BRAIN TUMOR DETECTION USING MACHINE LEARNING & DEEP LEARNING

Dr. Zankhana Shah[1], Sneh Shah[2], Akshaykumar Kathiriya[3], Anchal Singh[4]

1234Information Technology Department,

Birla Vishvakarma Mahavidhyalaya,

Anand, Gujarat, India

Abstract: *As Brain tumor is one of the leading causes of death. A brain tumor is a growth of abnormal cells in the brain. Primary and secondary brain tumors are the two main categories. Primary brain tumors develop in the brain's tissues or tissues nearby. Secondary brain tumors are tumors that develop when cancer spreads from another part of the body to the brain. So, this paper work concentrates on MRI images having brain tumor and classifies in benign and malign. Here, Discreate wavelet transform is use for feature extraction and support vector machine for classification. The results are tested on Kaggle dataset and improved accuracy then other paper which have done work on different dataset.*

Keywords: **Brain Tumor Detection, Wavelet Transform, PCA, Support Vector Machine, CNN, Classification**

1. INTRODUCTION

The central nervous system (CNS), which is made up of the brain and spinal column, regulates all essential bodily processes. These processes include voice, movement, and thought. This implies that a person's mental processes, speech, or move movement might be affected when a tumor arises in the CNS. According to the International As- sociation of Cancer Registries (IARC), about 24,000 people pass away each year as a result of brain tumors. The brain cancer market is predicted to develop at a compound annual growth rate of 1.11 percent through 2030, according to a Delve Insight analysis. If the predictions come true, brain tumors may rank as the second most frequent malignancy by 2030, according to medical authorities.

The usual method to detect brain tumor is Magnetic Resonance Imaging (MRI) scans. Our proposed methodology will identify the tumor from MR image by using Machine Learning algorithm. Our system will identify tumor very fast in efficiently

2. Literature Survey

Machine Learning and Deep Learning Techniques are widely used in different medical domains. Viewed research papers proposed various techniques and conclude its result.

To reduce the computation, it is necessary to reduce data. Also features should not be reduced. Central moments i.e., mean and standard deviation are used to extract features from images used in [1]. Proposed methodology has achieved maximum 91.91% accuracy using Artificial Neural Network.

Feature extraction is necessary before applying classification algorithm. Discrete wavelet Transform (DWT) is used by [12]. They have used this technique for feature extraction from leaf images. Principal Component Analysis (PCA) is also useful in feature extraction and dimension reduction, but it is lossy reduction. [13] have used PCA for feature extraction on cancer images.

Deep Learning is used to solve more complex problems. Convolutional Neural Network (CNN) is more useful when we have data in terms of images. CNN can extract features by itself, we don't have to apply any specific algorithm for that. Waleed Saad. Et al. has introduced classification using CNN algorithm [4]. They have achieved 94.14% and 96.05% accuracy on train-test split ratio 70:30 and 80:20 respectively.

Deep Learning is used to solve more complex problems. Artificial Neural Network (ANN) algorithm is simple interconnected network of neurons. ANN and CNN are used in [5]. P Gokila Brindha, M Kavinraj, P Manivasakam and P Prasanth have used ANN and CNN for tumor detection. Accuracy achieved by ANN is 71.51% and CNN is 94%. ANN is not able to extract feature automatically so we have to apply such techniques that can extract features from image.

GoogLeNet is convolutional neural network that has 22 layers deep and ResNet-18 is convolutional neural network with 18 layers. These algorithms are specially used for object detection in images, used in [3]. S. Arora and M. Sharma has proposed ResNet, GoogleNet, ResNet-18 with SVM and GoogleNet with SVM algorithms with accuracy of 97.8%, 97.4%, 98% and 97.6% respectively.

Naïve Bayes and Decision trees are also used for classification. J48 is classifier that is used to generate decision tree. These techniques are used in [8]. Al-Ayyoub, Mahmoud, et al. proposed algorithms like Artificial Neural Network, J48, Naïve Bayes and Lazy-IBK. Accuracy achieved is 66.6%, 59.2%, 59.2%, 62.9% respectively.

