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Detecting and Diagnosing Brain Tumor MRI Image

Gudapuri Sudheer
Research Scholar, Department of ECE,
Bharath Institute of Higher Education and Research,
Chennai, Tamilnadu, India
sudheergudapuri@gmail.com

Ganesan V
Professor, Department of ECE,
Bharath Institute of Higher Education and Research
Chennai, Tamilnadu, India
vganesh1711@gmail.com

***Abstract*— Largely, brain-based illnesses are prevalent in society. The main reason brain diseases occur is because of cell growth. It therefore impacts the brain's regular operation, which in turn impacts the health of other essential organs' functionality. Aggressive brain cancer is ultimately the outcome of cell growth. Early detection of tumors in the brain is one of the primary strategies to lower the number of fatalities from brain tumors. With the help of image processing technique, the images from various sources such as computed tomography (CT) scan, MRI scan, etc. are collected and used for brain tumor detection. The noises in the images are eliminated in the pre-processing stage of the research. The model is developed using deep learning methods including support vector machines (SVM) and convolutional neural networks (CNN). The objective of this research is to create a model that can identify brain tumors from CT scan pictures. We took into account many parameters, including accuracy, recall, loss, and area under the curve , in order to assess the efficacy of the models.**

Keywords—brain tumor, deep learning, CNN, SVM, image processing.

I. INTRODUCTION

The brain, which along with the spinal cord constitutes the key component of the central nervous system, regulates the functions of nearly all of the body's critical organs. A brain tumor essentially results from the growth of aberrant cells, also known as tumor cells, which proliferate inside the skull and around the brain. Every year, some 2,50,000 persons worldwide are impacted by brain tumors. Early identification lowers the complexity of the cancer and contributes to a lower death rate, which makes it crucial.

Typically, the equipment used to scan a picture of a human organ contains noise, which might appear as fuzzy photos, unclear data, or other visual problems. It is crucial to keep in mind that medical photographs provide vital information regarding the disorders they depict. Improving the image quality is crucial if we need to diagnose a patient in order to obtain precise information. Recent developments in information technology and image processing will make it possible to extract correct information from photographs. Additionally connected to this evolution are imaging devices such as Positron Emission Tomography (PET), Computed Tomography (CT), Magnetic Resonance Imaging (MRI), and different radiological procedures such as cardiovascular and vascular contrast imaging.

II. LITERATURE SURVEY

A brain tumor may have a terrible, permanent, and sometimes fatal effect on a person's life. Brain tumors come in around 100 different kinds, each with unique traits and effects. Approximately one million Americans suffer from brain tumors; 41% of patients are men and 59% are women. Approximately 94390 new instances of brain tumors have been reported. 2023 is the year. In 2023, 18990 persons are projected to be at risk of dying from tumors. For those who are afflicted, an early diagnosis therefore presents a chance to save their lives. It is necessary to create a suitable early diagnostic technique for tumor identification in order to potentially reduce the fatality rate from brain tumors.[1][2][3]

One such method for identifying brain tumors is the use of MRI for short, which gives us a clear picture of the outcome. However, if the MRI procedure is so rapid, it would have been more advantageous for the doctors to interpret the results with early therapies and potential drugs that the patient may take to recover. Faster forecasts that can aid in prompt therapy necessitate an early and efficient diagnostic method. [4][5][6]

There are a number of computational processes involved in the handling of MRI pictures. However, one of the issues with MRI scans is that not all of them are identical and clear. Some may stray from the main structure and vary from the others. Some photographs may be too dark to see, while others may be too bright. This makes it difficult for practitioners and models to gain a good understanding of the image. Thus, a segmentation or filtration approach such as denoising should be constructed and used to get clear pictures in which all images follow the exact same procedure and are straightforward to analyze. [7][8][9]

Relying on deep neural networks, SVM (Support Vector Machine and Radial Basis Functional Neural Networks (RBF NN) might be used. Filtering, Grey Level co-occurrence Matrix extraction, and feature extractions may also be utilized for visual processing and analysis. Feature extraction is an important part of image processing since it includes recognizing a comparable or repeated pattern, which evaluates the trend of the dataset and aids in categorization. When employing algorithms like SVM, pattern recognition and creation are critical.[10][11][12]

