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Detection and Segmentation of Brain Tumour in MRI in Dwt Plane

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ABSTRACT: Various image segmentation techniques are used in detection of brain tumour. For proper working of body, cells are formed and multiply according to need. Medical imaging faces a big challenge of detecting brain tumour through magnetic resonance images (MRI). MRI is one of different methods that have been used in medical diagnosis of various diseases.

Keywords: tumour, MRI, features, feature extraction, classification, ground truth evaluation.

I. INTRODUCTION

Brain tumour is an abnormal growth of cells inside the brain. This may occur at any age [1]. It is one of life threatening disease which requires early detection and treatment for fewer risks to life. Brain tumours are of two types:

A. Benign tumour -.These are less dangerous tumours and can be treated easily. These tumours are also called non cancerous tumours.

B. Malignant tumours - These are fast growing tumours and can spread into surrounding brain. These are cancerous tumours and require radiotherapy and surgery for treatment.

There are different methods opted by medical field for detection of brain tumour. Some of these are

A. Biopsy- A biopsy is a surgical procedure to remove a small sample of tumour for examination under a microscope

B. CT scan – CT scan is a type of X ray that creates a 3 dimensional picture of head when patient is diagnosed with brain tumour.

C. MRI- Raymond V. Damadian invented MRI in 1969. MRI results in good contrast of tissues and better quality of image as compared to other techniques [2].

Difficulties in segmentation of brain MRI:

Though MRI is the best method for detection of brain tumour, there are some difficulties in using MRI:

A. Noise: random noise that is present in MRI results in faults in tumour segmentation [3].

B. Intensity in homogeneity: non uniformity during data collection results in shading effect [4].

As a result there is a strong demand of automated tumour detection and segmentation process.

II. IMAGE SEGMENTATION

Image segmentation helps in dividing a digital image into two or more segments. The goal of segmentation is to convert an image into something that is more meaningful and easier to analyse. Automated detection of brain tumour using MRI helps in reducing the time taken for detection. General steps involved in image recognition are:

Training

1. Get training data set
2. Pre-processing e.g. denoising, normalization, scaling, contrast equalization, binarization.
3. Feature extraction (e.g. DWT, DCT, DFT etc.)
4. Machine learning (e.g. neural network, SVM)
5. Check results on how good you are, and see whether you need more data. If so, go to step 1 and repeat the process again.

Recognition:

1. The same pre-processing in training
2. The same feature extraction in training
3. Feed your features into the trained classifier
4. Output classification results.

The image segmentation and detection approaches were studied under following categories

A. Thresholding approach
B. Region growing approach
C. Clustering approach

A. Thresholding based methods

Thresholding helps to find out an intensity value called threshold. In thresholding segmentation is done by grouping all pixels with intensity greater than the threshold into one class and all other pixels in another class. It helps in segmenting light objects in darker background [5].

From a grayscale image, thresholding can be used to create binary images. The simplest thresholding methods replace each pixel in an image with a black pixel if the image intensity is less than threshold value or a white pixel if the image intensity is greater than threshold value. Thresholding is done to extract pixels from some image which represent an object. Though the information is binary the pixels represent a range of intensities. Thus the objective of binarization is to mark pixels that belong to true foreground regions with a single intensity and background regions with different intensities.

B Region growing based methods

Region growing is a pixel-based image segmentation method. In this the pixels that are close to one another and have similar intensity values belong to the same object. The main objective of segmentation is to separate an image into regions. Segmentation is done by using grey values of the image pixels. Firstly in region growing, select a set of seed points. Seed point selection is based on gray scale range. The regions grow from seed points to nearby points depending on properties of pixel. When one region stops growing, choose another seed pixel which does not yet belong one of the regions and start again. The process is continued until all pixels belong to some region.[6]

Region split and merges: here image is divided into detached regions and merge the regions [5].

Region growing methods used so far are:

1. Texture feature FCM [7]: good results in terms of accuracy, effectively extract tumour region from brain MR images.
2. Seed based region growing [8]: here comparison was made between number of pixels of the raw MRI brain images and seed based region growing (SBRG) segmented abnormalities etc.

The main disadvantage of region growing approach is that it needs a seed point at the starting point of the segmentation process. This needs user interaction. Due to the differences in image intensities and noise, region growing can effect in holes and over segmentation.

C. Clustering based methods

Clustering is an unsupervised learning which deals with finding a structure in a collection of unlabelled data. Clustering is a method of grouping similar data and distinctly separating them from the dissimilar data. An important component of a clustering algorithm is the distance measure between data points. Lesser the distance greater is the similarity. There are different clustering methods used.

A. Fuzzy c mean [9]: Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. Each element of data is given a membership level. The membership level indicates the strength of the association between that data element and a particular cluster. Fuzzy clustering is a process of assigning these membership levels, and then using them to assign data elements to one or more clusters..

B. Fuzzy pessimistic means [10]: The method uses hybrid segmentation method which is combination of region and boundary information of image to segment the tumour.

More methods that have been used for segmentation and detection are:

A. Watershed segmentation: This method has been used in combination with active contour or edge detection [11]. It leads to less computational over heads and accuracy but fails by giving over segmented results.

B. K means: This is an unsupervised clustering method which takes less time for detecting tumour [12].

C. Entropy based segmentation: It uses entropy as the basis to measure the uniformity of pixels within a region. Entropy is the grey level of any individual pixels.[13]. Difficulty in this method is that the selection of number of grey levels is crucial.

D. Support vector machine: SVM is based on decision planes that define decision boundaries. Drawback of SVM is in size and speed during training and testing phase. The working of SVM is degraded in testing phase. It needs high memory for large scale tasks [13].