3. Methodology

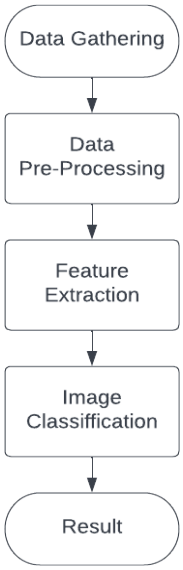

Fig. 1. Proposed Methodology

3.1. Data Gathering

Dataset is downloaded from the Kaggle.com. Our dataset contains 3000 brain MR images. There are 1500-1500 images of each benign and malign class

3.2. Image Pre-processing

Data Pre-processing is most essential step for any ML or DL model. It directly affects the accuracy of the model. So clean and suitable data for the model is needed.

We have resized the image in the size of 64x64, 128x128 and 256x256 according to the model and also image is converted to grey scale from RGB

3.3. Feature Extraction

3.3.1 Discrete Wavelet Transform

Wavelet Transform is widely used for feature extraction in Machine Learning. In this research paper Discrete Wavelet Transform is used for feature extraction.

When we apply DWT on any image, image will decompose in two parts i) Low pass Decomposition filter and ii) High pass Decomposition filter. Then again both decomposed in two-two parts. After second decomposition we get four coefficients i) Approximation Coef. ii) Horizontal Detailed Coef. iii) Vertical Detailed Coef. iv) Diagonal Detailed Coef.

After getting four coefficients Approximation Coef. further decomposed into four parts and it is called level two decompositions. In this research paper we have performed 6 level decomposition. In this operation we have made some coefficient part to zero so we can get better features.

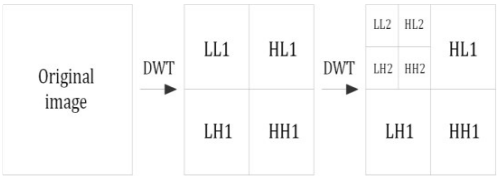

Fig. 3. Multilevel Decomposition [14]

After performing decomposition, we have recomposed the image. Below is the comparison of both images before and after applying the DWT.

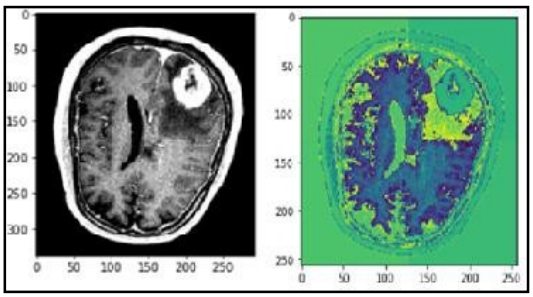

Fig. 4. Image before and after applying wavelet transform

3.3.2 Principal Component Analysis

PCA is a linear dimensionality reduction technique (algorithm) that transform a set of correlated variables (p) into a smaller k (k<p) number of uncorrelated variables called principal components while keeping as much of the variability in the original data as possible. When the number of dimensions or components increases, the image quality loss decreases.

We should always try to keep an optimum number of components that balance the explained variability and the image quality. So, we have kept dimensions accordingly, which is 55dimensions.We have resized each MR Image to 64x64.

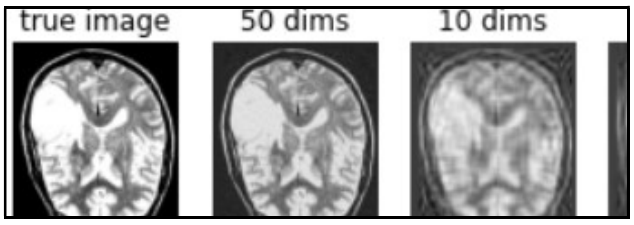

Fig. 4. Multilevel Decomposition

3.3.3 Central Moments

By calculating and storing the central moments window we can obtain the features and reduce the size of the image significantly

In this method we have taken the image size of 256 x 256 and segment it into 16 x 16 window. Central moments of each window stored in the metrics. This method helps to make the training faster.