MRI processing of pictures can also benefit from Data Mining approaches. These data mining approaches are divided into four parts. The initial and most significant step is picture pre-processing. The following phase is dividing pictures for item recognition. The next step is to extract characteristics such as form, color, and texture. The final stage incorporates procedures for identifying the brain tumor. In terms of form and intensity, many different features can be retrieved or identified. Texture-based characteristics may also be retrieved using neural network techniques. The Support Vector Machine is one similar ML approach.[13][14]. Studies clearly show that the continuing improvement of brain tumor identification utilizing MRI scan technology for processing may help physicians and practitioners contribute more to brain tumor diagnosis and recovery therapies. Because MRI detects brain tumors using high-resolution pictures, it may also be viewed as an effective image processing approach. [15]

METHODOLOGY

Early identification of brain tumours utilising appropriate medical imaging techniques can aid in disease cure. Magnetic Resonance Imaging (MRI) is a medical imaging technology used to identify the presence of tumours in the brain. For the identification of brain tumours from MRI scans, a machine learning model is created using techniques such as Support Vector Machine (SVM) and convolutional-neural-network (CNN). Preconditioning was the initial and most important stage. The collection of data is accomplished with the use of imaging methods for medicine such as MRI. The data undergoes processing once it has been extracted. The provided picture collection is cleaned up to provide clear and optimum skull images. Images that are unclear or fuzzy are eliminated.[16][17]

The picture in the database is separated into two parts: test data and train data. The train dataset is for training the model, while the test dataset is used to test the model. After the data has been preprocessed and separated, the model development step begins. We built the model using several methods to get an optimistic outcome and a clear viewpoint. Each of the approaches receive training using a train dataset as input, then tested and their preciseness determined. Finally, the method with the best precision is used for the modelling process.[18]

III. SYSTEM ARCHITECTURE

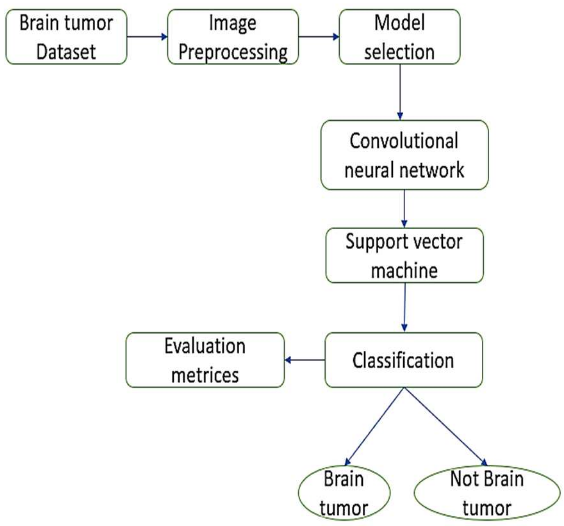

Fig.1.System Architecture for image denoising

The architecture as depicted in Fig.1. shows that the MRI image data of brain tumor are given as an input. From the input data, we preprocessing the data and then the processed data enter into the Deep learning techniques which consists of Convolutional neural network, Support vector machine. And as a result, we predict whether the patient is affected by brain tumor or not. Finally, we calculate the evaluation metrices of the model to see the performance of the particular algorithm in the model.[19]

IV. PROPOSED WORK

A. DATA COLLECTION

The input data of a medical information are in the different structure such as video, audio, images, text and so on. The data without noise are very difficult to extract from the scanning or any other devices. Most medical images are in the form of a CT scan, MRI scan images and these images are not accurate at all the time. The noises are removed with the help of preprocessing technique as shown in Fig.2. These datasets contain nearly 5000 MRI images of brain tumor which is used to build the efficient model. [20]

