Brain Tumor Detection Using Deep Learning Techniques

Prof. Kavita Bathe
Department of Computer Engineering
K.J.Somaiya Institute of Engineering and Information Technology.Sion, Mumbai.
University of Mumbai
kavitag@somaiya.edu

Varun Rana
Department of Computer Engineering
K J Somaiya Institute of Engineering and Information Technology,Sion, Mumbai.
University of Mumbai
varun.rana@somaiya.edu

Sanjay Singh
Department of Computer Engineering
K J Somaiya Institute of Engineering and Information Technology,Sion, Mumbai.
University of Mumbai
sanjay.singh@somaiya.edu

Vijay Singh
Department of Computer Engineering
K J Somaiya Institute of Engineering and Information Technology,Sion, Mumbai.
University of Mumbai
vijay.rs@somaiya.edu

Abstract - Brain tumor is considered as one of the aggressive diseases, among children and adults. Brain tumors grow very fast and if not treated well, the survival chances of the patient are very less. Early detection of brain tumors is very important. Proper treatment planning and accurate diagnostics is at the topmost priority to improve life expectancy of the patients. The best technique to detect brain tumor is Magnetic Resonance Imaging. The MRI images are examined by the radiologist. Manual examination can be error prone due to the level of complexities involved in brain tumors and their properties. Hence an automated brain tumor detection system is required to detect tumors at its early stage. This paper uses deep learning based Depth wise Separable Convolution Neural Network to detect the tumor based on the MRI images. Experiments are done on the public dataset available at kaggle. Experimental Results have shown that Depth wise Separable Convolution Neural Network gives better accuracy as compared Support Vector Machine, K Nearest Neighbour and Convolution Neural Network.

Keywords : MobileNet Architecture,Convolution Neural Network

I. INTRODUCTION

A brain tumor occurs when abnormal cells form within the brain. Tumor has a tendency to repeat itself and spread over the region of the brain. Medical imaging technique , Magnetic resonance imaging (MRI) is one of the most commonly used techniques to identify and locate the tumor in the brain. Deep learning based approaches for analysis of brain MRI images for tumor detection is gaining interest due its self learning ability. Deep learning is a robust and better approach in machine learning in many fields, such as medical image segmentation. It overcomes the inaccurate prediction of brain tumor done by humans. In this paper we have analyzed different deep learning techniques for brain tumor detection. In the model we used a Depthwise Separable convolution neural network algorithm which is better than a normal convolution neural network as it has more number of filters to detect the patterns in the magnetic resonance image, there is also less loss of data and it is based on streamlined architecture to build a lightweight deep neural network. It also has less computational time and has more accuracy than previously developed models.

The rest of the paper is organized as follows: Section II presents the literature review, Section III presents the proposed system, Section IV presents the results and discussion, finally Section V contains the conclusion and future work.

II. LITERATURE REVIEW

Medical image segmentation plays an important role in analysis of tumors from the magnetic resonance imaging(MRI). Many techniques have been proposed to detect tumors in MRI images. An overview and findings of some of the recent researches are presented here.

Convolution neural networks use biological models in order to classify tumors. In the method proposed by Subhashis Banerjee[4] ,the MRI image is passed through different layers like CONV2D, Pooling Layer, and Fully-Connected Layer, ConvNet. Brain tumor is predicted with the help of FCN(i.e. Fully convolutional neural network) in the method proposed by Sanjay Kumar[7]. In this paper[7] it is seen that using FCN for brain tumor Magnetic resonance imaging segmentation not merely to detect the growth but also gives an improved description of the center and the ornamental growth[7]. A method based on neural convolution was proposed by Fatemeh Derikvand [10]. This method [10] uses Glioma Brain Tumor Segmentation Networks in Magnetic resonance imaging and the process proposed is a mixture of Multiple different Convolution Neural Network architectures which makes use of Local and global knowledge of brain tissue to predict the label of each pixel, which helps to enhance results[10]. In another paper proposed by G.Hemanth [21] Convolution Neural Network has been employed for Segmentation of images. It explicitly extracts features from Images of pixels with the minimum pre-processing involved. The network used is LinkNet, a light, deep network. Architecture of a neural network built to perform Segmentation of Semantic. Contains the LinkNet Network Blocks of encoders and decoders which basically manage to Break the picture and rebuild it again until it is sent through a few final layers of convolution. The proposed Convolution Neural Networks performance is assessed with RMSE (Root Mean Square Error), recall, sensitivity, precision, F-score specificity, PME (probability of the

