JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

# Brain Tumor Detection Using Machine Learning Approach

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## ABSTRACT

These days, Brain tumor detection has become up as a fashionable causality inside the realm of fitness care. A brain tumor happens while extraordinary cells form inside the brain this is there is no control over the growth of the cells. The manner of photograph segmentation is adopted for extracting odd tumor area within the brain. In the MRI (magnetic resonance imaging), segmentation of brain tissue holds very significant for you to identify the presence of outlines concerning the mind tumor. With appropriate use of accurate data mining class strategies, early prediction of any sickness may be correctly done. Inside the clinical area, the techniques of ML (gadget studying) and statistics mining holds a enormous stand. Majority of which is adopted efficiently. The studies examine listing of risk elements which might be being traced out in mind tumor surveillance systems. Additionally, the technique proposed assures to be especially efficient and particular for mind tumor detection, class and segmentation. To reap this specific automated or semiautomatic strategies are needed. The studies propose an automated segmentation technique that is based upon CNN (convolution neural networks). With the aid of incorporating this unmarried technique, segmentation and category is accomplished. CNN (an ML technique) from NN (neural networks) wherein in it has layered based for outcomes type. Various levels worried in the proposed mechanisms. Through using the DM (data mining) techniques, huge family members and patterns from the records may be extracted. The strategies of ml (system getting to know) and facts mining are being successfully employed for mind tumor detection and prevention at an early level. This neural network offers us the chance of the way likely the lifestyles of tumor within the brain, and had skilled over magnetic resonance snap shots, the diversity of images changed into 1500 healthy brains and 1500 with tumor. The dataset contains of 3000 magnetic resonance images. The version gave us splendid results of predicting the lifestyles of a tumor which reached 95.42% in validation statistics and as much as 93.67% on check information.

**Keywords:** Brain Tumor, Magnetic Resonance Imaging (MRI), Machine Learning, Convolutional Neural Networks (CNN), Brain Tumor Detection, Feature Extraction, Cloud Computing.

## I. INTRODUCTION

A tumor outcomes from an uncontrolled department of atypical cells forming a mass that can forestall the ordinary functionality of the tissue or organ .A brain tumor happens while peculiar cells form in the brain this is there is no control over the increase of the cells. At gift, brain tumors are detected with the aid of imaging handiest after the beginning of neurological signs and symptoms. No early detection techniques are in use, even in people acknowledged to be at hazard for precise forms of brain tumors by means of virtue in their genetic adjustments. MRI imaging is a method that gives accurate pics of the mind and is one of the maximum not unusual and vital strategies for diagnosing and comparing the affected person's brain. Guide mind tumor categories from MR pictures having comparable structures or features is a complex and difficult task, relying on the radiologist's availability and enjoy to understand and diagnose the brain tumor because it should be. Tool reading (ml) is an utility of synthetic intelligence (AI) that offers structures the ability to automatically look at and beautify from revel in without being explicitly programmed. Those are 3 types of system mastering: supervised getting to know, unsupervised mastering, and

reinforcement mastering. In this paper we've constructed below supervised device getting to know. Supervised gaining knowledge of is a subcategory of machine mastering and synthetic intelligence. There are various strategies for brain tumor detection. The work proposes an automated detection technique that relies upon CNN (convolution neural networks) the use of device mastering technique for mind tumor detection. CNN (convolutional. Neural network) or convent is a deep device learning set of rules followed to have a look at the image. It utilizes numerous multilayer perceptions framed to benefit comparatively reduced pre -processing time. The tactics worried within the proposed method being: information collection, preprocessing where in noisy records is removed. Information sets containing MRI brain pictures were accumulated. Images were transformed into wide variety of arrays. Then the pictures will fed to CNN which includes 5 layers the algorithm converts all pics having exceptional translation, scaling, rotation, weight have been transformed into single array. Ultimately when predicted photo is given then it compares the skilled pics and it gives output as sure or no with accuracy in percent.

