AN EFFICIENT DEEP LEARNING NEURAL NETWORK BASED BRAIN TUMOR DETECTION SYSTEM

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Abstract: Brain tumor can be said as the very harmful type of cancer which has uncontrolled development of tissues in the human body. In the medical field Brain tumor has become the main causes of death for human beings. As we know, we focus more on processing the images of brain tumor in the medical field so that we can detect the rate of survival chances or classify the stages of brain tumor. As the number of neurological patient is increasing the burden on radiologist increases. In order to overcome the burden, the brain tumor needs to be diagnosed and treated efficiently as the cost and time required for this tumor is very high. Computerized tumor detection has helped the radiologists to not only improve the tumor detection but also reduces the time and bur- den of the radiologists. In this paper we have discussed about different kinds of methodologies to process these brain tumor images such as image pre-processing (local binary pattern), segmentation method (k- means) and feature extraction from magnetic resonance images (MRI) to detect brain tumor at an early stage.

Keywords: Brain Tumor, Segmentation methods, Image Analysis, MRI Images

I. INTRODUCTION

The normal working of the brain may get affected if there is any change in the structure of the brain. This change may be due to some unnecessary growth of cells which inside the skull. This unnecessary growth of cells is known as brain tumor. As these cells develop inside the skull which is protective layer, it prevents an early detection of the brain tumor during routine laboratory test. For an early detection of brain tumor it is necessaryto use the diagnostic tools at intracranial cavity. Beside from early detection another factor that plays major role is the location of the tumor. It becomes more complicated or less complicated to deal with brain tumor depend- ing on which half of the cerebrum, the tumor is located on as the function of two halves differ from each other. So basically we can say that brain tumor is a growth of unwanted cells under the skull in the brain which sup- plies the brain in the arteries are tightly bound together and have grown out of control. Brain tumor can be clas- sified mainly into two categories i.e., tumor that's not dangerous to other parts of the body (Benign) and tumor that's dangerous to other parts of body as well (Malignant). Brain tumor that starts in the brain is also known as primary brain tumor or benign. This brain tumor remains in the brain itself i.e., it does not spread into other brain tissues. The tumor that begins elsewhere and spreads to the brain is known as secondary brain tumor and this begins in the other parts of the body and reaches to the brain i.e., it does spread into surrounding brain tis- sues. Therefore we can say that it grows very rapidly and is more life threatening for people especially for those people who have a history of cancer. There are many techniques for detection of tumor such as simple neurolog- ical exam, MRI scan, CT scan, X-rays, biopsy etc., but the most important and effective technique is MRI scan because MRI images provides details about soft tissue anatomy which helps in improving the quality of brain diagnosis and treatment.

II. RELATED WORK

The characterization of cranial MR pictures and the discovery of tumors in the mind were performed with the structure of ELM-LRF [5]. The exhibitions of four unique techniques are additionally analyzed: Gabor wave- lets-based strategy, factual highlights based strategy, CNN, and ELM-LRF. 97.18% order precision is gottenwith the proposed technique (ELM-LRF). The second-best execution is gotten by CNN (96.45%). Measurable highlights based strategy and Gabor-wavelet highlights based techniques yielded precision estimations of 96.24% and 93.65%, separately. The most challenging task in the traditional automatic glioma segmentation methods [7] was conversion of prior information into probabilistic maps. The other most challenging task with this method was selecting features for classifiers and those features needed to be highly representable. In this paper, the state-of-the-art algorithm is used in order to focus or prioritize mainly on the deep learning meth- ods..For multi-modal MRI glioma segmentation task [12] a 3D CNN architecture is used where these multimo- dality 3D patches are used as inputs to a CNN. These multimodality patches are nothing but an extracted cubes

of voxels from different brain MRI modalities. The input which has 3D spatial intensity information and one additional dimension for MRI modalities is used in order to predict the tissue label of the center voxel of the cube. To increase the processing load of the network high dimensional processing is used in order to represent 3D nature of biological structure and thus 4D input data is handled by the CNN.The interpretation method [13]

is developed in comparison to the other high dimensional methods. Through this method first the 4D data is transformed and then in order to solve the brain tumor segmentation task standard 2D-CNN architectures are used. This entire process can not only increase computational efficiency but also removes the burden of high dimensional CNN design.

