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Research paper

A Comparative Study on Brain Tumor Diagnosis Techniques Using MRI Image Processing

Dr. G. Pradeepini[1], B. Sekhar Babu[2], T. Tejaswini[3] , D.Priyanka[4], M. Harshitha[5]

[1,2,3,4,5]Department of CSE, K L E F, Vaddeswaram, Guntur, Andhra Pradesh – 522 502
**Corresponding author E-mail: pradeepini_cse@kluniversity.in*

Abstract

Image processing is a technique to carry out certain operations on an image so as to obtain some helpful information from it i.e., an enhanced image would be more advantageous. It is a similar to that of signal processing where input would be the image and the output obtained through this processing would be attributes/characteristics corresponding to that image. Currently, Image processing is one among the trending technologies. It is definitely one significant study area in the fields of engineering and computer science. Medical images have a vital role in the diagnosis of disorders & for checking the accurate functioning of organs. Hence, this is an active research area where several methods are being used and developed in order to make diagnosis facile. This medicinal imaging technology gave the doctors an insight for diagnosis of internal parts of the body. Also it helped doctors in performing Minimally Invasive Surgery, more commonly called as the keyhole surgeries which is done by inserting long and thin instruments into the body through small incisions to reach the internal organs instead of traditional operation techniques. The brain is the utmost important internal organ in our body and tumors effecting it could be very critical and hazardous situation. The brain tumor is a soft intracranial mass made up by irregular growth of cells of the tissue in the brain or around the brain. MRI Imaging play a vital role in brain tumors for evaluation, diagnosis and treatment arrangement.

Keywords: *Ant Colony Optimization algorithm; Back Propagation Neural Network Classifier; Brain tumor; Image processing; MRI..*

1. Introduction

The Brain encompasses a terribly advanced framework and is taken into account as a kernel of the body. The mother nature has perfectly conserved our brain within a skull which hampers its performance analysis and also makes the detection of its diseases complicated. Brain is a soft mass that consists of the cerebrum, the cerebellum, the brainstem, nerve cells and the supportive tissues. All these together along with the spinal cord constitute the Central Nervous System (CNS). It is accountable for several activities of the body such as organizing, consolidating, and inter relating the information it received from the sense organs, and correspondingly sends responses to the rest of the body. Almost all of the crucial body functions like co-ordination, heartbeat, breathing, movement, the senses that are vision, audition, gustation, olfaction and somatosensation also our personality is guided by it. Once these cells get older or get impaired, they need to be replaced by the new cells and thus a biological process called cellular division take place. Sometimes, this process might go wrong and as a result irregular division of cells takes place subsequently resulting in tumors inside the brain. The abnormal growth/swelling of body tissue is called as Tumor. They may be classified as cancerous and non-cancerous. In general, the cell growth and division is done by the body. If this balance of cell division is disrupted, a tumor may occur. A brain tumor is a result of irregular cell division takes place inside the brain. The most common symptoms that are visible with tumors are loss of weight, fever, loss in appetite, sweating, fatigue and usually relies on the size and location of the tumor. There are, in general 3types of tumor: Benign, Pre - Malignant and Malignant tumor.

1. ***Benign Tumor***: It is that kind of tumor which doesn't grow around abruptly i.e., it wouldn't influence surrounding unaffected / good tissues. The most usual example of this benign tumor are the moles.
2. ***Pre-Malignant growth***: The stage prior to the cancer is the Pre –Malignant tumor, if it's not properly diagnosed and cured, it causes cancer.
3. ***Malignant Tumor:*** The sort of tumor that becomes worse as the time flies and eventually results in the person death is called the Malignant. It is essentially a technical word which describes a serious spreading sickness. Hence this term is employed for the outline of tumor.

Thus, diagnosis of tumor in brain in its earliest phase and appropriate therapy is solely the remedy that exists. Diagnosis of brain tumor in its early stages primarily comprises CT scan, MRI scan, diagnostic tests, nerve tests. This includes:

1. A Neurological Exam: This medicine test embodies, among different things, checking your vision, audition, balance, coordination, strength, reflexes and responses.
2. Imaging tests: It is often accustomed that Magnetic Resonance Imaging (MRI) facilitates diagnosis of brain tumors. Also there is a chance of injection of dye in your arm through your vein in your tomography study.
3. A number of specialized tomography scan elements — as well as purposeful tomography, introduction tomography

and resonance spectrum analysis — could facilitate your doctor measure the growth of tumor and arrange appropriate treatment. Some other tests for imaging are PET and Ct scan

4. Also there are ways to discover tumor in different areas of the body. If it has been reckoned that this tumor has resulted due to malignant tumor from other organ of your body, then the physician might suggest course of action to find out the origin of tumor. For instance a CT scan for chest is done to examine the symptoms of the bronchogenic carcinoma i.e., lung cancer.

