Brain Tumour Detection and Classification by Using Modified Region Growing Method : A Review

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Abstract

Medical Image Processing is a complex and challenging field nowadays. Processing of MRI images is one of the parts of this field. Automated and accurate classification of MR brain images is of importance for the analysis and interpretation of these images and many methods have been proposed Region growing is an important application of image segmentation in medical research for detection of tumour. In this an effective modified region growing technique for detection of brain tumour is used. Modified region growing includes an orientation constraint in addition to the normal intensity constrain. The performance of the proposed technique is systematically evaluated using the MRI brain images database. For validating the effectiveness of the modified region growing, the quantity rate parameter detection, the sensitivity, specificity and accuracy values will be used. Comparative analyses will be made for the normal and the modified region growing using both the Feed Forward Neural Network (FFNN) and Radial Basis Function (RBF) neural network.

***Keywords* - Tumour Detection, Image processing, Feature extraction, Modified region growing**

1. Introduction

Early detection and classification of brain tumors is very important in clinical practice. Many researchers have proposed different techniques for the classification of brain tumors based on different sources of information. Some discoveries such as X-rays, ultrasound, radioactivity, magnetic resonance imaging (MRI) or computed tomography (CT) and

the development of tools that can generate medical images using the physical principles of such phenomena have facilitated the development of some of the most efficient exploration tools in medicine. These tools are capable of exploring the structure, the function and the diseases that affect the human brain. This research deals with the cancer-affected region of the brain [1].Curing brain tumour has been a major goal of medical researchers for decades, but development of new treatments takes time and money. Science may yet find the root causes of all cancers and develop safer methods for shutting them down brain tumors are benign and can be before they have a chance to grow or spread [2, 3]. Approximately 40 percent of all primary successfully treated with surgery and, in some cases, radiation. The number of malignant brain tumours appears to be increasing but for no clear reason. Magnetic Resonance Imaging (MRI) has become a widely used method of high quality medical imaging, especially in brain imaging where MRI's soft tissue contrast and non-invasiveness is a clear advantage [5]. MRI provides an unparalleled view inside the human body. The level of detail we can see is extraordinary compared with any other imaging modality. Reliable and fast detection and classification of brain cancer is of major technical and economical importance for the doctors. Common practices based on specialized technicians are slow, have low responsibility and possess a degree of subjectivity which is hard to quantify. Many diagnostic imaging techniques can be performed for the early detection of brain tumors such as Computed Tomography (CT), Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI). Compared to all other imaging techniques, MRI is efficient in the application of brain tumour detection and identification, due to the high contrast of soft tissues, high spatial resolution and since it does not produce any harmful radiation, and is a non invasive technique [6]. Hence, in this proposed research we are presenting the improved method for brain tumour detection as well as disease classification. This proposed method is based on use of modified region growing and neural networks. The designed system is an efficient system for Detection and Classification of Brain Cancer from a given MRI image of cancer affected patients. According to the World Health Organization, brain tumour can be classified into the following groups:

Grade I: Pilocytic or benign, slow growing, with well defined borders

Grade II: Astrocytoma, slow growing, rarely spreads with a well defined border.

Grade III: Anaplastic Astrocytoma grows faster.

Grade IV: Glioblastoma Multiforme, malignant most invasive, spreads to nearby tissues and grows rapidly.

