

MRI Image Processing Operations for Brain Tumor Detection

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Abstract – The importance of an MRI for detecting a brain tumor has been discussed in several studies across the field of Biomedical Imaging. However, an MRI image produced possesses fewer artifacts and is higher in tissue contrast. Also, the various operations on an area infected with tumor, in order to accurately find out its characteristics are performed manually by radiologists, which are prone to human and environmental errors. Consequently, computer aided technologies are nowadays used to overcome human limitations. Hence, in this paper, we attempt to study different computer based approaches mentioned in literature for brain tumor detection, primarily for Astrocytoma-type of brain tumors. The detection of tumor requires several processes on an MRI output which primarily includes Image Filtering and Binarisation, Image Disintegration, Feature Selection, finally followed by its classification into Cancerous or Non-Cancerous, to further aid his/her experience-based manual inferences. Information about textural features in the isolated region of Interest has been derived with the help of Gray Level Co-occurrence Matrix (GLCM).

Key Words: Primary Processing, Disintegration, 2-D Median Filter, K-Means clustering

1. INTRODUCTION

Until recent, the most common procedure to analyze imaging data was visual inspection on a printed support. With technology paying more attention to detail, Magnetic Resonance Tomography has emerged as a promising tool for brain imaging, due to its increased contrast discrimination and ability to obtain images in many planes. Instead of traditionally using X-Rays, MRI makes use of a strong magnetic field, to provide a remarkably detailed picture of internal organs and tissue clusters. It is evident that the chances of survival of a tumor-infected patient can be increased manifold, if the tumor is detected accurately at an early stage [2]. Medical image analysis is an important Bio-medical application which is highly computational in nature, and requires the aid of an automated system. Automated Brain Disorder Diagnosis with the help of MR images after a highly advanced estimate of its many characteristics is one of the specific medical image analysis methodologies. The image analysis techniques include Initial processing, Image

Disintegration, Contrast Equalization, Image Clustering, Tumor Classification etc.

Image Pre-Processing(which includes Image Filtering and Binarisation) is required as the MR images consists of unwanted artefacts primarily because of human errors such as handling MRI Machine by operators, patient's motion during imaging, thermal noise and existence of any metal in the imaging environment. Various types of filters such as Gaussian Filters, Unsharp filters, 2-D Median filters [3] are used for this purpose. Histogram Equalization is another preprocessing tool used for equalizing intensities in an image. This preprocessing technique is particularly useful in the detection of edges of a tumor [4]. Segmentation, as the name suggests, refers to partitioning a digital image into many segment or sets of pixels with an aim for them to be more meaningful or/and simpler to evaluate. There are many segmentation techniques which come into play such as K-NN technique, K-Means Clustering and Level set methods etc. [5]. What follows Image Disintegration/Segmentation are basic morphological operations such as erosion, dilation and using of a structural element to obtain a clear version of the isolated abnormal region of the group of cells, in some cases, a cancerous tumor. [2]

1.1 Feed-Forward Backpropagation Neural Network Tool

The purpose of image classification scheme is to assign an input to each one of 'Astrocytoma type of brain cancer' pattern classes. It is a process of assigning a label to each unknown input image. In this paper, an Artificial Neural Network approach namely, Back propagation network (BPN) is used to classify the images shown in Figure 3. The Back-Propagation neural network consists of a provided input, a hidden layer, an output layer and finally the output, all of which operate under different mathematical logics and equations. It involves training and testing of a particular dataset with some pre-determined logic in the hidden layer. The ratio of data division for training, validation and testing are 0.70, 0.3 and 0.3 respectively.