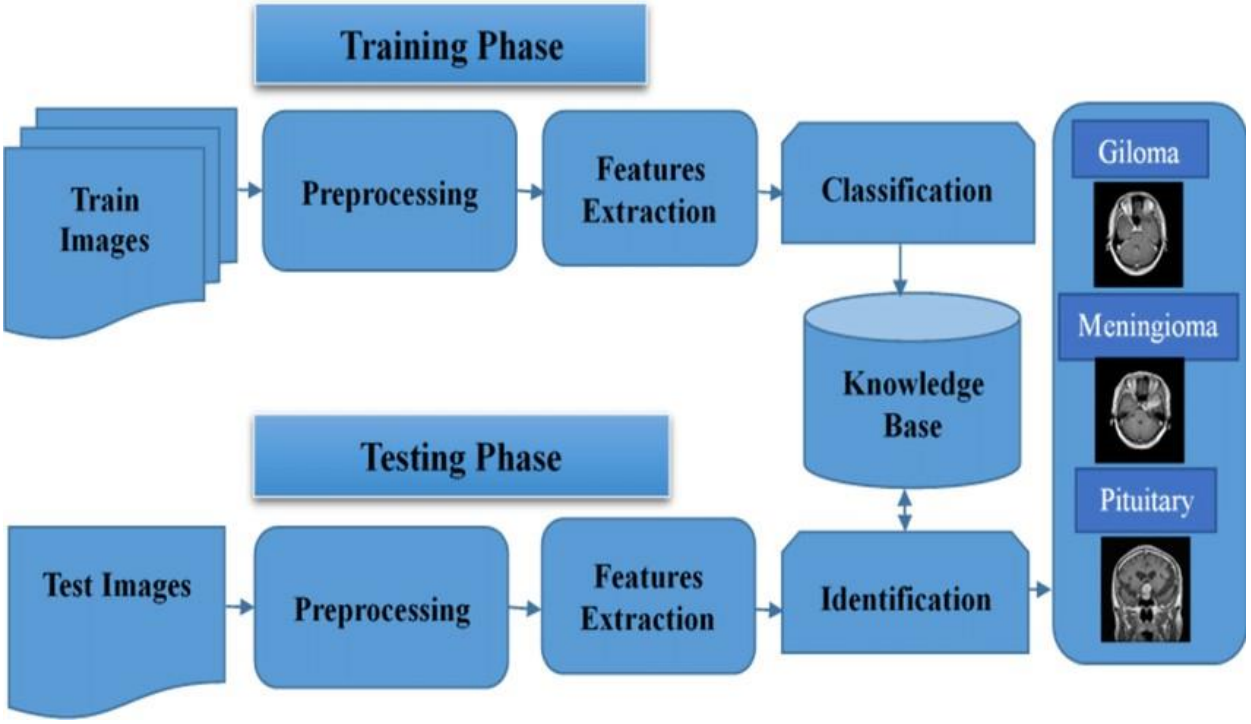


Figure 1: Block Diagram for Brain Tumor Detection and Segmentation

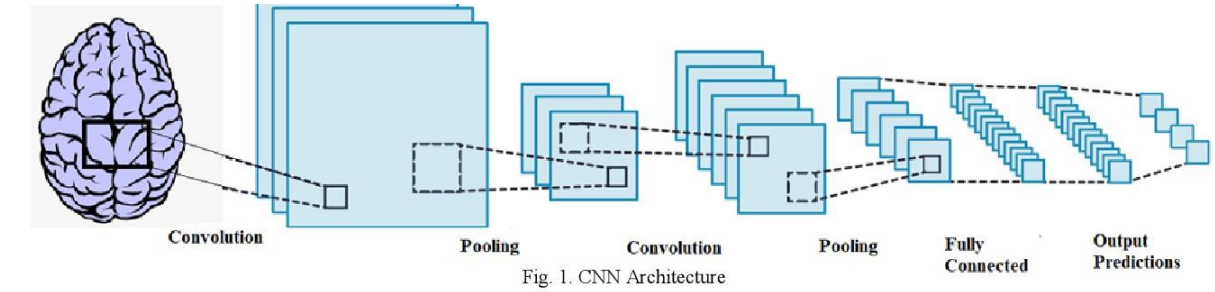


Fig. 1. CNN Architecture

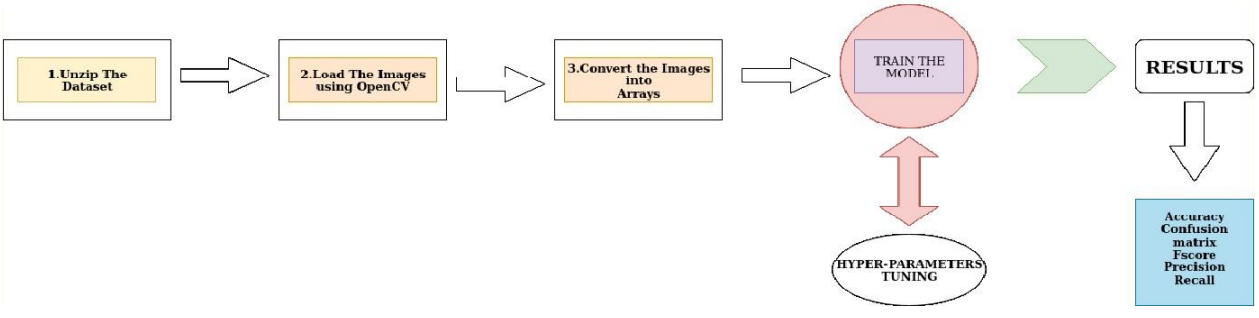


Figure 2: Convolutional Neural Network

III. EXPERIMENT AND METHODOLOGY

MRI is the medical imaging method which uses magnet linked to a computer in order to find whether the tumor is primary brain tumor or secondary brain tumor and also the size of the tumor. The MRI images of brain goes through these basic steps for processing i.e., detection and segmentation of brain tumor images as shown in basic block diagram below in figure 1:

Image Acquisition: We start with first or initial stage where we take a brain image as a result of MRI scan. This stage is equally important as any other stages because getting this image concerns invading rights of the patients to keep their record secret. This image is represented as different weighted image such as T-1 weighted, T-2 weighted and FLAIR weighted to give biological information about that patients brain tissue. The patient's brain image may be colorful, gray-scale or intensity images of default size. In the case of MRI scan the acquisition time is greater when compared to other technique like CT scan. This captured image is totally unprocessed and may contain high amount of noise or any other unwanted things therefore we proceed to the next step.

Preprocessing and Enhancement of an Image: After capturing an image we need to preprocess and enhance this image by removing unwanted errors that were captured during image acquisition step. By pre-processing we mean to improve the resolution or quality of image in for better view and detection of brain tumor not only bythe machine vision system but also by the human beings. We can use different filters depending on whether we need to remove text (like patient name), noise, strip skull tissues or any other error and smoothen the inner part of the brain which is not clear. Median filter is the most recommended tool in pre-processing and enhancementof MRI brain images, in which the value of a pixel is substituted by the median of the intensity values in its immediate neighborhood [1]. Enhancement of image means some modification made to this pre-processed im- age such as highlighting the important parts in the region, reducing the clarity of unwanted parts, contrast stretching, and edge enhancement.

Image Segmentation: As we already know that segmentation means "separation" therefore the pre-processed image is separated into the blocks. These blocks are basically made according to the similarities in their properties like color, contrast, brightness etc., and also according to the tumor location. It is necessary that the affected brain tumor tissues or dead cells from normal brain tissues are separated from the other normal brain tissues. This segmentation helps in understanding the complexity, location, and size of the brain tumor. With an aim for detecting tumors, edema and necrotic tissues there are three basic methods as explained below:

- ***Boundary approach:*** Multiple threshold can be used for each different specific region only when an image has many regions with a wide range of pixel values. Therefore we can say that this approach uses either pixel's gray level or image histogram.
- ***Edge approach:*** There are irregularities in the shape of the brain tumor such as they may have spread in discontinuous way leading to discontinuities in the image region. In order to detect these edges at first some first-order edge operators are used and then edges which has magnitude less than threshold are cropped.
- ***Region approach*****:** Here we focus on object region so we compare pixels to its neighbors and pixels with any sort of similarities in their properties are put in one cluster to form homogenous region. We compare one pixel at a time and this method can be further divided into merging or splitting of regions.

Feature Extraction: After all the above process the exact tumor part is extracted from the segmented image with an aim to mainly separate it from complex brain structure. Feature extraction can be based on size, shape, location and composition of the image. These feature extraction requires huge processing time as well as capaci- ty to decide whether or not they contain tumor. For this decision thefeatures are sent to the classification process whose performance is evaluated after this process has been repeated for entire brain MRI images in a data set.