misclassification error).[21] In the methodology proposed by Tonmoy Hossain[22] firstly skull striping is done to the input image which removes the skull portion from the Magnetic resonance imaging image. This filtered image segmentation is done using Fuzzy C-Means clustering algorithm. For Segmentation we only need the brain part rather than the skull for this we do morphological operations in our images. Now, Feature extraction is done to the image which are of two – Texture based (Dissimilarity, Homogeneity, Energy, Correlation) and Statistical based (Mean, Centroid, Standard Deviation, Entropy) features. Now, the extracted features are given as inputs to a 5-layer Convolution Neural Network model which is a 7-stage model including the hidden layer provides excellent results.[22] When convolution neural networks were used for brain tumor prediction the accuracy was high but the computational time was much higher when compared to other models.Feature extraction is an integral part for brain tumor detection and it can be done in various ways. One the way was suggested by Astina Minz[8] in which features were extracted by using Gray Level Co-occurrence Matrix technique.Gray Level Co-occurrence Matrix functions characterize the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image, creating a Gray Level Co-occurrence Matrix, and then extracting statistical measures from this matrix. In this paper [8], the classification was done by using the Adaboost classifier and accuracy achieved by the proposed system is 89.90%.

Rupsa Bhattacharjee proposed a method that offers the possibility to implicitly segment tumor-bearing brain images by atlas-based registration.[14] Detection of abnormal mass accumulation highly affecting pixel-wise intensity distribution of the image. In the processed output the tumor mass and volume is intact as in the original MRI image.Mircea Gurbin [16] proposed method uses different levels for wavelets, the high accuracy part is obtained using CWT. SVM was used to classify them correctly as a benign tumor, malign tumor or healthy brain. Support Vector Machines have significant computational advantages.The obtained results in this paper [16] shows that CWT provides higher computation compared with DWT. In this methodology proposed by Bhavana Ghotekar, a method to detect affected brain tissues due grade 4 GBM was proposed. Naive bayes Classification is done on the extracted properties. In this method [20] an accuracy of 83.33% was obtained. The algorithm first takes the Magnetic resonance imaging image as input to which filtering is done to smoothen the image and remove noise from the image. The next step is masking the filtered image which is removing brain tissues from the skull. In the last stage the obtained features are given to the Support Vector Machine classifier which classifies the image as cancerous or not. [20]

After studying different algorithms to detect brain tumor we found out that the accuracy algorithms had high computational time and on the other hand low computational time algorithms couldn't give higher accuracies. In cases where the number of features for each data point exceeds the number of training data samples, the SVM will underperform. One disadvantage of boosting is that it is sensitive to outliers since every classifier is obliged to fix the errors in the predecessors. Thus, the method is too dependent on outliers. Another disadvantage is that the method is almost impossible to scale up. This is because every estimator bases its correctness on the previous predictors, thus making the procedure difficult to streamline. So we wanted to implement an algorithm that would be lightweight and could give high accuracy.

III PROPOSED SYSTEM

There exist different types of machine learning and deep learning techniques. We have implemented different machine learning techniques like SVM, Adaboost and Deep learning techniques like Convolution Neural network and Depthwise Separable Convolution Neural Network.The experimental results shows that Depthwise separable CNN gives better accuracy as compared to others.

Depthwise Separable CNN:

Fig 1 depicts the block diagram of the proposed system. In this system starts by loading the MRI images from the dataset followed by preprocessing,train test splitting of the dataset ,model implementation finally classification if the tumor is present or not.