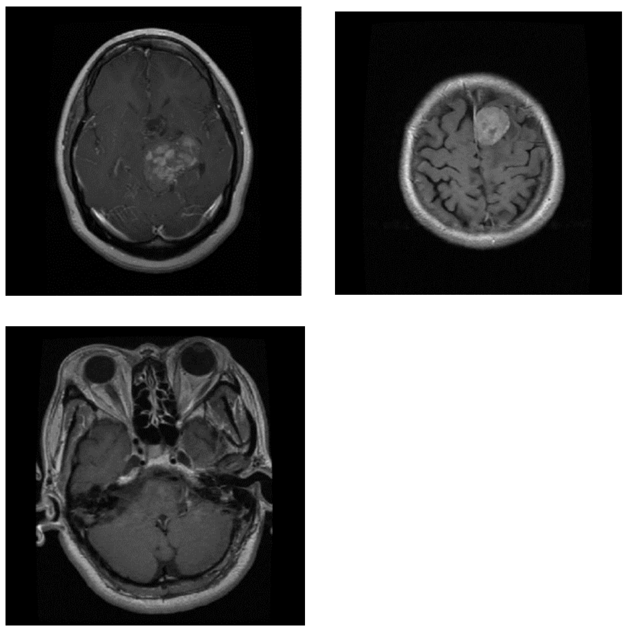

Fig.2. MRI images of Brain tumor

B. DATA PREPROCESSING

After collecting the dataset, the dataset is cleaned with the help of preprocessing technique. In this work, we use min-max-Scalar methos to preprocess the given input image of a brain tumor dataset. We import the Min Max Scalar method from the scikit learn preprocessing library [21][22]

FLATTEN LAYER

In this project, we add a flatten layer to the Convolutional neural network. The addition of this layer next to convolution layer will speed up computation and improve performance overall in this project because it flattens the multi-dimensional array of image features into a single dimension or linear vector, which is then fed as an input layer to a fully connected network to determine whether the given MRI image of a patient is affected by brain tumor or not.[23]

C. MODEL SELECTION

The preprocessed dataset is then entering into the model selection stage. In this stage, we select the deep learning or machine learning algorithm in order to build the predicting model. In this project, we use Convolutional neural network and Support vector machine algorithm to build the efficient model to predict the brain tumor disease in which the particular patients is affected by brain tumor or not.[24]

CONVOLUTIONAL NEURAL NETWORK (CNN)

In this project, we first work with the Convolution neural network (CNN) which is a Deep learning algorithm used to classify the input data.

Numerous algorithms are used in deep learning techniques. Convolutional neural networks, artificial neural networks, multi-level perceptron, long short-term memory networks, recurrent neural networks, and others are available.

Convolutional neural networks (CNN), support vector machines (SVM) are all used in this study. The keras packages contain deep learning algorithms. Therefore, we import Conv2D, also known as the convolution layer with two dimensions, from Keras. By doing this, the input picture will be filtered, producing a filtered output. Since we employ a sequential approach, pictures are sent linearly from the input layer to the output layer.

Here, we employ a 2-dimensional convolutional layer with four filters 32, 64 and each of which has a 3x3 matrix for the Kernal and a 2x2 matrix for the Pool. The methods utilized to extract features from the input MRI scan pictures are the Kernel and the Maxpool. In this model, the network is controlled during training by inserting non-linear function and activating the neurons as necessary using the Rectified Linear Unit activation function. The computing speed is accelerated using this function. Since it has a range of 0 to positive infinity, the value of ReLU for negative samples is 0.

To identify the picture as normal or tumor-affected, on the other hand, we employ the Sigmoid function. Between 0 and 1 the sigmoid function exists. The network may learn complicated models because of the non-linearity that this sigmoid function introduces. As a result, in this project, we employ both the rectified Linear unit function and the Sigmoid function. In this model, Adaptive Moment Estimator (Adam) is employed to mechanically alter the neural network's parameter by predicting the values from the network's preceding layer of neurons. The learning rate during sample training is improved with the aid of this optimizer, and the model's accuracy is also boosted.
Fig.3 shows the output of CNN.
We train the model with the help of 12 epochs in this project. Fig. 3.1 shows the training epochs in the convolutional neural network.