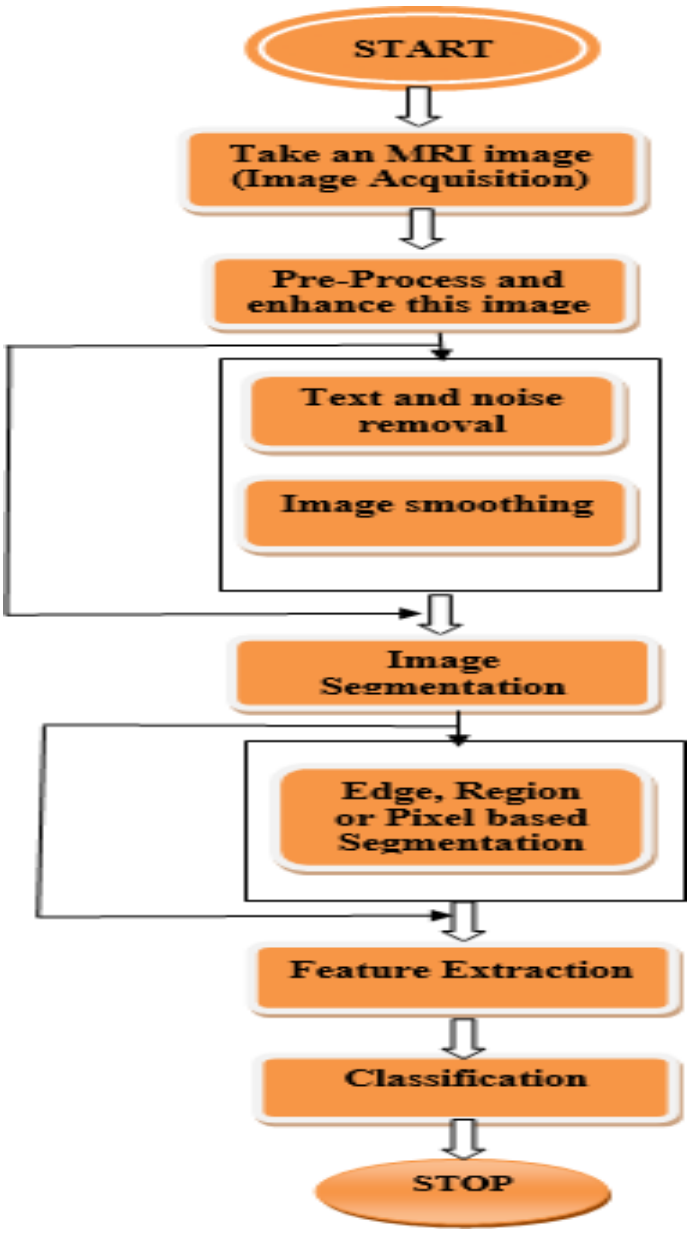


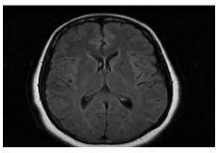
Figure 3: Basic Flow Diagram for Brain Tumor Detection and Segmentation

IV. RESULT AND DISCUSSION

We have applied total of eight deep MRI segmentation method over the brain image (from BRATS Data Set [1] [3]) to find the exact position of tumor with the biomarkers, which shows in the given figure below. We have extracted a color image in to gray scaled and find the tumor with the biomarkers (Part (a) and (b)), same we have done median filtering and identifies the biomarkers with the exact position shows in (part (c)). We have also perform the edge detection (part (d)) for pixel based edge detection to find the tumorimage on the basis of biomarkers. On other hand we have perform image thresh-holding (part (e)) as a different methods to find the brain tumor using biomarkers. For more than one tumor detection we have applied the method named Determining foreground and background which shows in (part (f)) with biomarkers. We have applied watershed method to convert grayscale image in to the color image and the portion of tumor identification with the blue biomarkers (part (g)). We have also applied metamorphic method to generate metamorphic for finding the rough view of tumors with the tumor endorsed biomarkers (part (h)).

a. Read color image

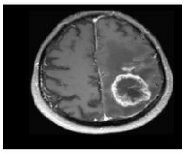
Input:



Output:

b. Convert to grayscale

Input:



Output

c. Median Filtering

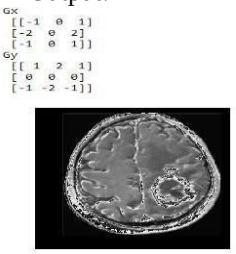
Input:

Output:

d. Edge Detection

Input:

Output:



e. Thresh-holding

Input:

Output:

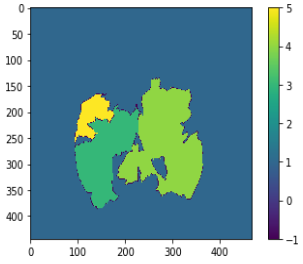
f. Determining foreground and back ground

Input

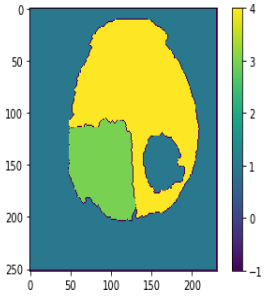
Output

Watershed Segmentation

Input:



Output:



Morphological Operations(Opening is achieved by erosion followed by dilation)

Input:

Output:

V. CONCLUSION AND FUTURE SCOPE

The purpose of the research is to propose a new method to diagnose brain tumor in its early stage using brain MRI images. Among the available solutions, a solution that implemented a median filter for pre-processing, spatial Fuzzy C-Means for segmentation, first statistical features and textural features for feature extraction, Principal Component Analysis for feature reduction and Support Vector Machine with non-linear kernel for classification was found to be the most effective. Owing to the limitations in the segmentation method such as poor accuracy and high computational cost, an alternative method for segmentation, which addressed these two limitations was proposed. The proposed segmentation method which utilized mathematical morphology for segmenting the pre-processed image produced superior accuracy in the segmented images and a ten-fold de- crease in the computation time.

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