## II. METHODOLOGY

The study undertakes the task of automatic detection of brain tumors in brain MRI images. The workflow of the proposed technique is illustrated in discern 1. Our proposed approach makes use of CNN architecture as the basis for brain tumor detection using MRI of the brain images. The proposed method consists of several steps. At first, the MRI of the brain images is taken as the input image. Next, data normalization is conducted where image resizing and dilations have been applied dispense with noise. The assembled database of MRI images of the brain is processed. After that the images were resized for the model's input and a pre-trained CNN, CNN is employed to classify the images into two classes of YES and NO. A Convolutional Neural Network (CNN) is a type of artificial neural network used in image recognition and processing that is specifically designed to process pixel data. The database used in this study is composed of images of brain MRI scans. There are a total of 3000 raw images of varying dimensions. The images are collected from Kaggle datasets of Brain MRI Images.
They are in JPG format. The dataset is labeled into two classes of YES and NO based on the presence of tumors.
Overall, there are 1500 images with brain tumors and the remaining 1500 images are of without tumors brains.

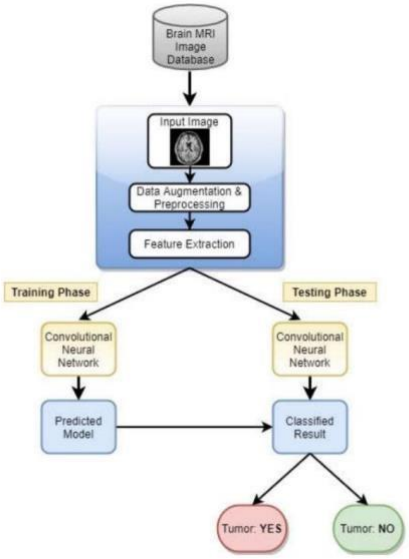
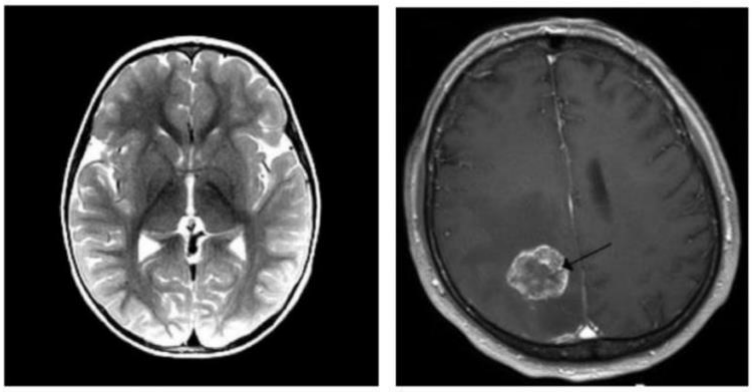



**Figure 1:** The workflow of the proposed method



With tumor without tumor

**Figure 2**

### A. Pre-processing and Removing Noise

Data pre-processing is transforming the normal raw data into an understandable data format. Inconsistent data will cause so many errors. Data pre-processing is a wise method of resolving unwanted errors in the dataset. Because of current noise disturbance the MR images get affected. For noise reduction the research work proposes local smoothing methods and nonlocal mean. Inside the photo there may also exist few extensive structures and details that can act as noise; such form of details are also eliminated. The method of image preprocessing includes records cleaning, statistics transformation, records integration, records resizing, data discount etc. The image pre-processing eliminates unnecessary data and smooth up noisy data, detect and eliminate the outlier and rectify the data inconsistencies. Lastly, normalization and aggregation are performed. The technique of Imageprocessing proves to be highly significant in determining particular MRI image, removing noise and for improvising the quality of the image. Removing the noise from data sets all images having different translation scaling, rotation, and weight were converted into array. Converting Image Pixel Values in to Array, Images are an easier way to represent the working model. In machine studying, python makes use of the picture facts in the format of top, width, and channel format, i.e. Photos are converted into numpy array in height, width, and channel format. Grey scale imaging, in this paper, MR image dataset is used as input. Mainly, this brain MRI is converted to a grayscale image. In this normal MRI is converted into a grayscale image for better accuracy. The grayscale image is basically black and-white image. In the grayscale image, red, green, and blue equally spread. It contains only luminance information and not color information. That is the main reason grayscale imaging method is used. Luminance is extra crucial in distinguishing visual capabilities. To identify important edges or feature grayscale image helps wisely. Resizing the image, in this paper we have used a dataset of images for machine learning training. Each image had a width of 120px and a height of 120px as well. Now, I want to test my machine learning model using images from kaggle.com datasets. The problem is that Kaggle datasets images are larger than training images, and I want to resize them so that their height and width are 120px (just like the images in the training set).