Fig. 3.2 shows that the accuracy and loss during the training stage of the model.

```
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_4 (Conv2D)            (None, 148, 148, 32)      896

activation_5 (Activation)    (None, 148, 148, 32)      0

max_pooling2d_3 (MaxPoolin   (None, 74, 74, 32)        0
g2D)

conv2d_5 (Conv2D)            (None, 72, 72, 32)        9248

activation_6 (Activation)    (None, 72, 72, 32)        0

max_pooling2d_4 (MaxPoolin   (None, 36, 36, 32)        0
g2D)

conv2d_6 (Conv2D)            (None, 34, 34, 64)        18496

activation_7 (Activation)    (None, 34, 34, 64)        0

max_pooling2d_5 (MaxPoolin   (None, 17, 17, 64)        0
g2D)
```

Fig.3. Output of CNN

```
Epoch 1/10
12/12 [==============================] - 16s 938ms/step - loss: 0.6416 - accuracy: 0.5989 - val_loss: 0.6665 - val_accuracy: 0.5842
Epoch 2/10
12/12 [==============================] - 11s 897ms/step - loss: 0.5277 - accuracy: 0.7467 - val_loss: 0.5034 - val_accuracy: 0.7737
Epoch 3/10
12/12 [==============================] - 11s 897ms/step - loss: 0.4325 - accuracy: 0.8034 - val_loss: 0.3476 - val_accuracy: 0.8684
Epoch 4/10
12/12 [==============================] - 11s 924ms/step - loss: 0.3620 - accuracy: 0.8377 - val_loss: 0.2826 - val_accuracy: 0.9105
Epoch 5/10
12/12 [==============================] - 11s 916ms/step - loss: 0.3383 - accuracy: 0.8641 - val_loss: 0.3077 - val_accuracy: 0.8947
Epoch 6/10
12/12 [==============================] - 11s 907ms/step - loss: 0.2982 - accuracy: 0.8799 - val_loss: 0.2546 - val_accuracy: 0.9105
Epoch 7/10
12/12 [==============================] - 11s 907ms/step - loss: 0.2765 - accuracy: 0.8892 - val_loss: 0.2234 - val_accuracy: 0.9211
Epoch 8/10
12/12 [==============================] - 11s 953ms/step - loss: 0.2335 - accuracy: 0.9103 - val_loss: 0.2121 - val_accuracy: 0.9368
Epoch 9/10
12/12 [==============================] - 12s 971ms/step - loss: 0.2397 - accuracy: 0.9103 - val_loss: 0.2098 - val_accuracy: 0.9263
Epoch 10/10
12/12 [==============================] - 11s 941ms/step - loss: 0.1777 - accuracy: 0.9406 - val_loss: 0.1890 - val_accuracy: 0.9368
```

Fig. 3.1. Epochs

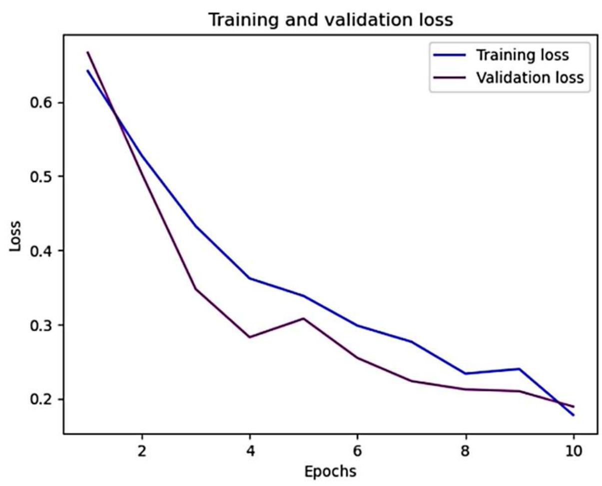

Fig.3.2. Graph for Loss

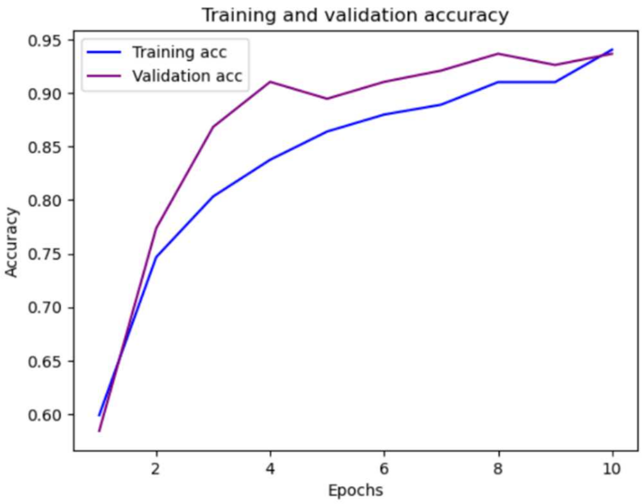

Fig.3.2. Graph for Accuracy

The accuracy score of Convolutional neural network (CNN) is 93%. And other evaluation metrices are calculated such as recall, precision and so on.

