

Brain Tumor Detection Using Medical Image Processing and Convolution Neural Network

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Abstract - Medical image processing is that the one among the foremost demanding and promising field nowadays. Tumor is a rapid uncontrolled growth of cell. The tumor is often classified as benign, malignant and premalignant. When a tumor is noticed as malignant then the tumor results in cancer. Earlier stage of tumor is used to be detected manually through observation of image by doctors and it takes more time and sometimes gets inaccurate results. Today different computer added tool is employed in medical field. These tools provide a quick and accurate result. Magnetic Resonance Images (MRI) is the most widely used imaging technique for analyzing internal structure of human body. The MRI is used even in diagnosis of most severe disease of medical science like brain tumors. The brain tumor detection process consist of image processing techniques involves four stages. Image pre-processing, image segmentation, feature extraction, and finally classification. There are several existing of techniques are available for brain tumor segmentation and classification to detect the brain tumor. There are many techniques available presents a study of existing techniques for brain tumor detection and their advantages and limitations. To overcome these limitations, propose a Convolution Neural Network (CNN) based classifier. CNN based classifier does the comparison between trained and test data, from this to get the simplest result.

Keywords: Brain Tumor Detection, CNN, Image Pre-processing.

1. INTRODUCTION

Brain is that the management center within the physical body. It is responsible to execute all activities throughout a large number of connections and a huge number of neurons. Brain tumor is one of the most serious diseases, occurred due to an abnormal growth of cells in the brain, affecting the functions of the nervous system. There are different types of brain tumors which can be either malignant or benign. The early stage of tumor detection depends on the physician's knowledge and experience, making the patients has a chance to recover his life and survival. An automated classification system of brain tumors is an effective tool for supporting the physicians to follow a successful treatment option. Such system uses the images captured by magnetic resonance (MR) imaging devices which are widely used by the radiologists of brain diagnosis.

Malignant brain tumors are usually in the form of blood clots accompanied by fat surrounding it. To detect the location and size of brain tumors required MRI images of brain tumors. MRI images can help differentiate brain tissue, brain tumors, edema, and spinal fluid supported differences in color contrast in each tissue. The problem in radiological remains analyzing the results of MRI brain tumour manually in order that it takes an extended time to seek out out the diagnostic from the doctor. Image processing is a process of analyzing, manipulating a picture so as to perform some operation to extract the knowledge from it. According to world health organization's statistics, cancer is considered as the second leading cause of human fatalities across the world, being responsible for an estimated 9:6 million deaths in this year.

Among different form of cancers, brain tumor is widely seen together of the deadliest cancers because of its aggressive nature, heterogeneous characteristics (types), and low relative survival rate (e.g., in US relative survival rate following a diagnosis of a primary malignant brain tumour is around 35%).

1.1 CNN

Convolutional neural network (CNN, or ConvNet) is type of profound learning and most usually applied to dissecting visual symbolism. CNNs utilize a variety of multilayer perceptron's intended to require negligible pre-processing. They are moreover insinuated as move invariant or space invariant artificial neural network (SIANN), supported their normal burdens structure and translation invariance characteristics.

Convolutional networks were propelled by natural procedures in that the availability design between neurons takes after the association of the creature visual territory. Individual cortical neurons answer stimuli only during a restricted region of the field of vision referred to as the receptive field. The receptive fields of various neurons partially overlap such they cover the whole field of vision. CNNs utilize moderately little pre-preparing contrasted with other image classification algorithm. This implies the system learns the channels that in customary calculations were hand-built. This autonomy from earlier information and human exertion in include configuration might be a significant bit of leeway. They have applications in image and video recognition, recommender systems, image classification, medical image analysis, and tongue processing. A CNN consists of an input and an output layer, also as multiple hidden layers. The hidden layers of a CNN typically contains convolutional layers, pooling layers, fully connected layers and normalization layers.