Since the MRI uses magnetic fields to provide us with complete detailed pictures of the body instead of x-rays, these are highly recommended and are preferred over CT scans. Also they can be used to compute the tumor's size. In order to get clearer images a special dye referred to as a contrast material is given in the form of a pill to swallow or injected into the patient's vein prior to the scan.

Thus neurosurgeons most typically advise MRI's because it provides them with ample data to identify even the tiniest abnormalities/irregularities but, as tomography uses magnetic waves, therefore it's inappropriate for patients with pacemakers and metal implants. Now that we've got the scanned brain image, it's imperative to precisely diagnose the tumor, its type, its size, and its location. All this data is critical for the surgeon to conclude the tumor detection. This is where Digital Image processing comes to rescue. With the employment of various segmentation and classification techniques and different feature extraction methodologies, we can precisely detect the growth of tumor.

2. Basic Methodology

Processing an image may be a sophisticated task. Before any image can be processed, it's vital to get rid of any unwanted artifacts it may hold. Then the image will be processed successfully. To process a medical image involves 3 main steps. The primary is that the pre-processing of the image. This involves operations like noise reduction and filtering so the image is appropriate for next step. The second step is to perform segmentation, classification and morphological operations. And the final step is to perform post processing where verification of the size of the tumor and also its location is done. This could be represented in the form a block diagram as follows:

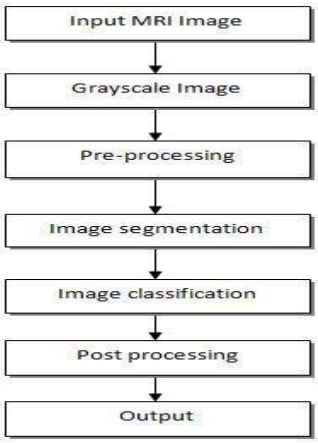

Fig.1. Basic methodology

2.1 Image Processing:

Before we start to process our image it's vital tha
t the image does not incorporates any unwanted data and is within the right format for process so the results are correct. This preparation is classified as pre- processing. This phase comprises of steps such as altering the input mri to grayscale, noise reduction and noise removal, image reconstruction, image enhancement and regarding medical images it involves steps like skull removal from an MRI. One of the most common pre-processing is that the conversion to a gray scale image. It's considered that a gray scale image is simply a black & white image but this is not true .A black & white image has a pair of shades i.e., black and white at some extent, the intensity will be either one or zero. However, a grey scale image consists of different shades of grey with no apparent color. This shows that each pixel represents the intensity value at the pixel while not showing any color. Unlike a black and white image, a greyscale image has many various shades with white being the lightest shade and black being the darkest shade. Also during a greyscale image the intensity values at a pixel don't seem to be absolute and might be in fractions. Gray scaling is vital because it provides an accurate color information that aids during the segmentation phase which is the initial work taken by any of the analysts. Once the image is converted into a greyscale image, it's then filtered to get rid of excess noise. Hence the filters are classified based on their capacity to allow the frequencies to pass i.e., low-end and high-end. Thus filter could possibly level the image or sharpen it. Once the image is smoothened, the noise is blurred resulting in a smooth picture but it is observed that the important attributes are lost. If the image requires to be sharpened then the filter enhances the finer details, but this results to an increased amount of noise within the image. The noise ought to be clipped before further processing it because it interferes with the accuracy of the detection program.

2.2 Image Segmentation and Classification:

The process of splitting an image into numerous segments is called as Segmentation. It creates different kinds of pixel sets in the same image. Segmenting an image simplifies the process of analysis and extraction of details. It describes as " The method of labelling every pixel in an image such that they share same characteristics". The process in pixels sharing a similar property. They are many approaches like Thresholding method, Edge based segmentation method, Region based segmentation method, Watershed method, Partial differentiation equation method and various clustering techniques are used to segment images. A cluster consists of a set of pixels that share some similar characteristics. It involves classifying objects based on their similarity to every alternative. Clustering techniques are divided into 2 types. Hard type clustering states that an object only belongs to at least one cluster only. This results in definitive segmentation. The aim of this method is to segment the image into n partitions which belongs to the cluster with the closest mean. Suppose, if the image has low resolution and contrast then this method becomes terribly hard. Another type of clustering is that the soft clustering technique. Here, it is not like the previous technique. In this we assume that the each entity has a likelihood of being included in every cluster rather than being in a sole cluster. It also presumes that an entity could be included in multiple clusters. This technique is used frequently in the field of image segmentation.