SUPPORT VECTOR MACHINE (SVM)

We use another classification algorithm in this project which is support vector machine (SVM). This algorithm is used to classifies whether the patients is affected by brain tumor or not from the given input image dataset.
This algorithm gives the accuracy score of 83%. Fig. 4 shows the evaluation metrices of the support vector machine (SVM) algorithm. These metrices are used to study the overall performances of the model.

	precision	recall	f1-score	support
0	0.78	0.93	0.85	95
1	0.91	0.74	0.81	95
accuracy			0.83	190
macro avg	0.84	0.83	0.83	190
weighted avg	0.84	0.83	0.83	190

Fig.4. Evaluation metrices of SVM

TABLE.1. EVALUATION METRICES COMPARISON TABLE

Evaluation metrices	**Convolutional neural network**	**Support vector machine**
Accuracy score	93%	83%
Precision	0- 0.84 1- 0.96	0- 0.78 1- 0.91
Recall	0- 0.88 1- 0.95	0- 0.93 1- 0.74
F1-score	0-0.952 1-0.924	0- 0.85 1-0.81

The TABLE. 1 shows that the value of different evaluation metrices of Convolutional neural network and the support vector machine algorithms.

V. CONCLUSION

Brain is the most important part of the body hence it is very important to take care of it, so we need to take proper care of it this paper involves in prediction of tumor in human brain with the help of powerful machine learning and deep learning techniques .At first the quality of the data should need to be high for medical images because it decides the life of the human beings therefore the data used in this are MRI images which consists of both the tumor and the normal brain from different viewpoints for better prediction of the tumor in the brain these images are preprocessed and resized the preprocessing technique used is minmax scalar available in scikit library and the images are resized with the help of CV2 package for maintaining uniform size for all the training, testing and validation images then the noises are removed from the image to lower the SNR ratio and get a less noise images after the preprocessing the images are converted into multidimensional NumPy array for the model to learn from it, in this there are two models used such as CNN and SVM for prediction and the CNN is built by adding multiple layers to it and making it efficient in learning by specifying activation and dropouts and other hyper parameters of the model and then the model is used to predict the results with the test dataset and these predictions and the actual results are compared with the scikit metrics such as classification report which gives the recall,f1score,accuracy and support by this the accuracy of the CNN model is 93% and the same dataset after the same preprocessing is given to the SVM model for learning and it is tested with classification report to see its performance and it has an accuracy of 83% and other metrics also shows less performance by SVM model by this we can see that the CNN model has performed better on the data available than that of SVM model. The preprocessed data can be feed into multiple deep learning model, and it can be evaluated and tested for any improvement in the precision and other performance metrics There is a possibility to find a better performing model

REFERENCES

[1] N.Gordilloo, E. Montseny, P. Sobrevilla, “State of the art survey on MRI brain tumour segmentation”, Magn. Reson. Imaging (2013).
[2] S.R.Telrandhe, A.Pimpalkar, A.Kendhe, “Detection of brain tumor from MRI images by using segmentation and SVM” in IEEE WCTFTR World Conf. Futur. Trends. Res. Innov. Soc. Welf. (2016)
[3] S.Cha, “Update on brain tumor imaging: from anatomy to physiology”, American journal of meuroradiology, (2006)