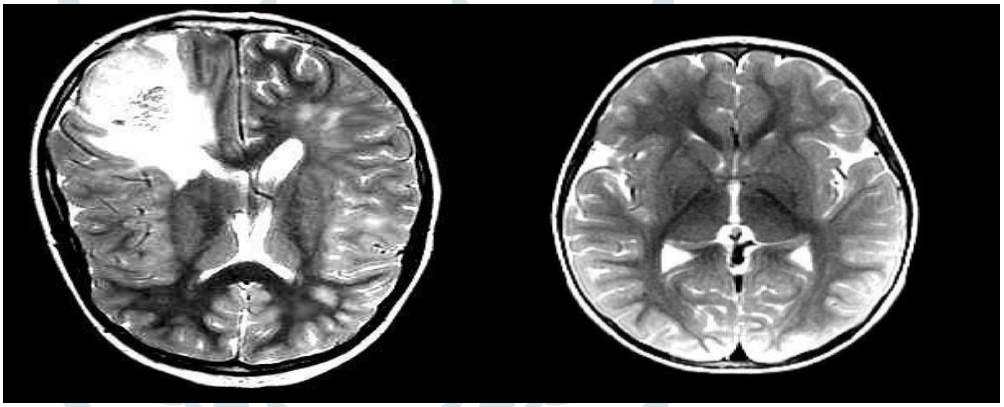


**Figure 3:** Resized Brain MRI images

The images were cropped into (120x120) resized images were appended in to folder and converted every image pixel values in to array.

### B. Convolution Neural Network

Model Building: In this paper TensorFlow is used as the framework of the model, TensorFlow is a free and open source software library for machine learning. It is able to be used throughout a variety of obligations however has a particular focus on schooling and inference of deep neural networks. Tensorflow is a symbolic mathematic library based on dataflow and differentiable programming. From tensorflow.keras.layers we imported Conv2D, Activation, Maxpooling, dropout, flatten, dense. Convolutional neural networks (CNN) are a sort of neural network that may extract essential capabilities from pix, examine the ones capabilities, and classify them appropriately. This lets in CNN to be greater suitable than every other conventional deep learning fashions inside the field of image classification. Convolution Neural Network is mostly used for deep neural networks. This consists of several nonlinear levels of, operation, such as neural networks with many hidden layers. It can view Brain images and frames from the film. The convolution neural networks learn the connections between pixels in the input image by extracting reflective attributes through pooling and convolution methods. The characteristics of every layer utilizing skilled kernels fluctuate in complexity, with easy elements like the edges extracted inside the first layer and high-degree capabilities extracted in the later layers. The pooling layer provides small shift invariance. A computer treats an image as an array of pixels and relies on image resolution wise. Computer will see a height of x width of x dimension image. Each enter image is filtered via a series of layers together with convolution, pooling, and fully linked layers. It makes use of the function softmax to classify items with possibly values among 0 and one.

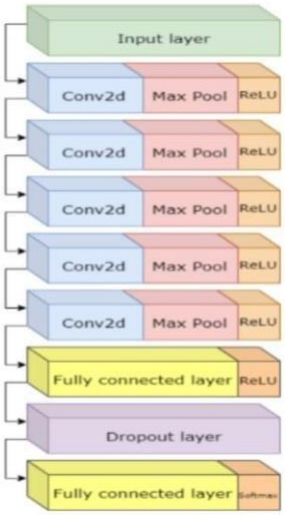



**Figure 4:** shows the architecture of typical CNN

1) Input Layer: The data input corresponding to the CNN model is usually a multi-channel image. Unlike traditional machine, learning methods, for most problems, input can generally be directly input into the CNN network without pre-processing, and achieve better results.