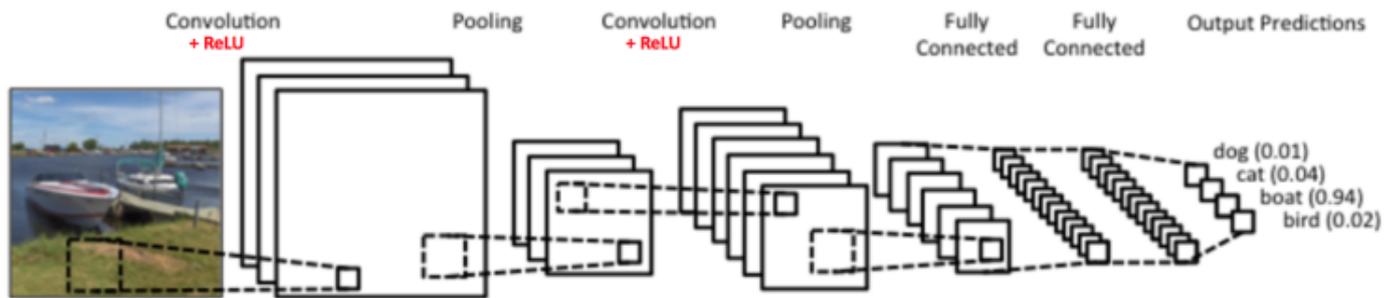


Fig 1. Simple ConvNet.

There are four primary activities in the ConvNet appeared in fig. above:

1. Convolution
2. Non-Linearity (ReLU)
3. Pooling or Sub Sampling
4. Classification (Fully Connected Layer)

The Convolution Step:

The main objective of Convolution is to gather features from the input image. Convolution conserves the spatial relationship within pixels by learning image features using small squares of input data. Here every image can be considered as a matrix of pixel values. Let's consider a 5 x 5 image whose pixel values are only 0 and 1, the 5x5 matrix is a special case where pixel values are 0 and 1.

Also, consider another 3 x 3 matrix as kernel. Then, the Convolution of the 5 x 5 image and the 3 x 3 matrix can be computed as given below:

The output matrix is called Convolved Feature. We slide the orange matrix over our original image by 1 pixel (called 'stride') and for every position, we compute element wise multiplication and add the multiplication outputs to get the final integer which forms a single element of the output matrix.

As an example, consider the following input image: It is evident from the animation above that different values of the filter matrix will produce different Feature Maps for the same input image. As an example, consider the following input image:



Fig 2. Sample Image

In the table below, we will see the consequences of convolution of the above image with different filters. As shown, we will perform operations like Edge Detection, Sharpen and Blur just by changing the numeric values of our filter matrix before the convolution operation– this suggests that different filters can detect different features from a picture, for instance edges, curves etc.

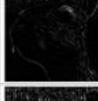
Operation	Filter	Convolved Image
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Edge detection	$\begin{bmatrix} 1 & 0 & -1 \\ 0 & 0 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	
Gaussian blur (approximation)	$\frac{1}{16} \begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$	

Fig 2: convolution Step

The Pooling Step:

Spatial Pooling reduces the dimensionality of each feature map but keeps the important information. Spatial Pooling are of numerous types like Average, Sum, Max etc.

In Max Pooling, we need to define a spatial neighborhood and take the largest element from the corrected feature map within that window. Instead of taking the largest element we could also take the average or sum of all elements in that window. In practice, Max Pooling has been shown to figure better.

Shows an example of Max Pooling operation on a Rectified Feature map (obtained after convolution + ReLU operation) by employing a 2x2 window.

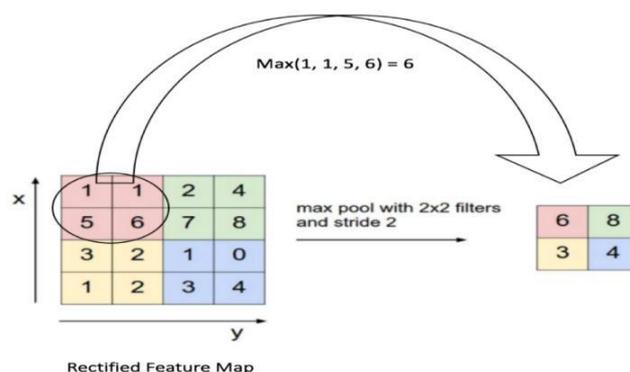


Fig 3: Pooling Step

1.2 SVM

Support Vector Machines (SVMs) square measure supervised learning models with associated learning algorithms that analyze knowledge used for classification and statistical procedure. Given a gaggle of coaching examples, each marked as belonging to a minimum of 1 or the opposite of two categories, an SVM training algorithm builds a model that assigns new examples to a minimum of 1 category or the opposite, making it a non-probabilistic binary linear classifier (although methods like Platt scaling exist to use SVM during a probabilistic classification setting). An SVM model could even be a representation of the examples as points in space, mapped so as that the samples of the separate categories are divided by a transparent gap that's as wide as possible. New examples are then mapped into that very same space and predicted to belong to a category supported the side of the gap on which they fall.