[30] Hany Kasban, Mohsen El-bendary, Dina Salama, "A comparative study of medical imaging techniques" International J. Inf. Sci. Intell. System (2015).
[4] V.K.Gunjan, P.S.Prasad, S.Mukherjee, "Biometric template protection schema-cancelable biometrics" Proceedings of the 2nd Internationall Conference on Communication and Cyber Physical Engineering ICCCE (2019)
[5] P. Shanthakumar, P. Ganesh Kumar, "Computer aided brain tumor detection system using watershed segmentation techniques", Int. J. Imaging Syst. Technol. (2015)
[6] G.Litjens, T. Kooi, B.E.Bejnordi et al, " A survey on deep learning in medical image analysis" in Medical image Analysis vol.42(2017)
[7] J.G and H.Inbarani, "Hybrid Tolerance Rough Set-FireFly Based Supervised Feature Selection for MRi Brain Tumor Image Classification" in Appl. Soft. Comput. J. (2016)
[8] M.Gubrina, M.Lascu, D.Lascu, "Tumor detection and classification of MRI brain image using different wavelet transforms and support vector machine" ,the International Conference for Telecommunication and Signal Processing(2019).
[9] D. Surya Prabha, J. Satheesh Kumar, "Performance evaluation of image segmentation using objective methods" by in Indian J. Science and Technology (2016)
[10] D.N.Louis , H.Ohgaki, O.D. Wiestler et al, "The 2007 WHO classification of tumours of the central nervous system" in Acta Neuropathologica (2007)
[11] E.I. Zacharaki, S.Wang, S.Chawla et al, "Classification of brain tumor type and grade using MRI texture and shape in a machine learning scheme". In Magnetic Resonance in Medicine (2009).
[12] "An Intelligent System for Early Assessment and Classification of Brain Tumor" by T.Keerthana, S.Xavier in Proc. Int. Conf. Inven. Commun. Comput. Technol(2018)
[13] S.Harish, G.F.A.Ahammad, R.Banu, "An extensive research survey on brain MRI enhancements, segmentation and classification" in Int. Conf. Electr. Electron. Commun. Comput. Technol. Optim. Tech. ICEECCOT (2017)
[14] P.Praveen, "Detection of brain tumor in MRI images using combination of fuzzy c-means and SVM" in Proceedings of the 2nd International Conference on Signal Processing and Integrated Networks (2015)
[15]G.SuryaNarayana, K.Kolli, M.D.Ansari and V.K.Gunjan "A traditional analysis for efficient data mining with integrated association mining into regression techniques" in the Proceedings of the 3trd International Conference on Communication and Cyber Physical Engineering ICCCE (2021)
[16 T.Saba, A.Sameh Mohamed, M.El-Affendi, J.Amin, M.Sharif] "Brain Tumor detection using fusion of hand crafted and deep learning features" Cognitive Systems Research, volume 59 (2020)
[17]M.Al-Ayyoub, G.Husari, O.Darwish, A.Alabed ,"Machine Learning approach for brain tumor detection" in Proceedings of the 3rd International Conference on Information and Communication Systems(2014)
[18] P.Thejaswini, M.B.Bhat, M.K.Prakash "Detection and classification of tumor in brain MRI" in International Journal of Engineering and Manufacturing (2019)
[19] G.Shobana,l R.Balakrishanan, "Brain tumor diagnosis from MRI feature analysis- a comparative study" in International Conference Innovation Information Embedded Communication Systems (2015)
[20] S.Maqsood, R.Damasevicius, F.M.Shah, "An efficient approach for the detection of brain tumor using fuzzy logic and U-NET CNN classification" in International Conference on Computational Science and its Applications (2021)
[21]C.Narmatha , Eijack S.M., A.A.R.M.Tuka, S.Manimurugan, M.Mustafa, "A hybrid fuzzy brain-storm optimization algorithm for the classification of brain tumor MRI images" in J.Ambient Intell. Humaniz. Comput (2020)
[22]S.Ahuja, B.K. Panigrahi, T.K.Gandhi "Enhanced performance of Dark-Nets for brain tumor classification and segmentation using colormap-based superpixel techniques" in Mach. Learn. Appl (2022)
[23] Bodapati J.D., Shaik N.S., Naralasetti V., Mundukur N.B., "Joint tarining of two channel deep neural network for brain tumor classification" in Signal Image Video Process (2020)
[24] Deepak S, Ameer P.M, "Brain tumor classification using deep CNN features via transfer learning". in Comput. Biol. Med (2019).