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Survey on Tumor Detection towards Neural Network

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***Abstract*—Brain tumor is a mass of unusual cells in brain. The advancement in applied science and machine learning can help out medical specialists in brain tumor recognition. Magnetic Resonance Image classification is the best way to detect tumor in brain. MRI scans use secure magnetic field and radio wave to get images of brains. After that, separation of tumor is important. This project will be particularly using Convolutional Neural Network (CNN) model to detect whether a subject has brain tumor or not from his/her MRI scans. The procedure will be as follows: collection of data, data pre-processing, development of a neural network model, and model training and testing. Generally CNN offers quite high accuracy i.e. up to 88 percent; also the error rate of CNN is quite low.**

***Index Terms*— Tumor Detection, Convolutional Neural Network, Machine Learning, Magnetic Resonance Imaging and Brain Tumor.**

I. INTRODUCTION

Brain tumor is a threatening disease. It is a group of unusual cells formed in brains. Numerous dissimilar kinds of brain tumor subsist. Several are cancerous while the others are non-cancerous. Noncancerous do not spread out of the brain while cancerous spread rapidly in the body and can lead to death [19]. Brain tumor symptoms depend upon the size, area and the kind of tumor. The common symptoms are: facing trouble in walking and balancing, headache, vomiting and nausea [8]. Brain tumor detachment using Magnetic Resonance Imaging (MRI) is the greatest research area because of its extreme resolution and very fine standard of images [17]. Fig. 1 shows that the manual identification of tumor from MRI scans is a time-taking and tedious task and an automated system needs to be developed which can reduce the overhead and is efficient.Convolutional Neural Network (CNN) method is used in this research. CNN is a category of deep neural networks and mostly applied to study visual imagery. CNN image categorization extracts an input scan, exercises it and then arranges it [20]. The self-determination from earlier understanding and human attempt in characteristic design is an utmost advantage of CNN.

II. LITERATURE SURVEY

Machine Learning is an understudy of artificial intelligence. The primary steps are as follows: the necessary algorithms and data must be given to the system and then the analysis rules must be defined for the recognition of patterns in data [14]. On the completion of these two steps, following tasks are performed: Unearthing, extricate and recapitulate linked data; Making prognosis on the base of reasoning data; Consideration of probabilities for specific results; Accustom to certain improvements separately; Revamping processes based on perceived design s [10]. Image pre-processing is a process to execute some transactions on an image, to get a

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heightened vision, or to elicit some useful erudition from it. In this, image is input while component related to the particular image is output [3]. It includes the following three steps: Introducing the image via image procurement tools; Classifying and shaping the image; Output in which outcomes can be reconstructed picture or record that is based on concept interpretation. The art used to synthetically enlarge the size of a training dataset by establishing altered renditions of images in the dataset is known as Image augmentation [7]. It adjoins extra modification to the training dataset.

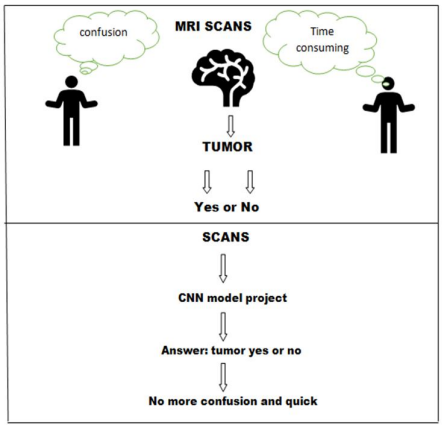

Figure 1. Need of an effiecient automated system because manual system is time consuming and confusing

A series of algorithms that try to acknowledge fundamental correlation in a set of data through a method that impersonates the way human brain work is known as neural network [12]. Neural networks can accommodate to swapping input; so the system makes the outstanding possible outcome without needing to refurbish the output criteria [4].

There are numerous neural network models which can be used in the detection of tumor from brain MRI images. Table I gives the major subject used in each algorithm while below is the description of them:

A. Local Independent Projection-based Classification (LIPC)

The brain voxel classification and path feature extraction is also done using the LIPC technique [13]. The downside of this scheme is low efficiency.

B. Fuzzy C-Means (FCM)

In this method, with the help of multilevel Discrete Wavelet Transform (DWT), wavelet feature is extracted [6]. The disadvantages of the technique are high complexity and poor performance.

C. Cellular Automata (CA)

It is a seeded tumor segmentation method composed of innovative techniques [1]. Both the complexity as well as the accuracy of this method is low.

D. Bio-Physiomechanical Growth Modeling

This technique is applied to breakdown the vital tumor mass impact for gliomas and solid tumor with distinct margins. The disadvantage associated with this technique is its high computation time [5].

E. Multimodal Segmentation

This method introduces a new technique for segmentation of brain tumor combining older techniques. This is done to increase model performance than the existing ones [11]. A harm of this model is high complexity.

F. Multi Feature Extraction

Techniques namely multi-fractal feature extraction and AdaBoost classification schemes are taken to perform detection and segmentation of brain tumor [18]. The complexity of multi feature extraction is high.

G. Fuzzy Interference System (FIS)

FIS is a fuzzy-based approach. It is specific for tumor segmentation and falls under supervised learning [2]. A fuzzy controller membership function is built in this system. FIS has low efficiency but great performance.

H. Support Vector Machine (SVM)

SVM settles into supervised learning category. It maximizes the margin around the separating hyperplane [9]. The efficiency of SVM is in just four to five rounds is higher than traditional methods.