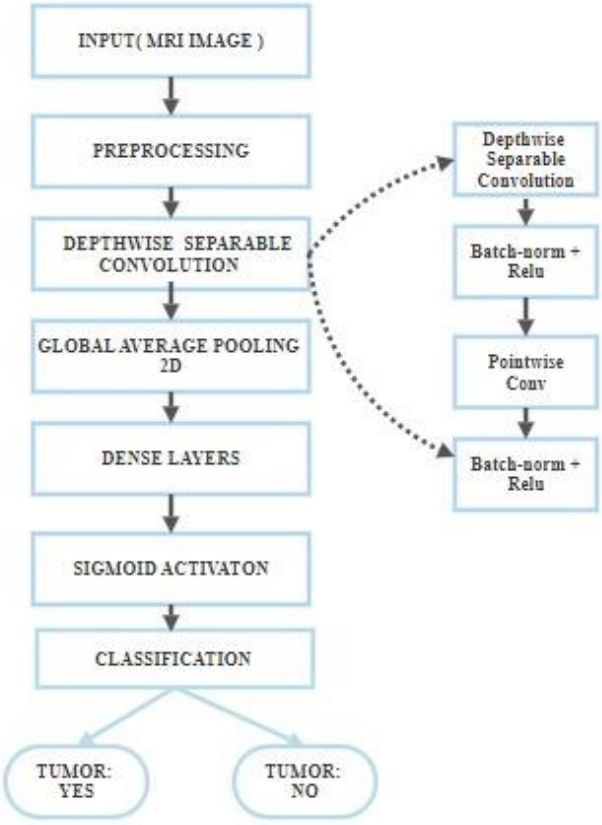

Fig. 1: Block diagram of proposed system

A. Dataset collection:

The dataset used is provided by Navoneel Chakrabarty on the Kaggle website which was previously used by various researchers in their research paper. This dataset altogether has 253 MRI images with 98 images of non cancerous type and 155 images of cancerous type.

B. Preprocessing:

Before feeding the MRI images to the proposed structure preprocessing step is performed on the images. In the image preprocessing part first ImageDataGenerator method of keras library is used to Generate batches of tensor image data with real-time data augmentation so that our model gets different types of images. Also the preprocess_input parameter of the ImageDataGenerator method of keras library is set to adequate MRIimage to the format the model requires. All the necessary steps of preprocessing including cropping of image, rotation of image, defining brightness range, flipping the image and finding the 4 rectangular boundary coordinates of the cropped image is done inside this ImageDataGenerator method of keras library.

C. Data Modelling:

After we have standardised our entire dataset we have splitted our dataset into training set as well as test set. 80% data is used for training and 20% data is used for testing. Then using Image Data Generator, images are splitted into test and training sets.

D. Methodology:

MobileNet architecture is an efficient architecture that uses depthwise separable convolutions as shown in Fig. no.2, to construct lightweight deep convolutional neural networks and provides an efficient model. This MobileNet model is saved as a base model & on that base model global average 2D pooling layer is applied. Global average 2D pooling layer minimizes overfitting by reducing the total number of parameters in the model. After this two dense layers with 1024 neurons each are added to the base model with relu activation function so that model can learn more complex functions & classify for better results faster. The result obtained from the previous layer is then passed through another dense layer with 512 neurons with sigmoid activation function, which will classify the image as tumor detected positive(yes) or negative(no). Model is then compiled using binary cross entropy and Adam optimizer. Binary cross entropy minimises the loss function & Adam optimizer combines the best properties of the AdaGrad and RMSProp algorithms to provide an optimization algorithm that can handle sparse gradients on noisy problems. Atlast base model is trained for 150 epochs so that the model can learn different complex patterns with maximum accuracy of 92%.