3.4. Image Classification

3.4.1 Support Vector Machine (SVM)

Support Vector Machine is one of the most popular techniques for classification. SVM creates best line or hyperplane to segregate n-dimensional datasets.

SVM selects the most extreme points to set the hyperplane. Points which are used to measure maximum distance or to find maximum margin are support vectors.

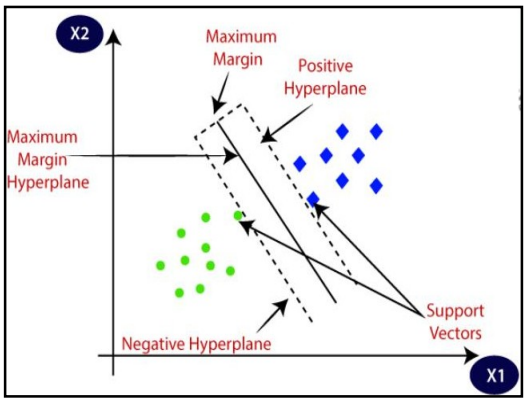

Fig. 5. Support Vector Machine [15]

We can use various kernels in SVM to fit best hyperplane and achieve more accuracy. In this research paper we have used three different kernels*:*

linear kernel uses single line to separate the data points
When the data is not linearly separable polynomial curve is used for classification
When the data is linearly inseparable RBF kernel is recommended

3.4.2 Convolutional Neural Network (CNN)

Convolutional Neural Network is very effective in field of image recognition and classification. CNN is known for its feature extraction and high accuracy. CNN has many layers explained below:

Convolution 2D: In the Convolution 2D extract the featured from input image. It given the output in matrix form.

Max Pooling 2D: the MAX polling 2D it takes the largest element from rectified feature map.

Dropout: Dropout is randomly selected neurons are ignored during training.

Flatten: Flatten feed output into fully connected layer. It gives data in list form.

Dense: A Linear operation in which every input is connected to every output by weight. It followed by nonlinear activation function.

Activation: It used Sigmoid function and predict the probability 0 and 1.

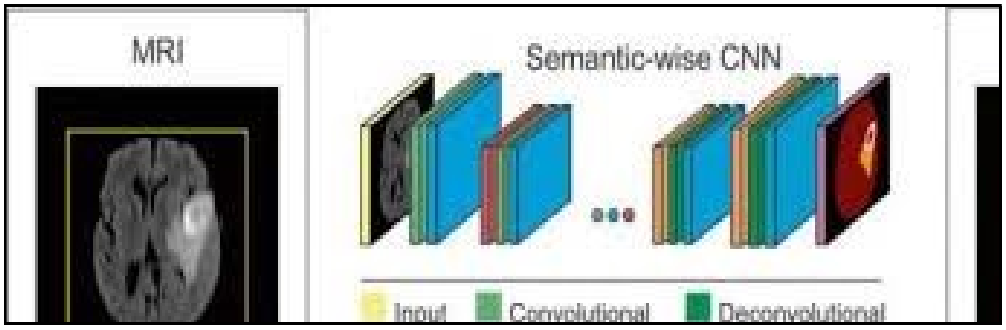

Figure 6. Semantic-wise CNN [16]

4. Result Analysis

We have trained our model with the training testing ratio of 70:30 and 80:20

Table 1. Result Analysis for 70:30 training-testing splitting ratio

Model	Accuracy	Precision	Recall
Only SVM	95.44	96.45	94.52
PCA + SVM	96.88	97.37	96.52
Central Moments + SVM	89.88	96.31	84.87
DWT + SVM	96.88	97.54	96.75
CNN	98.13	97.33	98.2

Table 2. Result Analysis for 80:20 training-testing splitting ratio

Model	Accuracy	Precision	Recall
Only SVM	95.66	96.10	95.48
PCA + SVM	97.33	97.40	97.84
Central Moments + SVM	91.66	97.41	87.75
DWT + SVM	97.33	97.11	98.25
CNN	99.05	98.33	99.1