TABLE I. DIFFERENT ALGORITHMS AND THE SUBJECT USED IN THEM

S.No.	Algorithms	Subject Used
1	Local Independent Project based Classification	Softmax Regression
2	Fuzzy C-Means	Clustering, Cluster Analysis
3	Cellular Automata	Automata Theory
4	Bio-Physiomechanical Growth Modeling	Growth Kinetics
5	Multimodal Segmentation	Supervised Multimodal Image Analysis
6	Multi Feature Extraction	Artificial Intelligence Big Data Detection
7	Fuzzy Interference System	Artificial Neural Network
8	Support Vector Machine	Supervised Machine Learning

III. METHODOLOGY

Fig. 2 describes the implementation using a flowchart. Each step is described below in detail:

A. Setting up environment

This step includes importing the required libraries such as NumPy, cv2, Tensorflow, Keras, sklearn etc. It also involves the collection of images of MRI scans from different sources and storing them in a dataset. The dataset will contain two folders – Yes and No. The first one will contain images that have a tumor and the second without a tumor. The dataset will then be imported. Required arrays and classes will be declared. Input to the arrays is given. This dataset is now ready for further implementation.

B. Data Splitting

Now the dataset is categorized into training, validation, and test sets. This makes the data easier to pre-process. The data is split in the following way: 70% for the training set, 15% for validation, and the rest 15% for testing. Hyperparameters are adjusted using the validation test during model training.

C. Data pre-processing

1. Data Augmentation

Data augmentation is a technique that helps practitioners to increase the size of the data significantly without collecting new data. It is done to increase the size of dataset taken. This also tackles the problem of data imbalance. This step is essential because it will spare the dataset from over-fitting to the model.

2. Image Resizing

a. Crop out the brain part

In this, the brain part is cropped out by finding the extreme points. Cropping can be done by finding the extreme right, left, top, and bottom points. OpenCV helps in finding the extreme points of the contours.

b. Resize the images

The images are then resized to width = 240, height = 240 and channels = 3. Since all the images available in the dataset are of different sizes, this is done so that all the images get into the same shape before feeding them to the neural network.

D. Model building:

Here, a neural network CNN model for Tumor Detection from Brain MRI Images will be developed. Each image with shape (240, 240, 3) is fed into the neural network. It will go through the following layers:

1. Zero padding layers (pool size = 2, 2):

By this technique, the original input size of the images is preserved. This will add a type of padding around the image containing all zeroes i.e., it is helpful in adding rows and columns at the left, right, top, and bottom of zeroes in an image.

2. Convolutional layer (filters = 32, filter size = (7, 7) and stride = 1):

The Convolutional layer has a set of parameters that contain kernels or learnable filters. The kernels have a short receptive field. In spite of being small, the kernel can extend to the input volume's full length.

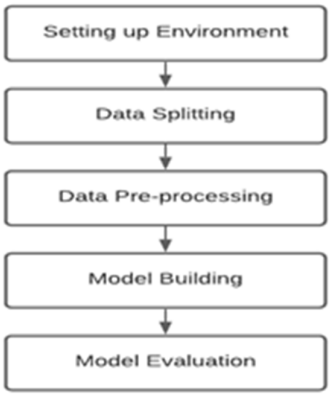

Figure 2. Flowchart representing all the steps of the project

3. Batch normalization layer

The purpose of this layer is to normalize the pixel values and increase the speed of computation. Batch normalization is a method that is used to make neural networks more stable and fast. In this layer, the input layer is re-centered and re-scaled.

4. ReLU activation layer

The Rectified Linear Unit layer is the most common action function deployed in CNN neurons' output. It is a linear function which will directly display the positive input else it will return a zero.

5. Max pooling layer (filter = 4, stride = 4)

The pooling operation which selects maximum elements from a feature map region is known as Max pooling. It outputs a feature map that contains the previous feature map's most prominent features. This layer is applied twice to reduce the computation cost.

6. Flatten layer

The Flatten layer is always applied between the Convolutional and fully connected layers. This layer is applied in order to convert the 3-D matrix into a 1-D vector. This is done so that the vector can now be fed to the fully connected layer.

8. Dense fully connected layers

This is the layer where the inputs taken from a layer are then connected to each activation unit of the next layer. This includes sigmoid activation. They compile the extracted previous units' data into a single output.

F. Model evaluation

In the last step, testing will be performed on the model. The accuracy and f1 score of the model is calculated to test the efficiency. The efficiency of the model came out to be as follows: approx 89% accuracy and f1 score = 0.88 as per the test set, while the validation set got an accuracy of 91% and 0.91 f1 score.

IV. CHALLENGES

To create an efficient system for tumor detection that gives minimum error and maximum accuracy, many challenges need to be overcome. Some of which are:

- If a small dataset is used for testing, it will lead to model over-fitting [15].
- Another problem is the Exploding gradient. This is where large error gradients collect and that results in updating of training weights.
- When there are highly imbalanced class distributions, a Class imbalance problem arises. Cost-sensitive learning can resolve this issue to a great extent [16].

V. CONCLUSION

The recognition of brain tumor needs accuracy without deviation. Any misrecognition will give rise to an incurable disease. An efficient and correct procedure of brain tumor classification is required to be suggested urgently, which can resolve these issues. This project contains detailed information about the prototype which

was utilized for the recognition of brain tumors from the MRI scans of the brain from the normal individuals to affected individuals. The affected individual can reach the hospital for treatment if the tumor is identified by the prototype. This practice also saves an individual's money. Brain tumor recognition using CNN has been a good approach because of its many advantages like immediate results with very high accuracy, less time consuming, and easy navigation.

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