3. PROPOSED SYSTEM

As per literature survey, it had been found that automated brain tumour detection is extremely necessary as high accuracy is required when human life is involved. Automated detection of tumor in MR images involves feature extraction and classification using machine learning algorithm. Our approach consists of three steps: (A) Brain image pre-processing, (B) Brain feature extraction, and (C) brain tumour classification. The input of the approach is that the brain images and therefore the output are the respective sort of the brain tumour. The small print of the steps of our proposed approach are described within the subsections below. during this paper, a system to automatically detect tumor in MR images is proposed as shown in figure 3.

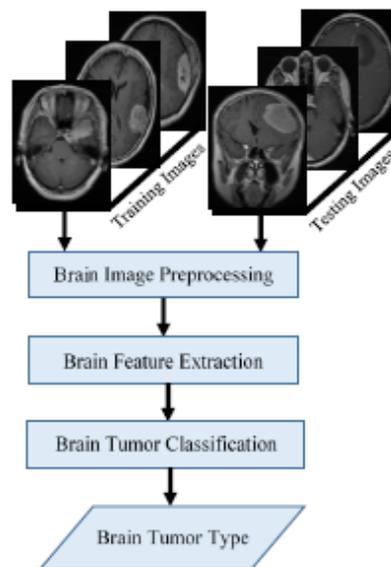


Fig 5. Proposed System

A. Image Pre-processing

Pre-preparing might be a typical name for activities with pictures at absolute bottom degree of deliberation both info and yield are intensity images.

The purpose of pre-handling with is an improvement of the picture data that smothers unfortunate curves or redesigns some picture features huge for extra handling. The reason for picture preparing is separated into 5 gatherings.

They are:

a. Gray Scale

Grayscale picture otherwise called highly contrasting picture is the one wherein every pixel of the picture conveys power data. Dim scale picture has just two hues: Black and white. The changed over grayscale picture may lose contrasts, sharpness, shadow, and structure of the shading picture. The luminance of a pixel estimation of a grayscale picture ranges from 0 to 255.

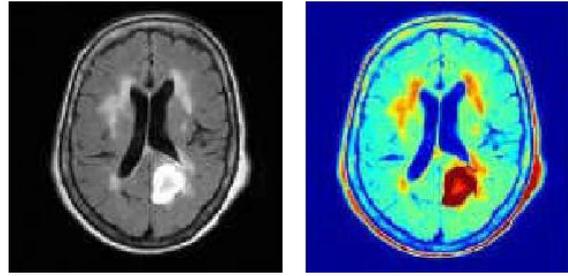


Fig 6.Gray Scale Image

b. Smoothing

The low-pass filters for the most part utilize moving window administrator which influences each pixel of the picture in turn, changing its incentive by some capacity of a local region (window) of pixels. The administrator moves over the picture to influence all the pixels in the picture. The operator moves over the image to affect all the pixels in the image.

c. Edge Detection

Watchful edge recognition is a used to remove valuable basic data from various articles and lessen the measure of information to be handled. The general criteria for edge recognition incorporate: -

1. Detection of edge with low blunder rate, which implies that the discovery ought to precisely get however many edges appeared in the picture as could reasonably be expected.
2. The edge point identified from the administrator ought to precisely confine on the focal point of the edge.
3. A given edge in the picture should just be checked once, and where conceivable, picture clamour ought not make bogus edges.

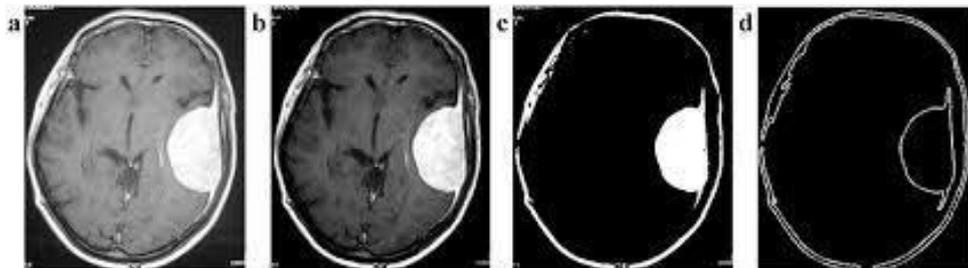
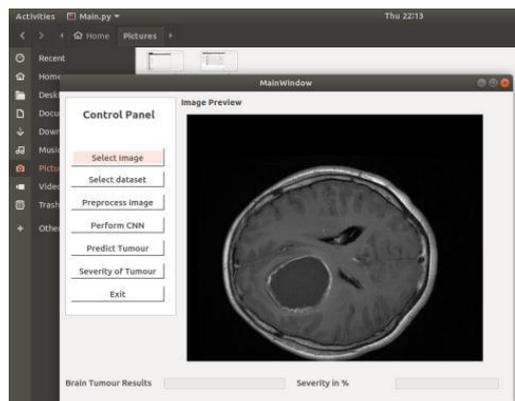


Fig 7. Edge Detection

4. IMPLEMENTATION AND RESULT

In the proposed system, we will be using supervised CNN approach which further will improve the accuracy of the prediction. CNN is proved for better accuracies with supporting to the deep learning methods.