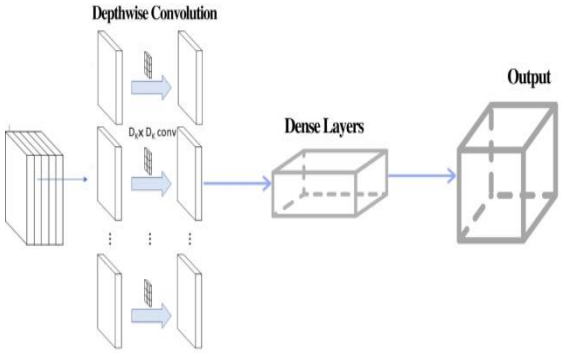

Fig. 2 : Depth-Wise Separable convolution

IV RESULT AND DISCUSSION

There are two main types of separable convolutions spatial separable & depthwise separable. Depthwise Convolution is a kind of convolution where we apply a solitary convolution channel for each information channel. In the standard 2D convolution performed over numerous info channels, the channel is pretty much as profound as the information and allows us unreservedly to blend channels to create every component in the yield. Interestingly, depthwise convolutions keep each channel independent. Depthwise separable CNN has multiple filters which maps the input image for different patterns. These filters one by one searches for patterns & then gives it to the next layer in architecture. Major advantages of it is it gives higher accuracy & can detect different patterns at the same time as compared to traditional CNN

The maximum accuracy was between 87.5% to 95.8% and minimum loss of 0.2957 to 0.8555 with epochs between 135 to 145 as shown in Fig.3 and Fig. No 4 respectively.

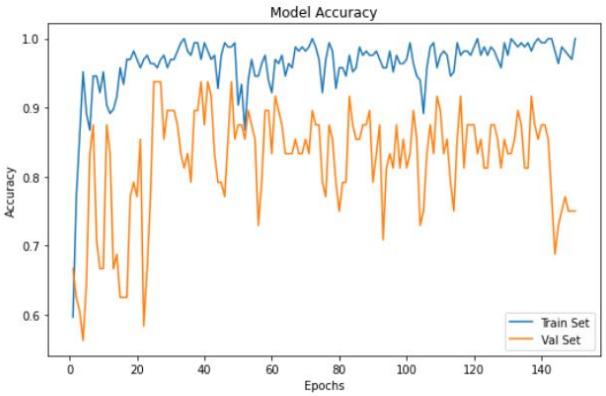

Fig.3 : Model Accuracy with depth wise separable convolution

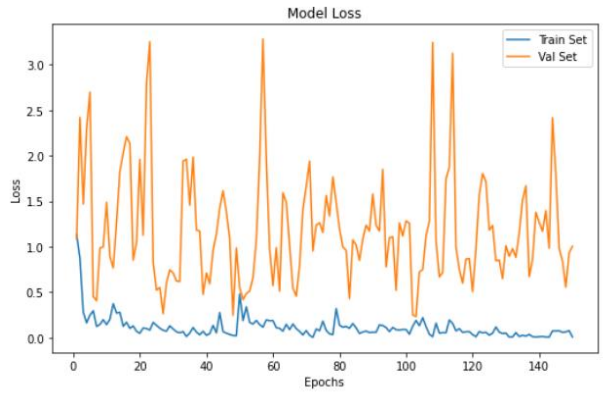

Fig 4 : Model Loss Accuracy with depth wise separable Convolution

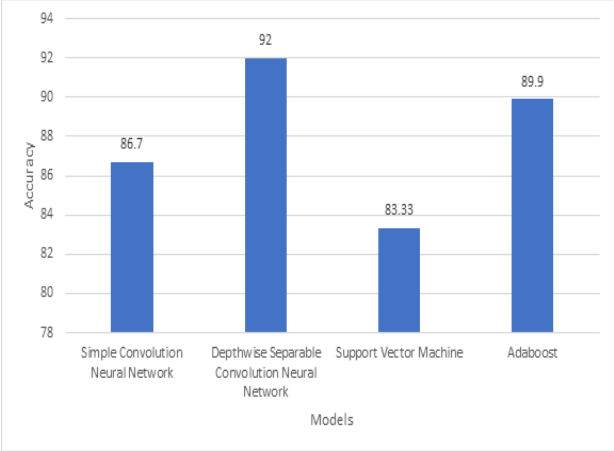

Fig-5: Result analysis of various models

Fig.5 depicts the accuracies obtained using various models i.e Simple Convolution Neural Network, Depthwise Separable CNN, Support Network Machine and Adaboost algorithm. The best result was obtained using the Depthwise Separable CNN which had an overwhelming accuracy of 92%. Other algorithms also gave decent accuracy for brain tumor prediction.