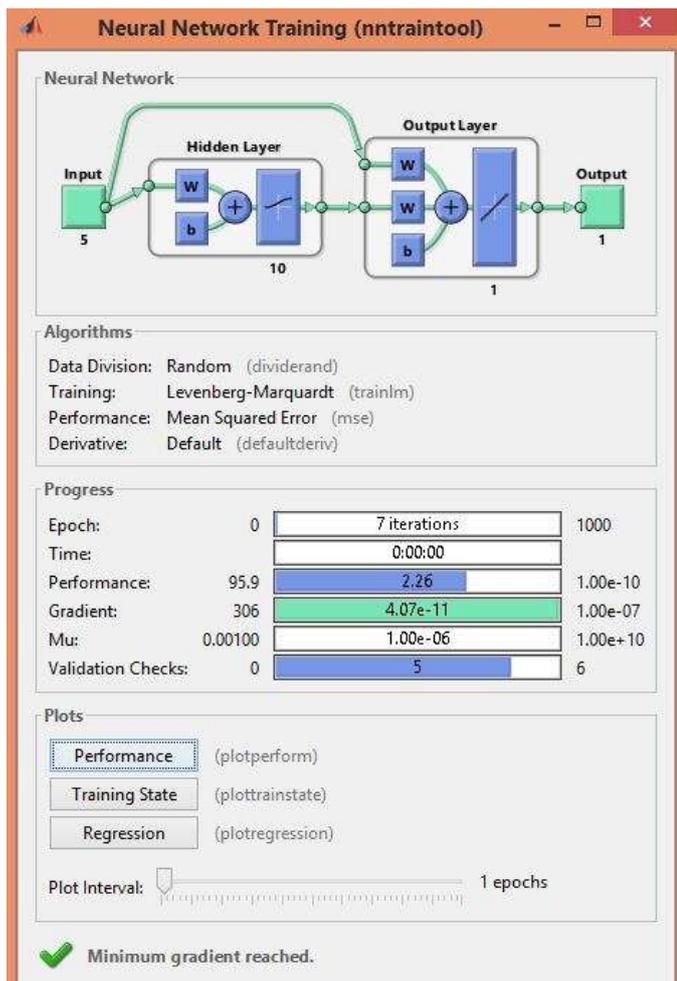


Fig - 1: A Neural Network Tool in execution

2. PROPOSED METHOD

With reference to all the research work, the paper attempts to, apart from using a few Image Processing methods to locate the position of the tumor more accurately, provide a radiologist a reliable second and third opinion (As different classifiers have various limitations and advantages [7]) in the form of Back-Propagation Neural Network and Linear Support Vector Machine (SVM) respectively to classify the dataset more accurately into two classes namely:

- a) The Benignant or No Tumor Class and,
- b) The Cancerous Class

25 images have been used which have been accessed by different websites which aim to assist researchers with a training dataset. Inbuilt Neural Network Tool has been used in order to facilitate backpropagation on MATLAB R2013b.