2. Literature Review

According to the literature study, Mohd Fauzi Bin Othman, Noramalina Bt Abdullah [7] in 2011, performed classification of brain tumour using wavelet based feature extraction method and Support Vector Machine (SVM). Feature extraction was carried out using wavelet and the approximation coefficients of MR brain images were used as feature vector for classification. Accuracy of only 65% was obtained, where; only 39 images were successfully classified from 60 images. It was concluded that classification using Support Vector Machine resulted in a limited precision, since it cannot work accurately for a large data due to training complexity. Whereas, in 2011, Mohd Fauzi Othman and Mohd Ariffanan Mohd Basri [8], presented their work on, Probabilistic Neural Network (PNN) for brain tumour classification. This paper introduces the brain tumour classification using Principal Component Analysis for feature extraction and PNN for classification. They concluded that PNN is a promising tool for brain tumour classification, based on its fast speed and its accuracy which ranges from 73 to 100% for spread values (smoothing factor) from 1 to 3. Hence in this research work, PNN has been used for classifying brain tumors, since it is considered to be superior over SVM and other neural networks in terms of its accuracy in classification. Classification of brain MRI using the LH and HL wavelet transform sub-bands was performed by Salim Lahmiri and Mounir Boukadoum [9], in 2011. This proposed approach shows that feature extraction from the LH (Low-High) and HL (High-Low) sub-bands using first order statistics has higher performance than features from LL (Low-low) bands. In 2010, Ahmed kharrat, Karim Gasmi, Mohamed Ben Messaoud [10], presented their work on A Hybrid Approach for Automatic Classification of Brain MRI Using Genetic Algorithm and SVM. This paper proposes a genetic algorithm and SVM based classification of brain tumour. It is concluded that, Gabor filters are poor due to their lack of orthogonality that results in redundant features at different scales or channels. While Wavelet Transform is capable of representing textures at the most suitable scale, by varying the spatial resolution and there is also a wide range of choices for the wavelet function. Ahmed Kharrat, Mohamed Ben Messaoud, Nacera Benamrane, Mohamed Abid [11], in 2009, proposed their work on, Detection of Brain Tumors in Medical Images. This paper proposes contrast enhancement using mathematical morphology algorithm, segmentation by wavelet transform and classification using K-means algorithm, for an efficient detection of brain tumour from cerebral MR images. Their future work is to classify brain tumors into benign and malignant brain tumours'. B. Kekre et al [2] have presented a vector quantization segmentation method to detect cancerous mass from MRI images. In order to increase radiologist's diagnostic performance, computer-aided diagnosis scheme have been developed to improve the detection of primary signatures of this disease: masses and micro calcifications. Morphological segmentation extracts other regions with tumour region. Thresholding was used to convert input image into binary image. Global threshold methods suffer from drawback as threshold value was given manually. The algorithms were tested on twenty one MRI images. Identification rate for Morphological Segmentation was 66.7%.S. Klein, et al [4] studied the likelihood in a premature period of detecting dementia, using no rigid registration of MRI. A k-NN classifier was trained on the dissimilarity matrix and the performance was tested in a leave-one-out experiment on 58 images. A. El-Dahshan, T. Hosny, and A. M. Salem [5], presented proposed hybrid techniques consist from three steps, extraction of feature using DWT, reduce the large dimension using principal component analysis PCA and classify the output using two classifiers. The first classifier based on ANN and the other classifier is based on k-nearest neighbour (k-NN). S. Chaplot, L. Patnaik, and N. Jagannathan, [6], the authors used ANN and SVM to classify brain MRI. The pre-processing phase uses DWT and used as input for Neural Network NN and SVM.

3. Proposed Method

The performance of the proposed technique is systematically evaluated using the MRI brain images received from the public sources. For validating the effectiveness of the modified region growing, the quantity rate parameter has been considered.[1]

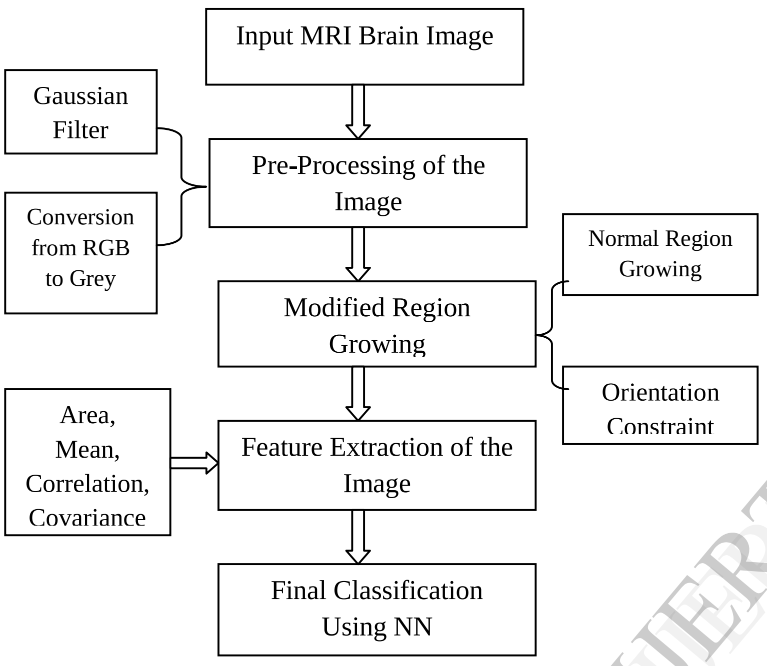

Figure 1.Block Diagram of Proposed System [1]