The complexity in different parts may yield hints regarding the area in your brain that might be influenced by a brain tumor. There are several kinds of brain tumors which makes the decision more difficult. Thus the classification of brain tumor is absolutely vital so as to categorize the tumor type exactly from which the patient suffers. A better classification method prompts a right choice and provides an appropriate and good treatment. Treatments differ depending on the types of brain tumor which are decided by:

- Patient's age & tolerance for certain cures and remedies

- Complete medical background of the patient
- Size, location and type of tumor
- Degree of severity

The Neural network techniques consists of three steps which are feature extraction, dimensionality reduction and classification. The feature extraction includes the compression of the size of MRI images which is the foremost component analysis step. Feature extraction strategies are used to get vital information within the image to curtail the screening time and minimize the complexity in the image processing. In second step, Dimensionality reduction is implied to minimize the dimensions/size of the images and at last in the classification step, the classifier helps to categorize a usual and unusual brain tumor images and it's done using a back propagation neural network (BPNN).The BPNN gives quick/accurate result for classifying the images. Among all neural networks, the most importantly used neural network is the BPNN. The neural network is used to vary the weight and bias so that it reduces the cost function. BPN classifier gives the accuracy of 100% to 75% in the testing part. In further the performance can be increased by taking the large no of database from the hospital or from the open source.

2.3 Post Processing

Successful segmentation of the image is followed by the post – processing of the image. This involves the steps to evaluate the size of the tumor and size of the tumor. Thus it involves different types of optimization techniques to improve the result

3. Literature Survey

The authors of this paper [1] proposed a technique for detecting the brain tumor. Image segmentation is done based on the canny edge detection algorithm. The canny edge detection algorithm performs better than any other edge detection algorithms and is based on 3 objectives i.e. lesser error rate, single edge point response and edge points should be well localized. Canny algorithm is the only algorithm which is having the potential of providing a fully unbroken edge for the brain's posterior boundary. In the original paper of canny's algorithm , the optimal filters derivation give on to a Finite Impulse Response filter, which in spatial domain may become slow to compute if there is importance for amount of smoothing. Because of this reason, it is recommended to use Rachid Derinche's Canny - Derinche detector which is in finite impulse response form. Canny Derinche detector is recursive, and we can compute it in a fixed and short amount of time for any level of smoothing.

An assessment on identification of dementia is done using texture analysis of brain MRI followed by classification with the back propagation network and wavelets is presented in [2]. The steps for classification are: The region of interest can be obtained from the mri image by GLCM, wavelets and Haralick features. The Backpropagation network classifier will give more accuracy and can give sensitivity which is much needed in regular clinical treatment. This classifier's specificity is enhanced when Haralick features which are based on wavelet are provided as input to neural network in place of solely GLCM features or a combination of GLCM & Haralick features.

In this paper [3], different medical images like MRI are taken for conducting experiments on noise removal for different kind of noises like Salt pepper Noise, Gaussian Noise, Poisson Noise. From that experiment they came to conclusion that appropriate filters must be used for this purpose based on the type of noise. They have shown comparative results of filters used for different noises and those filtering methods depends on the size of the image, it's clarity and histogram and concluded that there is no fixed filter for noise removal and the filter will be based on type of image.

The authors of this paper [4] discussed about the neural network techniques which mainly consists of three steps. Those steps include classification, feature extraction and dimensionality reduction. In the first step i.e, in the feature extraction phase, for compressing the size of the MRI image we will use principal component analysis. The BPN will gives us the correct and fast results for image classification. The most used neural network is Back Propagation Neural Network (BPNN) among all other neural networks. The texture or shape of the tumor region can be acquire from the MRI brain image will be imperfect and asymmetric. Because of this reason we use region of interest (ROI) in image segmentation to recognize and analyze the tumor region and then we divide the tumor region. BPNN can be used for training, testing, and also for classification of the tumor.

This paper [5] deals with the concept of brain tumor feature extraction and segmentation. Feature extraction is important for locating and identifying the brain tumor and for predicting its next stage. It's a special kind of dimensionality reduction. If the input data which we are giving to an algorithm is very large and is suspected to be redundant, then that data will be transformed into a reduced set of feature representation (feature vector). This reduction or transformation of the input data into feature set is called Feature Extraction. In this paper efficient results are observed by them by extracting some of the characteristics using GLCM like Contrast, Correlation, Homogeneity, Entropy, Energy, Shape, Color, Texture and Intensity.