2) Convolution Layer: Convolution is a very common linear operation in signal processing theory. The name of CNN is also derived from this special convolution operation for image signals. The purpose of convolution in CNN is to extract features from images. Convolution operations with convolution kernels of different levels and images can be used to obtain feature descriptions from general to abstract to more advanced, while retaining the spatial relationship between pixels during the extraction process.

3) Activation Layer: The activation layer is an activation function that is concatenated after the convolutional layer. It is precisely because of the features captured by the activation function CNN that the nonlinear description is more prominent. Common activation functions are mainly Sigmoid, ReLu (Rectified Linear Unit), tanh, and so on.

4) Maxpooling Layer: Pooling is a convolutional neural network that is a means of reducing the amount of computation and is an aggregate statistical operation of images. The feature map obtained after the input image passes through the convolution layer, if directly expanded to do classification or other tasks, results in a large amount of calculation. The purpose of the pooling operation is to remove some redundant information and reduce the dimension of the feature map, which can reduce the feature, thereby reducing the amount of calculation, and effectively avoid over-fitting. In addition, the convolutional layer obtains the local features of the upper layer output through local sensing, and the function of adding the pooling layer is to combine these similar local features into more advanced features.

5) Fully Connected Layer: Pooling is a convolutional neural network that is a means of reducing the amount of computation and is an aggregate statistical operation of images. The feature map obtained after the input image passes through the convolution layer, if directly expanded to do classification or other tasks, results in a large amount of calculation. The purpose of the pooling operation is to remove some redundant information and reduce the dimension of the feature map, which can reduce the feature, thereby reducing the amount of calculation, and effectively avoid over-fitting. In addition, the convolutional layer obtains the local features of the upper layer output through local sensing, and the function of adding the pooling layer is to combine these similar local features into more advanced features.

6) Dropout Layer: This layer will drop a certain percentage of the values and weights to avoid ambiguity in the outputs. Dropout layer helps in avoiding over fitting the training data, and it is considered as regularization method that helps in training large amount of training data.

7) Flatten Layer: Flatten is the function that converts the pooled feature map to a single column that is passed to the fully connected layer. Dense provides the completely related layer to the neural network.

8) SoftMax: The SoftMax function is used as the activation function in the output layer of neural network model that predict a multimodal probability distribution. **C. Algorithm for CNN based Classification:**

Step1. Convolution filter is applied in the first layer.

Step2. The filter sensitivity is minimized by smoothing the convolution filter that is by subsampling.

Step3. The activation layer controls the signal transfer from one layer to another layer.

Step4. Training period is being fastened by employing RELU (rectified linear unit).

Step5. The neurons in proceeding layer are associated with each neuron in the next layer.

Step6. At the time of training, Loss layer is appended in the end to provide a feedback to NN (neural network).

Rectified linear units (relu) it's miles utilized in deep neural nets. Currently it's been shown to have six times stepped forward convergence from the characteristic of tanh. Mathematically, Rectified liner units represented as:

Mathematically, ReLU is expressed as, f (x) = max (0, x)

The Fully-Connected layers help in obtaining the feature vectors which are passed to the SoftMax layer of 1000 units for classification. Below equation defines the SoftMax activation function.

$$\sigma(z)_x = \frac{e^{z_x}}{\sum_i^I e^{z_i}}$$

The model has flattened layer, which is followed by densely connected neurons. Some of the perceptron has been dropped off in order to prevent over fitting. The loss function utilized the "binary cross entropy" whereas the optimizer is adaptive learning rate optimization (ADAM).

$$f(x) = \frac{1}{1 + \exp(-x)}$$

### D. Training the model:

Using mobile net neural network architecture we train our model. We find the accuracy score using in-built keras module. We train the model with 50 epochs. We use call-backs to monitor the training.

In our CCN we have used:

- One Input layer.
- Five Convolutional blocks.
- Five Fully-connected layers.
- One Dropout layer.
- One Flatten layer.