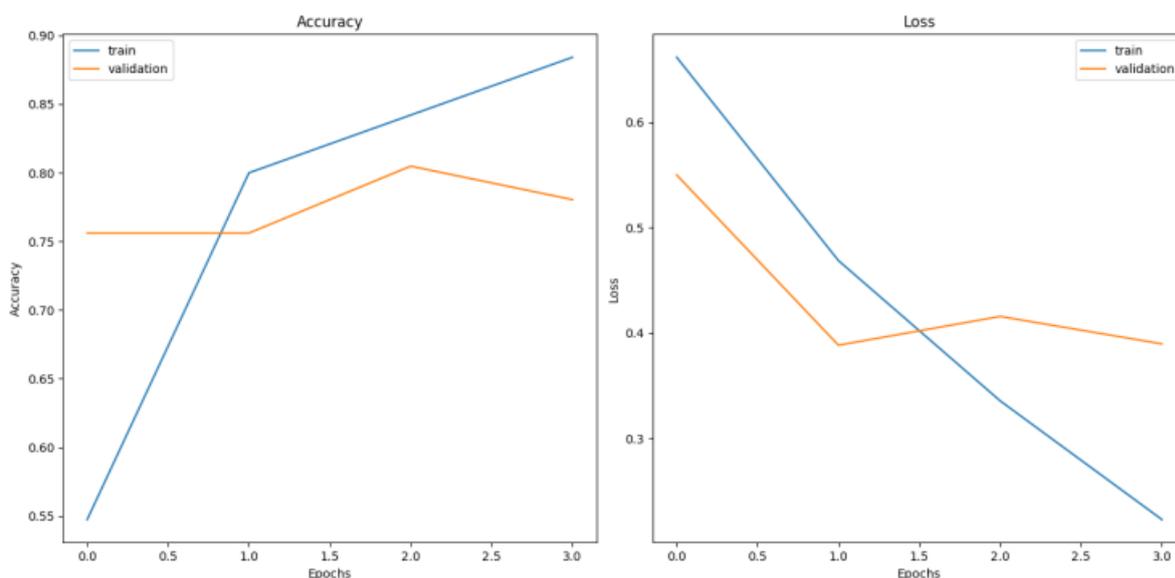
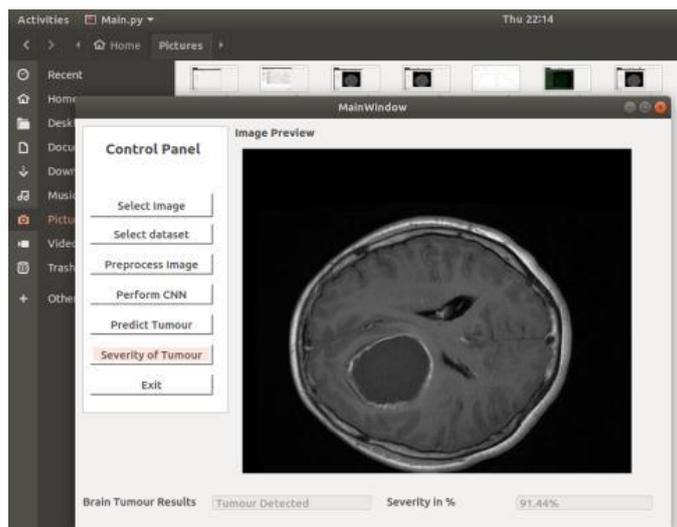


Fig 8: Test results output

It is also complemented with the light weight library in python for image processing as OpenCV which help us to classify the image and improves the speed of execution. System has used various parameters for classification between normal and tumorous brain.

5. CONCLUSION

In summary, we propose a CNN-based method for segmentation of brain tumors in MRI images. There are several existing techniques are available for brain tumor segmentation and classification to detect the brain tumor. There are many techniques available presents a study of existing techniques for brain tumor detection and their advantages and limitations. To overcome these limitations, propose a Convolution Neural Network (CNN) based classifier. CNN based classifier used to compare the trained and test data, from this get the best result.

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