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Machine Learning Based Brain Tumor Detection

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Abstract: *The brain tumors, are the most common and aggressive disease and it is challenging task to detect brain tumor in early stages of life, it leads to a very short life expectancy in their highest grade. Thus, treatment planning will be a key stage to improve the quality of life of patients. To evaluate the tumor in a brain used various image techniques such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and ultrasound image etc. Mostly, in this work MRI images are used to diagnose tumor in the brain. The huge amount of data generated by MRI scan that helps to classify tumor vs non-tumor in a particular time. But it having some limitation (i.e.) accurate quantitative measurements will be provided for limited number of images. To prevent death rate of human trusted and automatic classification scheme are essential. The automatic brain tumor classification will be very challenging task in large spatial and structural variability of surrounding region of brain tumor. In this work, automatic brain tumor detection will be proposed by using Convolutional Neural Networks (CNN) classification. The deeper architecture design will be performed by using small kernels. The weight of the neuron will be given as small.*

Key Word*: Neural Networks, MRI, Brain Image, CNN, Tumors.*

I. Introduction

The brain tumor is a massive or abnormal cell growth in a brain region. This can spread to any person among different ages. A brain tumor can be classified into different types; these tumors can either be Malignant (cancerous) or Benign (non-cancerous). The tumor that initially affects the brain is termed as the primary tumors whereas the tumors present in the other part of the body that might spread to the brain are known as the secondary tumors or metastatic tumors. It is estimated that in the United States in the year 2018 the statics states that approximately around 78,990 newer victims of primary tumors, (Benign)non-malignant tumors and other distinct tumors of the central nervous system are diagnosed. The brain abnormalities such as injuries, damages, tumors related causes, affects and symptoms are analyzed for recognizing the tumors by using the different image processing, data mining and machine learning techniques .Brain MRI image will mainly used to detect the tumor and tumor progress modeling process. This information will mainly used for tumor detection and treatment processes. MRI image gives more information about given medical image than the CT or ultrasound image. MRI image provides detailed information about brain structure and anomaly detection in brain tissue.

(NN) and Support Vector Machine (SVM) are the usually used methods for their good enactment over the most recent few years. In machine learning as the subterranean architecture can efficiently represent complex relationships without needing a large number of nodes like in the superficial architectures.

II. Material and Methods

Convolutional Neural Network is broadly used in the field of Medical image processing. Over the years lots of researchers tried to build a model which can detect the tumor more efficiently. We tried to come up with an exemplary which can accurately classify the tumor from 2D Brain MRI images. A fully-connected neural network can detect the tumor, but because of parameter sharing and sparsity of connection, we adopted CNN for our model.