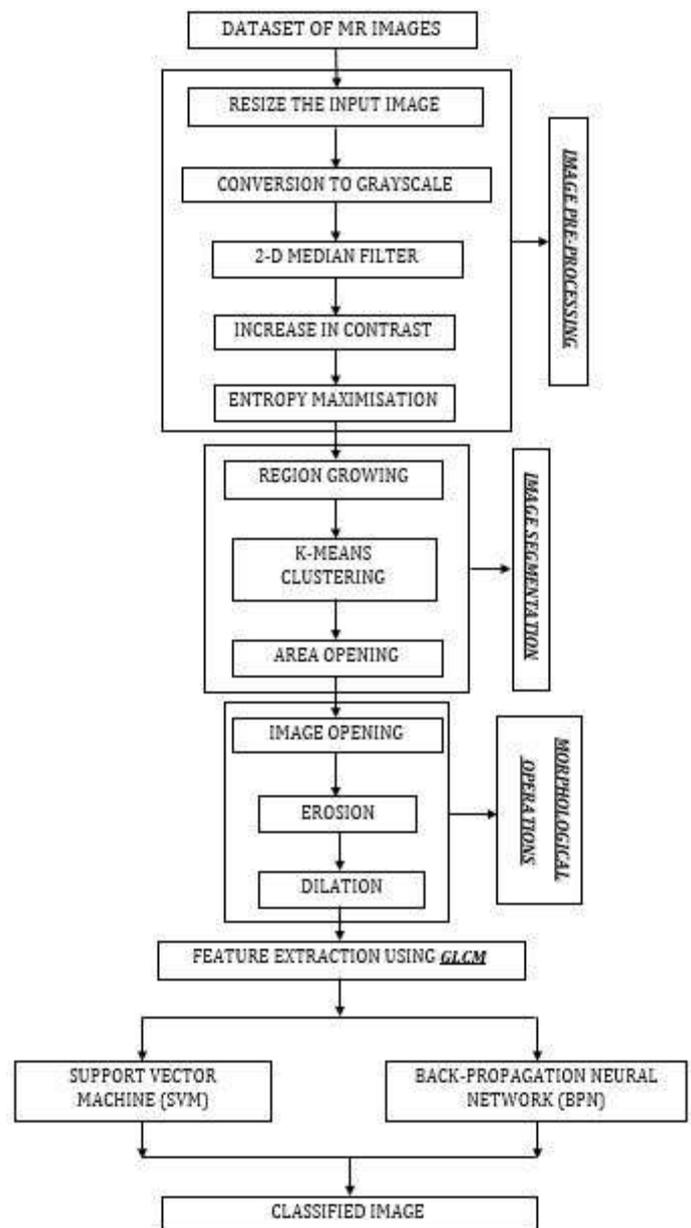


Chart -1: Proposed Method for detection and classification of MR Images

The proposed system initially includes the **Pre-processing** of an MR Image sample by the means of resizing the input image followed by converting it into a **grayscale**. What follows is the use of a **2-D Median Filter** to remove 'Salt and Pepper' noise. Next we use a property of MATLAB which helps us to increase the contrast levels for an effective visualization of the entire structure of the brain. What follows is the process of **Thresholding**, which helps us divide the pixels accurately into foreground and background.

Image Segmentation follows Image Pre-processing, the first step of which is a region-based Image Segmentation method, where a region is iteratively grown by comparing all the neighboring unallocated with the region. The difference in the intensities between a certain neighboring

pixel and the mean intensity of a region is a measure of similarity. The region incorporates neighboring pixels to itself in this way. The segmentation method stops when the intensity difference between a certain pixel and the region exceeds a certain threshold. The process which follows next is the one in which we remove all the connected components which have less than a certain value of pixels in its neighborhood(s) (See “bwareaopen” command in MATLAB help for further details). What follows next is the K-means clustering method [8] which essentially obtains a fixed number of clusters which minimizes the sum of squared Euclidean distances between an object and a cluster centroids. Following segmentation are the enhancements that take place after we assign a structural element. Next, which we analyze the texture of the tumor by understanding the spatial dependency of pixels in an image by the means of a Gray Level Spatial dependence matrix or a Gray Level Co-Occurrence matrix.

The next step which follows re the classifiers which are extremely important for deducing whether a tumor is cancerous or not. Back-Propagation Neural Network (BPN) from the Neural Networks toolbox in MATLAB [6], and Support Vector Machine (SVM) [1] [2] are used to classify a sample undergoing the testing phase as cancerous or non-cancerous.

3. RESULTS

A step-by-step analysis of the entire process of tumor detection and classification has been shown in the next few pictures. The software used is MATLAB R2013b and the database consists of healthy brain images and those which are infected by Astrocytoma type of Brain tumor.