3.1Input MRI Brain Image

The Brain image dataset are divided into two sets; (1) Training dataset (2) Testing dataset. The training dataset is used to segment the brain tumour images and the testing dataset is used to analyze the performance of the proposed technique.[1]

3.2 Pre-Processing

MRI brain images cannot be fed directly as the input for the proposed technique. The input image is subjected to a set of pre-processing steps so that the image gets transformed suitable for further processing. We employed two step pre-processing procedure in which first the input image is passed through a Gaussian filter to reduce the noise and get a better image. Passing the image through the Gaussian filter. Also enhances the image quality. In the second step in the pre-processing, the image is converted from the RGB model to Gray Image which makes the image fit for region growing process.[1]

3.2.1 Gaussian Filter

A Gaussian filter has an impulse response which is a Gaussian function. The Gaussian filters are developed to avoid overshoot of step function input while reducing the rise and fall time. This character is very much linked to the fact that the Gaussian filter has the minimum possible group delay. In mathematical terms, a Gaussian filter changes the input signal by convolution with a Gaussian function; this change is also called the Weierstrass transform. The Gaussian function is non-zero for X € [-∞,∞] and would supposedly need an infinite window length. The filter function is to be the kernel of an integral transform. The Gaussian kernel is continuous and is not discrete. The cut-off frequency of the filter can be taken as the ratio between the sample rate Fs and the standard deviation a σ. In the pre-processing step, the input image is passed through a Gaussian filter which results in the reduction of noise in the input image and also results in obtaining an image fit for further processing. Passing the image through the Gaussian filter also enhances the image quality.[1]

3.2.2 Conversion of RGB image into the Grey Image:

A greyscale or grey-scale image is an image which is composed exclusively of shades of grey, varying from black at the weakest intensity to white at the strongest. Greyscale images are often the result of measuring the intensity of light at each pixel in a single band of the electromagnetic spectrum. The intensity of a pixel is expressed within a given range between a minimum and a maximum, inclusive. This range is represented in an abstract way as a range from 0 (total absence, black) and 1 (total presence, white), with any fractional values in between. Conversion of a colour image to gray scale is not unique, as different weighting of the colour channels effectively represents the effect of shooting black-and-white film with different-coloured photographic filters on the cameras. A common strategy is to match the luminance of the gray scale image to the luminance of the colour image. To convert colour image (RGB) to a greyscale representation of its luminance, add together 30% of the red value, 59% of the green value, and 11 % of the blue value of the RGB image. Regardless of the scale employed which may be 0.0 to 1.0, 0 to 255 or 0% to 100%, the resultant number is the desired linear luminance value and it typically needs to be gamma compressed to get back to a conventional gray scale representation. Conversion of the RGB to the Grey scale image makes the input image fit for region growing technique.[1]

3.3 Modified Region Growing Technique

Region growing is a simple image segmentation method based on the region. It is also classified as a pixel-based image segmentation method since it involves the selection of initial seed points. This approach to segmentation examines the neighbouring pixels of initial "seed points" and determines whether the pixel neighbours should be added to the region or not, based on certain conditions. The process is iterated to yield different regions. In a normal

Region growing technique, the neighbour pixels are examined by only the "intensity" constrain. For this, a threshold level for intensity value is set and those neighbour pixels that satisfy this threshold is selected for region growing. The normal region growing has the drawback that noise or variation of intensity may result in holes or over segmentation. Another drawback is that the method may not distinguish the shading of the real images. For improving the normal region growing and effectively tackling the draw backs of a normal region growing, we have added an additional constrain of "orientation". In the modified region growing, there are two thresholds; one is for the intensity and the other for orientation. Region is grown if only both constrains are met. The inclusion of this additional constrain have yielded in a much better result when compared to the normal region growing. The modified region growing is a three step process which consists of gridding, selection of seed point, applying region growing to the point. In gridding, a single image is divided into several smaller images by drawing an imaginary grid over it. That is, gridding results in converting the image into several smaller grid images. The grids are usually square in shape and the grid number to which the original image is split is considered as a variable. For evaluation of the proposed technique, we have spilt the original image into 4, 18 and 24 grids. Gridding results in smaller grids so that analysis can be carried out easily. In this technique each of the grids is treated separately to which the region growing technique is applied. The initial step in region growing for the grid formed is to select a seed point for the grid. The initial region begins as the exact location of the seed. We have also carried out histogram analysis to find out the seed point of the grid. The histogram is found out for every pixel in the grid. As the image is a grey scale image, the values of this image is from 0 to 255. For every grid, the histogram value that comes most frequent is selected as the seed point pixel. From this, any one of the seed point pixel is taken as the seed point for the grid. After finding out the seed point, the region is grown from it. The neighbouring pixels are compared with the seed point and if the neighbour pixel satisfies constrains, then the region is grown else it is not grown to that pixel.