V. CONCLUSION

Magnetic Resonance Imaging (MRI) has become an effective tool for clinical research in recent years and has found itself in applications such as brain tumour detection.Deep learning techniques when applied on these MRI images helps to detect the tumor.We have implemented two techniques such as CNN and depth wise separable method on the MRI image dataset .Experimental results shows that depthwise separable cnn gives better accuracy as compared to CNN. The accuracy was found out to be 92% for the test set using Depthwise Separable CNN. The system will be definitely helpful in the healthcare domain.

Through the proposed method is able to detect if a tumor exists or not. However, in future the system can be further enhanced to detect a particular type of tumor and suggest the treatment accordingly.

REFERENCES

1. Rupal R. Agravat, Mehul S. Raval, " Prediction of Overall Survival of Brain Tumor Patients ", 2019 IEEE Region 10 Conference (TENCON 2019) 978-1-7281-1895-6.

2.Tonmoy Hossain, Fairuz Shadmani Shishir , Mohsena Ashraf, "Brain Tumor Detection Using Convolutional Neural Network", 1st International Conference on Advances in Science, Engineering and Robotics Technology 2019 (ICASERT 2019) 978-1-7281-3445-1.

3. P. Mohamed Shakeel, Tarek E. El. Tobely, Haytham Al-feel, Gunasekaran Manogaran, and S. Baskar " Neural Network Based Brain Tumor Detection Using Wireless Infrared Imaging Sensor", 2019 IEEE. Translations and content mining are permitted for academic research, ISSN: 2169-3536.

4.Subhashis Banerjee, Francesco Masulli, Sushmita Mitra, Brain Tumor Detection and Classification from Multi-Channel Magnetic resonance imagings using Deep Learning and Transfer Learning"(2017).

5.Sneha Khare, Neelesh Gupta, Vibhanshu Srivastava, "Optimization Technique, Curve Fitting and Machine Learning used to Detect Brain Tumor in Magnetic resonance imaging", 2014 IEEE International Conference on Computer Communication and Systems(ICCCS 114), Feb 20-21, 2014 Chennai, INDIA

6.G.Hemanth, M.Janardhan, L.Sujihelen, "Design And Implementing Brain Tumor Detection Using Machine Learning Approach" Proceedings of the Third International",Proceedings of the Third International Conference on Trends in Electronics and Informatics (ICOEI 2019),ISBN: 978-1-5386-9439-8.

7. Sanjay Kumar, Dr. Ashish Negi, Dr. J.N Singh, Mr. Himanshu Verma, "A Deep Learning for Brain Tumor Magnetic resonance imaging Images Semantic Segmentation Using FCN ", 2018 4th International Conference on Computing Communication and Automation (ICCCA), ISBN: 978-1-5386-6947-1.

8. Astina Minz, Prof. Chandrakant Mahobiya," Magnetic resonance imaging Image classification using adaboost for brain tumor type", 2017 IEEE 7th International Advance Computing Conference (IACC), ISBN: 978-1-5090-1560-3.

9. Komal Sharma, Akwinder Kaur,Shruti Gujral Assistant Professor M.E - CSECU, Gharuan Mohali, Punjab, INDIA , "Brain Tumor Detection based on Machine Learning Algorithms", International Journal of Computer Applications (0975 – 8887) Volume 103 – No.1, October 2014 .

10. Fatemeh Derikvand,Hassan Khotanlou,"Brain Tumor Segmentation in Magnetic resonance imaging Images Using a Hybrid Deep Network Based on Patch and Pixel", 2020 International Conference on Machine Vision and Image Processing (MVIP), ISBN: 978-1-7281-6832-6.