In this paper [6], an approach which allow segmentation of tumor in mri images called the Ant Colony Optimization (ACO) has been described and it is tested on different MRI images of brain. For testing the MRI images they used selective global or local segmentation, canny algorithms and sobel operators. They conclude that results of ACO is better than CANNY segmentation. The technique of ACO is to find the shortest path among the available paths from source to destination. ACO does not need any pre-processing like Canny Algorithm and it works faster than CANNY.

This paper [7] deals with Segmentation, Extraction, Classification and Enhancement of the brain MRI Image. The different algorithms presented here are CLAHE algorithm, K-means algorithm and Ant Colony Optimization (ACO). They compared the existing methods and find drawbacks in those techniques. According to their study the drawbacks in thresholding approach are it has only binary values 0 and 1, so it becomes a limitation when a bitmap image is considered some of the tumor cells can be ignored. In region growing approach it needs the more user interactions for seed selection. In fuzzy c- means technique it needs high computational time and low computational rate. Watershed transform suffers with over segmentation due to absence watershed lines. And they finally concluded that by using algorithm ACO, extraction from brain MR image is done effectively.

The authors of this paper [8] have proposed an Improved Edge Detection algorithm for brain tumor diagnosis. The edge detection is the commonly used approach for identifying the edges. It also depends on finding sudden local changes in the intensity of the image. This algorithm depends on Sobel edge detection. To find the distinct regions using closed contour

Table 1: Comparative analysis of different Brain Tumor detection techniques

Paper no.	Methods used	Results
1	Canny edge detection algorithm	Slow in computing if smoothening is an important factor
2	Texture analysis	A combination of GLCM & Haralick features is used for better results
3	Different noise removal methods	The noise removal filter to be used solely depends on the characteristics of the MRI
4	Fuzzy neural network (BPNN)	The Region of Interest i.e., ROI is calculated in the MRI image segmentation and BPNN is used for classification
5	Feature extraction using GLCM	Feasible for larger data sets which are suspected to contain unwanted data
6	Ant Colony Optimization (ACO)	Segmentation is done using ACO which when compared to canny yields better results
7	CLAHE, K -means and ACO algorithms	Extraction of tumor from MRI is done effectively using these algorithms
8	Combination of threshold and sobel methods	This improved edge detection algorithm combines the sobel edge detection and threshold methods
9	Seeded region growing method	Though this method is fully automatic but is observed to be time consuming
10	Hidden random markov field and Expectation Maximization algorithm	Deterministic in terms of distinguishing the spatial and statistical properties of the image. But doesn't assure accurate results

algorithm, it binds the threshold method with sobel method which depends on image. Many of the edge detection methods which are prevalent today, detects object boundaries in the image. But the improved algorithm in this paper is extended for segmentation of the object, which can be used effectively for the separation of tumor in image.

In this paper [9], Seeded region growing method is used for segmenting the input MRI brain image which determines the presence of tumor. The proposed method consists of four steps: skull removal, texture analysis, seed point selection, morphological image enhancements and Seeded region growing method.

In this paper [10], Expectation maximization algorithm is used for the segmentation purpose and for incomplete-data problem where certain parameters and the class label are unknown which are interdependent model fitting is done in the hidden random markov field. This method effectively distinguishes both the statistical and spatial properties of the MRI. Also this technique requires calculating threshold. Though this framework is theoretically good, it does not guarantee producing accurate results.of smoothing is vital. Instead we can opt for the Canny detector which is recursive in nature for any required amount of smoothing. Also we are proposing a detection technique where Ant Colony Optimization is used for segmentation which does not need any pre-processing and Back propagation neural network is for classification which gives high level of accuracy. Since this require feature extraction, it is performed using GLCM method a statistical approach where texture examination is done accurate results for different input images. by considering the spatial relationship of pixels. Thus the following methodology must provide most

4. Conclusion

Papers mentioned above give us the absolute idea of how the diagnosis of brain tumor is done using different techniques. It is understood that still there is scope of improvement in terms of performance of these methods i.e., accuracy of results. Even in the most recent technique of canny edge detection algorithm in the deduction of optimal filter resulted in Finite Impulse Response filter which is slow in computing in the domain of spatial characteristics if the quantity Though the method was presented as the robust and fully automatic algorithm oriented yet the entire process is a bit time taking and also there are some pixels which are misclassified.

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