Constrains for the proposed region growing is the "intensity" and the "orientation". In a normal region growing, only the intensity constrain is taken into account. For the intensity constraint, an intensity threshold is also set in-order to check if the neighbour pixel satisfies the condition. Intensity threshold defines the maximum value by the neighbour pixel value can differ from the pixel in consideration. Suppose the pixel is having the intensity value I_P , and I_N the neighbouring pixel has the value and the intensity threshold is set as T_I , if $\|I_P - I_N\| \leq T_I$ then intensity constrain is met and satisfied. In-order to find the "orientation" constraint, first the gradients in x and y axes are found out. Let Ix be image values after applying the gradient in X axis and Iy be the values after applying gradient in Y axis. After taking the gradient, the pixel values which had value from 0 to 255 is changed to 0 to 3.14. The gradient values will be in radian which is converted into degree measure and it will have the value in the range 0 to 180 degrees and gives the orientation values. Then both the values are combined to form the gradient matrix g where $g = 1/1+(Ix +Iy)$.from this matrix g , we can get the orientation for each of the pixels. Suppose the pixel is having the orientation value O_P, and the neighbouring pixel has the value O_N and the orientation threshold is set as T_O,$\| O_P - O_N \| \leq T_O$ then the orientation constrain is met and satisfied. When both the intensity constraint and the orientation constraint are satisfied by a neighbouring pixel, the region is grown to the neighbour pixel and the region grows. When $\| I_P - I_N \| \leq T_I$ AND $\| O_P - O_N \| \leq T_O$ then the neighbour pixel is added to the region. For every grid, the region is grown.[1]

3.5 Feature Extraction

After finding out the regions for every grid, features are extracted from these regions. Normally in other techniques features are extracted from the pixels but in this technique,

We extract from the region. The extracted features include the area, orientation, mean, correlation and co-variance of the region. The features give essential details of the region and are used to train the classifier. The classifier used is neural network classifier. The shape, next to colours, is considered as an important characteristic in describing the salient objects in images and can help discriminate between two images and therefore in retrieval.

Mean of the region is found out by adding all the pixel values of the region divided by the number of pixels in the region. Suppose there are N number of pixels in the i^{th} region each having a pixel value P_i then mean of the i^{th} region is given by $\mu_i = \sum P_i/N$.

Covariance is a measure of how much two variables change together. The covariance between two real real valued random variables X and Y with finite second moments is given by: Cov(X,Y)= E[(X - E(X))(Y - E(Y))] , Where E(X) is the expected value of X .

Correlation refers to any of a broad class of statistical relationships involving dependence. Here, correlation of the image is given as the covariance divided by the standard deviation. After extracting the features of the each of the regions, the details are fed into the neural network for training.

3.6 Classification

In-order to detect the presence of the tumour in the input MRI image, we use the neural network classifier to classify the image into timorous or not. Neural networks have come forward as a significant tool for classification. First, neural networks are data driven self-adaptive methods in which they can fine-tune themselves to the data exclusive of any clear specification of functional or distributional form for the unique model. Second, they are universal functional approximates in which neural networks can approximate whichever function with random accuracy. Neural networks are nonlinear models, which makes them suitable in modelling real world intricate relationships. Neural networks are able to approximate the subsequent probabilities, which offer the basis for setting up classification rule and performing statistical analysis. The neural network consists of three layers which are input layer, hidden layer and the output layer.

4. Conclusion

This method an effective modified region growing technique for detection of brain tumour. The technique consists of pre-processing, modified region growing, feature extraction of the region and final classification. The performance of propose technique is evaluated by considering the region growing algorithm and the modified region growing algorithm in terms of the quality rate. The normal region growing has the drawback that noise or variation of intensity may result in holes or over segmentation. Another drawback is that the method may not distinguish the shading of the real images. For improving the normal region growing and effectively tackling the draw backs of a normal region growing, we have added an additional constrain of "orientation". In the modified region growing, there are two thresholds; one is for the intensity and the other for orientation.

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