Study Design: Prospective open label observational study

Study Duration: October 2020 to April 2021

Sample images: 50 to 100

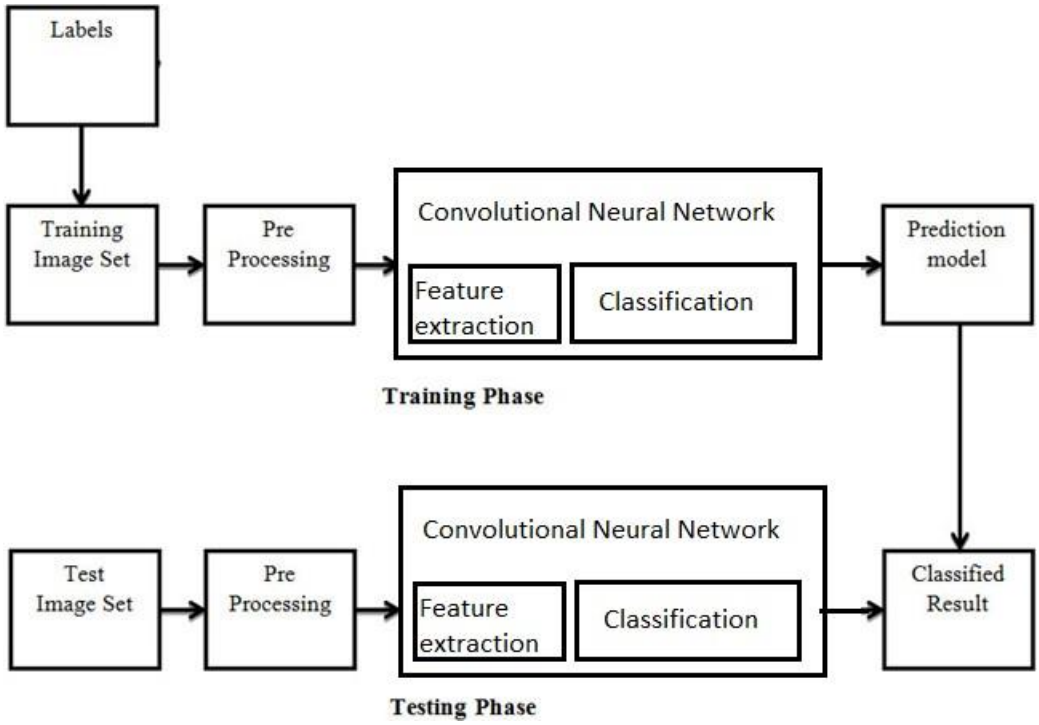
III. Procedure methodology

The main objective of this project is to make a software that can detect brain tumor from the MRI images.

The system consists of the following components: The human brain will be modeled by using design and implementation of neural network. For vector quantization, approximation, pattern matching, optimization functions and classification techniques for this neural network will be used. The neural network will be divided into three types based on their interconnections so these three types neural networks are feedback, feed forward and recurrent network. The Feed Forward Neural network will be further divided into single layer network and multilayer network. In the single layer network, the hidden layer will be not presented. But it contains only input and output layer. The multilayer consists of input layer, hidden layer and output layer. The closed loop based feedback network will be called as recurrent network

In the normal neural network, image cannot scalable. But in convolution neural network, image can scalable (i. e) it will take 3D input volume to 3D output volume (length, width, height).The Convolution Neural Network (CNN) consist of input layer, convolution layer, Rectified Linear Unit (ReLU) layer, pooling layer and fully connected layer. In the convolution layer, the given input image will be separated into various small regions. Element will be activation function will be carried out in ReLU layer. However, the pooling layer will be mainly used for down sampling. In the final layer (i. e) fully connected layer will be used to generate the class score or label score value based on the probability in between 0 to1.

Figure No 1: Block diagram of brain tumor classification based on convolution neural network.



The CNN based brain tumor classification will be divided into two phases such as training and testing phases. The number of images will be divided into different category by using labels name such as tumor and non-tumor brain image… etc. In the training phase, preprocessing, feature exaction and classification with Loss function will be performed to make a prediction model. Initially, label the training image set. In the preprocessing image resizing will be applied to change size of the image. Finally, the convolution neural network will be used for automatic brain tumor classification. The brain image dataset will be taken from image net. Image net will be a one of the pre- trained model. If you want to train from the starting layer, have to train the entire layer (i. e) up to ending layer. So time consumption will be very high. It will affect the performance. To avoid this kind of problem, pre-trained model based brain dataset will be used for classification steps.

Algorithm for CNN based Classification:

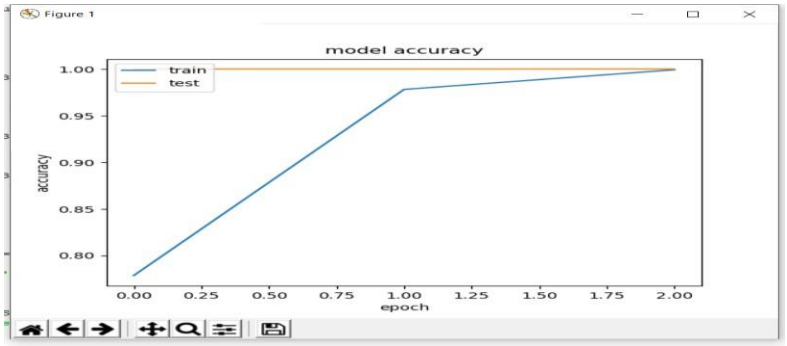
1) Apply convolution filter in first layer.
2) The sensitivity of filter is reduced by smoothing the convolution filter (i.e.) subsampling
3) Activation layer transfers the signal from one layer to another layer.
4) Fasten the training period by using rectified linear unit (RELU)
5) The neurons in proceeding layer is connected to every neuron in subsequent layer
6) During training Loss layer is added at the end to give a feedback to neural network.