5. Conclusion

Our proposed methodology is giving better results than some methodology we have studied. Feature extraction using Discrete Wavelet Transform and classification using SVM is giving more accuracy than studied model. Feature extraction through PCA and central tendency is not giving expecting accuracy because those are lossy data reduction techniques. With the use of CNN, we can achieve more than 99% accuracy which is better. We can use ResNET and GoogleNET to achieve more promising results in future

REFERENCES

6.1. Journal Article

[1] *R. Jahan and M. M. Tripathi, "Brain Tumor Detection Using Machine Learning in MR Im- ages," 2021 10th IEEE International Conference on Communication Systems and Network Technologies (CSNT), 2021, pp. 664-668, doi: 10.1109/CSNT51715.2021.9509695.*

[2] *H. Kibriya, M. Masood, M. Nawaz, R. Rafique and S. Rehman, "Multiclass Brain Tumor Classification Using Convolutional Neural Network and Support Vector Machine," 2021 Mohammad Ali Jinnah University International Conference on Computing (MAJICC), 2021, pp. 1-4, doi: 10.1109/MAJICC53071.2021.9526262.*

[3] *S. Arora and M. Sharma, "Deep Learning for Brain Tumor Classification from MRI Im- ages," 2021 Sixth International Conference on Image Information Processing (ICIIP), 2021,pp. 409-412,doi: 10.1109/ICIIP53038.2021.9702609.*

[4] *S. A. El-Feshawy, W. Saad, M. Shokair and M. Dessouky, "Brain Tumor Classification Based on Deep Convolutional Neural Networks," 2021 International Conference on Elec- tronic Engineering (ICEEM), 2021, pp. 1-5, doi: 10.1109/ICEEM52022.2021.9480637.*

[5] *P Gokila Brindha, M Kavinraj, P Manivasakam and P Prasanth "Brain tumor detection from MRI images using deep learning techniques" https://iopscience.iop.org/arti- cle/10.1088/1757-899X/1055/1/012115/pdf*

[6] *Yongli Zhang "Support Vector Machine Classification Algorithm and Its Application"*

[7] *Mahmoud Ayyoub,Ghaith Husari, Omar Darwish, Alabed Ahmad, 2012/04/03,"Machine learning approach for brain tumor detection" DO:10.1145/2222444.2222467, ACM Interna-tional Conference Proceeding Series*

[8] *Al-Ayyoub, Mahmoud, et al. "Machine learning approach for brain tumor detection." Pro- ceedings of the 3rd international conference on information and communication systems. 2012.'*

[9] *Sheela, V. K., and S. Suresh Babu. "Pre-processing Technique For Brain Tumor Detection and Segmentation." International research journal of engineering and technology (IRJET) 2.3 (2015)*

[10] *Budati, Anil Kumar, and Rajesh Babu Katta. "An automated brain tumor detection and clas- sification from MRI images using machine learning techniques with IoT." Environment, Development and Sustainability 24.9 (2022): 10570-10584.*

[11] *Gaidhane, Vilas, Vijander Singh, and Mahendra Kumar. "Image compression using PCA and improved technique with MLP neural network." 2010 International Conference on Ad- vances in Recent Technologies in Communication and Computing. IEEE, 2010.*

[12] *Kamarul Ghazali, Mohd Fais Mansor, Marzuki Mustafa and Aini Hussain. "Feature Extraction Technique using Discrete Wavelet Transform for Image Classification" The 5th Student Conference on Research and Development DOI:10.1109/SCORED.2007.4451366*

[13] *G. S. Pradeep Ghantasala, Bonam Tanuja, Golla Surya Teja, Anagurthi Sai Abhilash. "Feature Extraction and Evaluation of Colon Cancer using PCA, LDA and Gene Expression" IJCST (2020)*

6.2. Figures

[14] *Figure3: https://www.researchgate.net/figure/Wavelet-decomposition-The-Discrete-Wave-let-Transform-analyzes-the-signal-at-different_fig3_279135484*

[15] *Figure-5: https://www.javatpoint.com/machine-learning-support-vector-machine-algorithm*

[16] *Figure-6: https://livebook.manning.com/book/machine-learning-for-mortals-mere-and-oth-erwise/chapter-6/148*