We used five Convolutional blocks; we tuned each block to play a different role from the other, making a good, consistence and cohesive CNN. We tuned the number of filters in each Convolutional layer 2D, is as follows:

- Convolutional layer 1: Filter (512 x 512, 5)
- Convolutional layer 1: Filter (256 x 256, 5)
- Convolutional layer 1: Filter (128 x 128, 5)
- Convolutional layer 1: Filter (64 x 64, 5)
- Convolutional layer 1: Filter (32 x 32, 5) **E. Model Summary:**

**Table-1:** Parameters Of Convolution Of Neural Network

| Parameters | Numbers |
|---|---|
| Total parameters | 1574422 |
| Trainable parameters | 1574422 |
| Non-trainable parameters | 0 |

**Table 2:** Sequential

| Layer (type) | Output Shape | Parameters |
|---|---|---|
| conv2d (Conv2D) | (None, 118, 118, 512) | 5120 |
| activation (Activation) | (None, 118, 118, 512) | 0 |
| max_pooling2d (MaxPooling2D) | (None, 59, 59, 512) | 0 |
| conv2d_1 (Conv2D) | (None, 57, 57, 256) | 1179904 |
| activation_1 (Activation) | (None, 57, 57, 256) | 0 |
| max_pooling2d_1 (MaxPooling2 | (None, 28, 28, 256) | 0 |
| conv2d_2 (Conv2D) | (None, 26, 26, 128) | 295040 |
| activation_2 (Activation) | (None, 26, 26, 128) | 0 |
| max_pooling2d_2 (MaxPooling2 | (None, 13, 13, 128) | 0 |
| conv2d_3 (Conv2D) | (None, 11, 11, 64) | 73792 |
| activation_3 (Activation) | (None, 11, 11, 64) | 0 |
| max_pooling2d_3 (MaxPooling2 | (None, 5, 5, 64) | 0 |
| conv2d_4 (Conv2D) | (None, 3, 3, 32) | 18464 |
| activation_4 (Activation) | (None, 3, 3, 32) | 0 |
| max_pooling2d_4 (MaxPooling2 | (None, 1, 1, 32) | 0 |
| flatten (Flatten) | (None, 32) | 0 |
| dense (Dense) | (None, 60) | 1980 |
| dense_1 (Dense) | (None, 2) | 122 |

## III. RESULTS AND DISCUSSION

Since this was a classification task of whether a brain tumor is with or without tumor not based on MRI images, we used some classical tools like accuracy, f-score, recall, accuracy, and confusion matrix to evaluate the model's performance.

**Table 3:** Testing

| Category | | |
|---|---|---|
| | Accuracy | Loss |
| Training | 95.42% | 4.58% |
| Testing | 93.67% | 6.33% |

Accuracy


**Figure 5:** Describes the training pattern of the model, which explains the accuracy of the model.

Loss

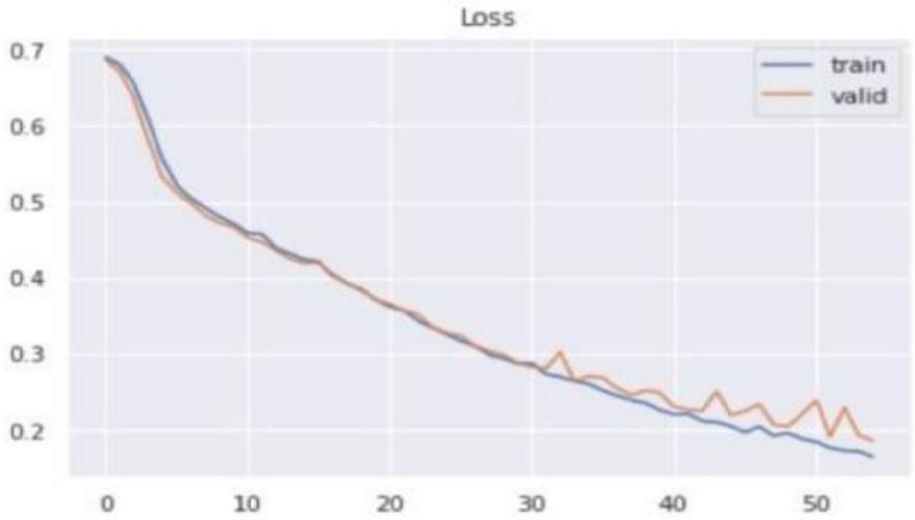



**Figure 6:** Describes the model's training pattern, which explains the model's failure. It is clear that the loss was gradual and not too steep.