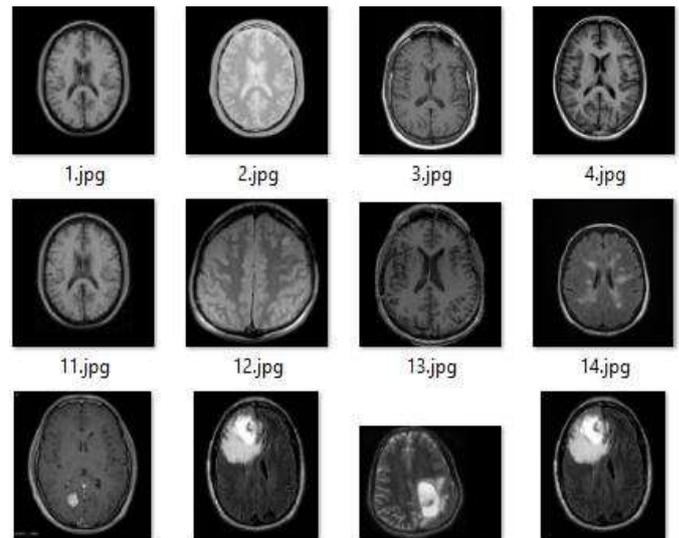


Fig -3: A portion of the dataset

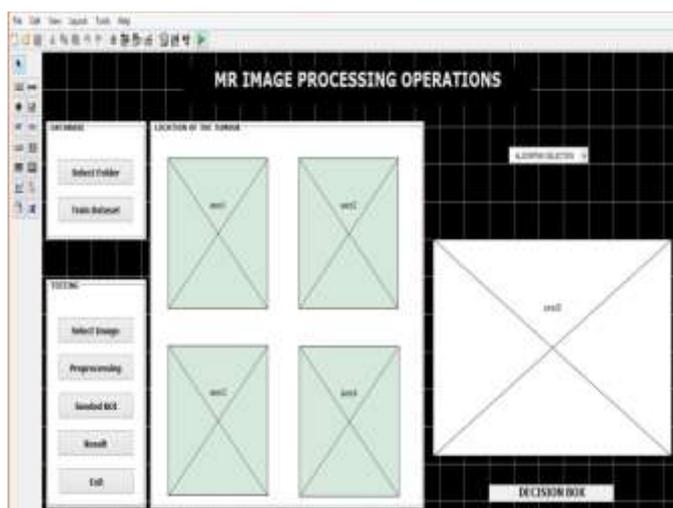


Fig -2: Design of MATLAB GUI

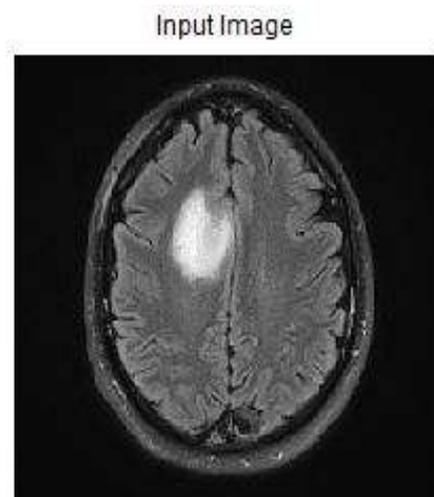


Fig -4: Input Image

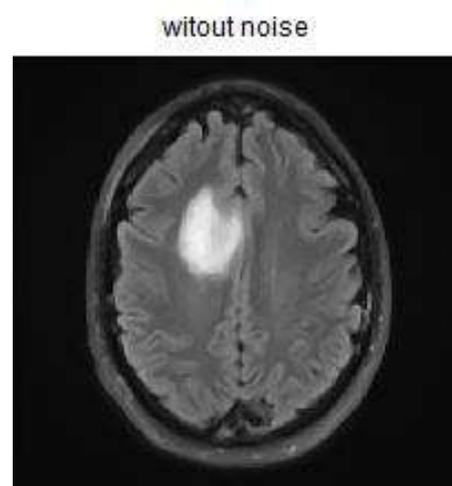


Fig -5: Initial processing

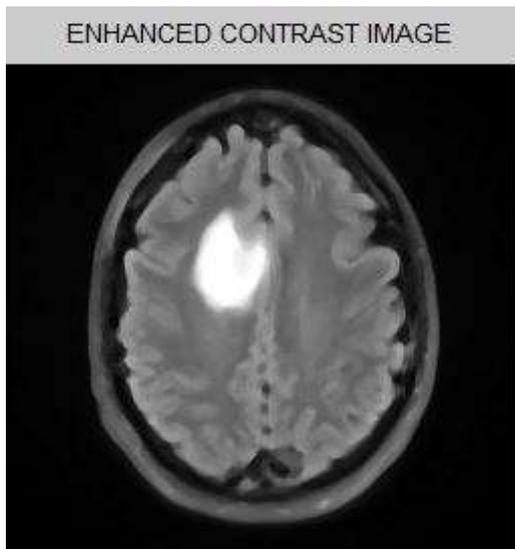


Fig-6: Enhanced Contrast image

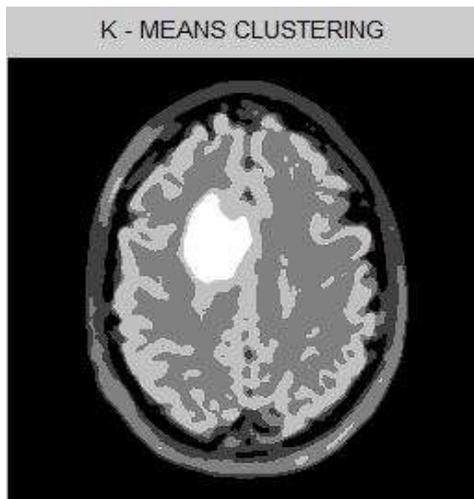


Fig -7: K-Means Clustering

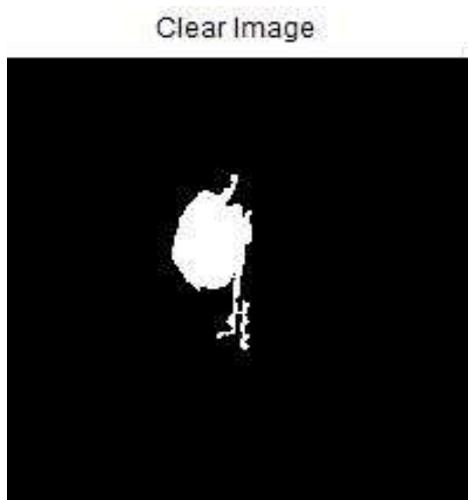


Fig -8: Image obtained after Area Opening

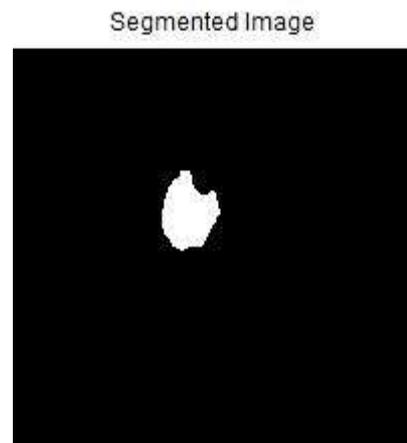


Fig- 9: Final isolated image of Tumor

Fig 10: Output when a Neural Network is selected

4. FUTURE SCOPE AND CONCLUSION

Estimating the existence and characteristics of a particular tumor in its early stages is an extremely significant part of Biomedical Imaging. We begin with conversion of the image from a database to a grayscale image, follow it with Image Filtering and dividing the image into multiple segments in order to obtain detailed information about the image. We use two classifiers in order to provide the radiologist with a reliable second and third opinion about the exact structure and nature of the tumor.

The need of a unified database is ever-present in the field of Brain Tumor detection and treatment to provide a more concrete course of action for the doctors after deducing the existence and stage of the tumor. Also, the project has a lot of scope for further improvements with the use of more accurate classifiers (such as an upgrade from the conventional MATLAB Neural Network Tool and Binary SVM) and further, complex the image processing techniques which would be a part of the process.

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