IV. Statistical analysis

Classifier classifies input images as normal or infected with brain tumor. For training 20 images and for testing 6 images are used. Then applied 03 convolutional layers, 03 times Relu, 02 times pooling layers. For each iterations we take 10 epoch, steps per epoch was 800,validation steps were 6500.So it takes 3 hours to complete the task and shows the accuracy Fig.2 and loss Fig.3 graph. So we get results as training accuracy 90% and testing accuracy 100%. Validation loss 5.7916`-06 classification will be performed by using convolutional neural network (CNN), texture and shape feature extraction.

V. Result

Figure No 2: Result of Tumor Detection System



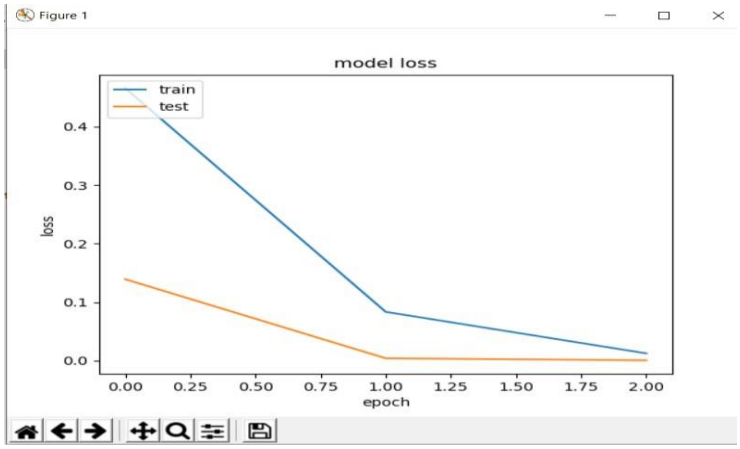


Table No 1: CNN Model

No. of convolution Layer	03
No. of Relu	03
No. of Pooling	03
No. of Classes	02
Total Epoch	10
Steps Per Epoch	800
Validation Steps	6500
Training Images	20
Testing Images	06
Training Time	3 Hours
Training Accuracy	90%
Testing Accuracy	100%
Validation Loss	5.796-06

Software Platform : Python Ide
Language: Python

4.1 Python:
Python is a general-purpose language. It has wide range of applications from Web development, scientific and mathematical computing to desktop graphical user Interfaces. The syntax of the language is clean and length of the code is relatively short to work in Python because it allows you to think about the problem rather than focusing on the syntax

VI. Discussion

Convolutional Layer:

Convolution is the first layer to extract features from an input image. Convolution preserves the relationship between pixels by learning image features using small squares of input data. It is a mathematical operation that takes two inputs such as image matrix.

Non Linearity (ReLU):
ReLU stands for Rectified Linear Unit for a non-linear operation. The output is $f(x) = \max(0,x)$. ReLU's purpose is to introduce non-linearity in our ConvNet. Since, the real world data would want our ConvNet to learn would be non-negative linear values

Pooling Layer:

- Pooling layers section would reduce the number of parameters when the images are too large. Spatial pooling also called subsampling or down sampling which reduces the dimensionality of each map but retains important information. Spatial pooling can be of different types:
- Max Pooling
- Average Pooling

- Sum Pooling

Fully Connected Layer:

- The layer we call as FC layer, we flattened our matrix into vector and feed it into a fully connected layer like a neural network

VII. Conclusion

The main goal of this project is to design efficient automatic brain tumor classification with high accuracy, performance. In the conventional brain tumor classification will be performed by using convolutional neural. Also the classification results are given as tumor or normal brain images. python language is used for implementation.

Image net database will be used for classification

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