**A.** Confusion Matrix

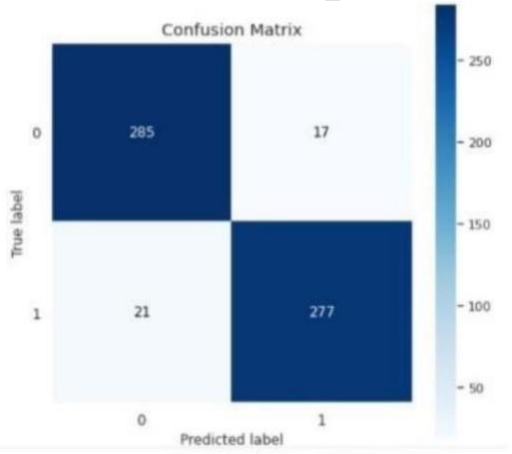



**Figure 7:** confusion matrix

**Table-4:** Testing Evaluations

| | Precision | Recall | F1-score | Support |
|---|---|---|---|---|
| 0 | 0.93 | 0.94 | 0.94 | 302 |
| 1 | 0.94 | 0.93 | 0.94 | 298 |
| accuracy | - | - | 0.94 | 600 |
| Macro avg | 0.94 | 0.94 | 0.94 | 600 |
| Weighted avg | 0.94 | 0.94 | 0.94 | 600 |

**B.** Feature Extraction

In this paper, we used online platform called ngrok.com for the detection of the brain tumor. Firstly Save the model, model is saved in .hdf5 (hierarchical data format version 5). Deploy the model in the cloud, model is deployed in the cloud using ngrok.com; ngrok is a cross platform application that enables developers to expose a local development server to the internet with minimal effort. The software makes your domestically hosted internet server appear to be hosted on a subdomain of ngrok.Com, which means that no public IP or domain call on the local machine is wanted. Create a front-end web page, Server port is connected then URL is generated to web page. Test with real time data by clicking the URL which creates a web page to test the real time data. This is how brain tumor is detected using online cross platform.

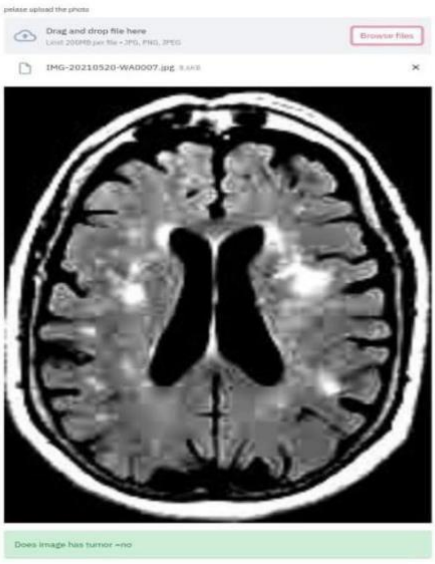


**Figure 8:** Resulted output (Tumor –NO)

**Figure 9:** Resulted output (Tumor –YES)

## IV. CONCLUSION

This paper discussed the application of machine learning models for the detection of brain tumor using magnetic resonance imaging. In this paper, the model achieved the accuracy of 95.42%, with f-score of 94.00%. CNN automatically detects the important features without any human supervision and Very High accuracy in image recognition problems. We can reduce PET scan step for Detection though it produces radiation. And using this method is zero investment. With accuracy 90+ is good prediction. Lots of training data is required which is time consuming. A CNN is significantly slower due to an operation such as Maxpool. If there is a microscopic tumor, the symmetry characteristic will be weakened.

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