig. 3. Plot showing Testing accuracy on Different Feature Selection.

classifiers are nearly 100 percent and Testing accuracy for Hog Feature Selection are nearly 92 percent.

- Fig2 shows two images left one is MRI images in which no tumor is detected and right one is MRI image in which Tumor is detected
- Fig3 shows the bar plots for testing accuracy on different Feature selection for Random Forest, SVM ,XGBoost Classifiers. We can clearly see HOG transforms has given excellent results on testing .
- Fig 4 shows the graphs plots for testing accuracy for validation split of 0.2 and no of epochs. It also shows the testing loss and accuracy for different CNN architectures. First one is VGG2 Block CNN model which have achieved excellent validation accuracy and another one is VGG16 Block CNN model. This model have achieved more accuracy without any Feature selection Techniques.
- The baseline model accuray are shown in tatble 2 and table 3 . This are taken as baseline models for further improvements . Our Proposed model and architectures and new techniques has shown better results compared to baseline models.

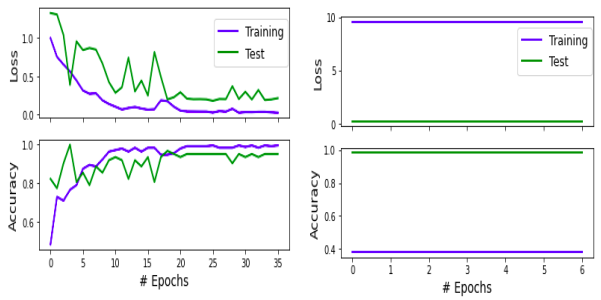

Fig. 4. Testing accuracy and loss vs epochs plots for 2 CNN models

IV. DISCUSSIONS

This paper first discusses about the baseline model which applies median filter on the images and then uses simple machine learning algorithms on the features based on the GLCM features.The results obtained were quite satisfactory, however,the glcm features mainly include the co-relation between the gray pixels of the image.However, due to the high dimensionality of the matrix formed its quite unfeasible to apply it on a large dataset. Moreover, since its a statistical based method it didn't consider other properties of the image such as edges and borders.The maximum accuracy achieved was using SVM with 82% with the median filter whereas without the filter it was 78%.

This paper proposes a work on brain tumor detection system using advanced feature selection techniques specifically for images, then based on the extracted features various machine learning algorithms are applied along with boosting algorithm XGboost.This paper also proposes a deep learning Convolution Neural Network model for image classification using the VGG-3 and VGG-5 model.The best results obtained was using XGBoost with hog transform with 90.3%.Moreover, with the CNN model the accuracy obtained was 98% with split of .20 size.

Many techniques and algorithms are still left for future implementations which include various advanced image enhancement techniques and deep CNN models.Moreover, due to limited size of dataset, model's accuracy is confined.Hence, in the future with a large dataset of images, the validation accuracy of the model could be more accurately defined.

V. CONTRIBUTION OF EACH AUTHOR

- Anand Sharma (MT19059)
  Background research on improved methods. Implementaion of CNN VGG2 Block architecture model and applied feature selection technique.

- Abhishek Singh Chauhan (MT19085)
  Background research of baseline methods. Implementation of baseline model.Added feature selection Technique , preprocessing , data Balancing and proper visualisation.

- Kamal Awasthi (MT19091)
  Background research on improved methods. Implementaion of CNN VGG16 Block architecture model and feature selection technique.

- Vishal Srivastava (MT19102)
  Background research of baseline methods. Implementation of baseline model. Added feature selection Technique and models on existing approaches

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