11.Prachi Gadpayle and Prof. P.S.Mahajani, "Detection and Classification of Brain Tumor in Magnetic Resonance Imaging Images", International Journal of Emerging Trends in Electrical and Electronics (IJETEE – ISSN: 2320-9569).

12.Bala Venkateswarlu Isunuri ,Jagadeesh Kakarla Assistant Professor, Dept. of Computer Science and Engineering, IIITDM Kancheepuram, Chennai, India jagadeeshk@iiitdm.ac.in, "Brain Tumor Extraction using Adaptive Threshold Selection Network", 2019 IEEE 1st International Conference on Energy, Systems and Information Processing (ICESIP), ISBN:978-1-7281-0419-5.

13.Hayder Saad Abdulbaqi ,Ahmad Fairuz Omar, Iskandar Shahrim Bin Mustafa,Mohd Zubir Mat Jafri, " Detecting Brain Tumor in Magnetic Resonance Images Using Hidden Markov Random Fields and Threshold Techniques", 2014 IEEE Student Conference on Research and Development, ISBN: 978-1-4799-6428-4.

14.Stefan Bauer, Christian May, Dimitra Dionysiou, Georgios Stamatakos, Philippe B¨uchler, and Mauricio Reyes, “Multiscale Modeling for Image Analysis of Brain Tumor Studies”, IEEE Transaction on Biomedical Engineering, VOL. 59, No. 1, JANUARY 2012, 0018-9294/$26.00 © 2011 IEEE.

15.Rupsa Bhattacharjee, Dr. Monisha Chakraborty, “Brain Tumor Detection From MR Images: Image Processing, Slicing and PCA Based Reconstruction.”, 2012 Third International Conference on Emerging Applications of Information Technology (EAIT), ISBN: 978-1-4673-1827-3.

16.Mircea Gurbin, Mihaela Lascu, and Dan Lascu, “Tumor Detection and Classification of Magnetic resonance imaging Brain Image using Different Wavelet Transforms and Support Vector Machines”, 2019 42nd International Conference on Telecommunications and Signal Processing (TSP), ISBN:978-1-7281-1864-2.

17.Tamjid Imtiaz, Shahriar Rifat, Shaikh Anowarul, “Automated Brain Tumor Segmentation from Magnetic resonance imaging Data Based on Local Region Analysis”, 2019 IEEE International Conference on Biomedical Engineering, Computer and Information Technology for Health (BECITHCON) 28-30 November 2019, Dhaka, Bangladesh, ISBN:978-1-7281-5389-6.

18.Annisa Wulandari, Riyanto Sigit, Mochamad Mobed Bachtiar,” Brain Tumor Segmentation to Calculate Percentage Tumor Using Magnetic resonance imaging”, 2018 International Electronics Symposium on Knowledge Creation and Intelligent Computing (IES-KCIC), ISBN:978-1-7281-0067-8 .

19. Hein Tun Zaw, Noppadol Maneerat, Khin Yadanar Win, “Brain tumour detection based on Naïve Bayes Classification”, 2019 5th International Conference on Engineering, Applied Sciences and Technology (ICEAST), ISBN:978-1-7281-0067-8.

20. Bhavana Ghotekar, K. J. Mahajan, Brain Tumour Detection and classification using SVM, National Conference on Innovative Trends in Science and Engineering ISSN: 2321-8169

21.G.Hemanth, M.Janardhan, L.Sujihelen, Design and Implementing Brain Tumor Detection Using Machine Learning Approach, Proceedings of the Third International Conference on Trends in Electronics and Informatics (ICOEI 2019) IEEE Xplore Part Number: CFP19J32-ART; ISBN: 978-1-5386-9439-8

22. Tonmoy Hossain, Fairuz Shadmani Shishir, Mohsena Ashraf, MD Abdullah Al Nasim, Faisal Muhammad Shah, Brain tumour detection using Convolution Neural Network (2019), 1st International Conference on Advances in Science, Engineering and Robotics Technology 2019 (ICASERT 2019)