E. Mathematical morphology: DWT k means: it is applied for improving quality of image using morphological operations, wavelet transform is used to decompose MRI and k means is applied to extract tumours from brain.

III. FEATURES FOR BRAIN TUMOUR

Feature extraction is mainly done to obtain relevant information from the original data and represent that information in lower dimensionality space. Feature extraction process is classified into two steps

-Feature selection
-Classification

There are different types of features of MRI image, whose extraction takes place using various feature extraction techniques. Features that can be extracted are:

1. Size: There are numerous studies to build estimation model of growth and size of the tumour. This feature helps in differentiating between malignant and benignant tumour [14].

2. Colour: This is one of essential feature which can be used in detection of brain tumour [15].

3. Edge: This feature helps in detecting the boundaries of an image part.

4. Contrast: It plays an important role in differentiating tumorous and non tumorous part of brain MRI [16].

5. Statistical: Features like mean, median variance etc are used to find segment an image based on intensity levels.[17]
6. Morphological features: Shape is essential feature to detect tumour.
7. Entropy: Tumour part has more energy and entropy as compared to normal tissues. So this feature can be used to find out tumour regions.
8. Inhomogenity: The tumour part becomes less uniform and less homogeneous as compared to parts which does not have tumour. Homogeneity reflects the uniformity of the elements of an object and express how similar they are.
9. Smoothness: It is one of the texture feature method which helps us to detect smooth and non smooth tissues for tumour detection [18].

IV. CLASSIFICATION

Image classification is used to put data into different categories according to their numerical values of image features. Classification consists of two parts: *training* and *testing.* Classification system consists of database that contains patterns which are used to compare detected object and predefined pattern to put in particular class. Image classification is needed in various applications like medical imaging, artificial intelligence, biometry, robot navigation, and remote sensing. There are different types of classification techniques used in image processing [19]:

1. Artificial Neural network: ANN Classification is used as a learning tool for separating samples. Samples having same features are categorized into one category. Having it automated provides speeding up of the system, and the faster we can be in treating the patients. It involves human like thinking and they can handle noisy or missing data. They can work with large no. of variables and provide good accuracy results. Performance and accuracy depends upon the network structure and number of inputs.
ANN is capable of performing logical functions used in MATLAB. It efficiently handles noisy inputs and computation rate is high [19].
2. Decision tree: DT calculates class membership by partitioning a dataset into uniform subsets. Hierarchical classifier permits the acceptations and rejection of class labels at each intermediary stage. This method consists of 3 parts: Partition the nodes, locating terminal nodes and allocating class label to terminal nodes. DT is simple and computational efficiency is good [19].
3. Support Vector Machine: The SVM algorithm was invented by Vladimir N. Vapnik in 1963. It helps in pattern recognition. It represents data as points in spaces so that data of separate categories is divided by visible gap that is as wide as possible. They are suitable for Binary classification tasks [19].

V. GROUND TRUTH VALIDATION

Ground truths are measurements that are more correct as compared to the measurements from the testing system. Ground truth database is used in areas, like satellite imagery, machine learning, remote sensing, etc in lots of cases the effect of image processing algorithms cannot be evaluated by device or existing objective indicators, ground truth is often generated manually by human experts in the corresponding fields. Segment the region of interest, but doctor is not around to confirm if the ROI is correct. Thus the ground truth image database is presented for the convenience [20]. For example, there are databases in [20], including medical databases ,face databases, fingerprints databases, gesture databases ,eyes detection, object and shape detection, and so on.

Methods used for validating the ground truth are:

A. True positive rate: when the process of tumour detection is done in an image, the correctness of a class is done on the bases of the amount of genuine positives which means the amount of things accurately marked tumours e.g. positive class may be non-tumour separated by the number of components having a place with the positive class.

B. Specificity and sensitivity: Sensitivity and specificity are terms which are used to calculate the work done by the system. The results are used in considering the estimation of work done. The sensitivity and specificity of a quantitative test are reliant on the cut-off quality above or underneath which the work is positive value.

VII. COMPARISON OF CLUSTERING TECHNIQUES

The matlab function k mean used for k mean clustering to partion the points in form k clusters. This partioning minimizes the overall sum of clusters. K mean uses Euclidean distance for its calculation. For the given dataset for 3 clusters the total sum of distance is 7897.88 and total time elapse is 0.443755 [21].
Similarly applying FCM to same dataset, the function takes the desired number of clusters and returns cluster centres and membership grade for each data point. The process stops when maximum number of iterations is reached. The results are total distance 6058.6899 and total time elapsed is 0.781679.which showed k means is better than FCM [21].

VIII. COMPARISON OF DCT AND DWT PLANE

In biometric recognition i.e. related to human body, feature extraction can be carried out mainly through 2 approaches
A. Spatial domain approach
B. Frequency domain approach

The spatial domain approach utilizes the spatial data directly from image. On other hand frequency domain approach uses DCT for feature extraction. In frequency domain it is not necessary that pixel by pixel comparison is done

-DCT avoids complex arithmetic and offer ease of implementation in practical application.

-DCT can handle most of signal information in a few low frequency components. As a result efficient feature extraction scheme can be made.

IX. CONCLUSION

To detect a brain tumour accurately in an MRI, it is essential to use segmentation method. Information is given in form of images from various sources; these are used in diagnosis of tumours and treatment purpose. The available data uses computation processing to make the decision. Now-e-days, speed of computation is no longer an issue for researchers. As a result, there is need to focus on improvement of outputs from images obtained using detection system to get an accurate picture of the brain tumour.

In this current paper, review of previous work done in field of brain tumour detection is done. Through this review we obtained the conclusion about automation of systems that can be used in detection of brain tumour from MRI images. This is one of the active research area that has been done so far. However, currently there is no clinically accepted automated method.

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