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Brain Tumour Detection Using Self Organising Maps

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Abstract – Brain tumour is one of the serious diseases so it is necessary to have accurate detection at an early stage. Generally by using CT-scan and MRI techniques visual examination is done by doctors for detection of parts of brain having tumour. In this paper self organizing map algorithm is used to carry out brain tumour detection from MRI image. In first stage, image pre-processing is done to remove file artifacts and unwanted skull part then median filter is used for noise reduction. In second stage, segmentation is performed on preprocessed image by self organizing maps method which partitions the image into different regions. SOM is an unsupervised algorithm having high diversity of data. This has been constructed mainly for identifying tissues including White Matter (WM), Grey Matter (GM), and Cerebrospinal Fluid (CSF). At the end of the process tumour is extracted from the MR image and its exact position and the shape is determined.

Keywords— Tracking Algorithm, Skull Removal, Median Filter, Self Organizing Maps Method

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INTRODUCTION

Tumour is an abnormal growth of cells in body which forms a mass of tissues. It can be cancerous, i.e. malignant or non-cancerous, i.e. benign. Malignant tumour involves abnormal cell growth which spreads to other parts of the body. Benign tumour does not spread to other parts of the body. Normally brain tumour affects CSF (Cerebral Spinal Fluid). It causes strokes. The physician gives the treatment for the strokes rather than the treatment for tumour. So detection of tumour is important for the treatment.MRI (Magnetic Resonance Imaging), computed Tomography (CT), Digital Mammography (DM), and other imaging processes give an efficient means for detecting different types of diseases. MRI is used to visualize the internal structures of the body and doctors have different opinions about the images .Therefore, the brain tumour diagnosis at an appropriate time is very necessary. In order to overcome this problem, Image segmentation is applied to MRI images. Image segmentation technique partitions a given image into a finite number of non-overlapping regions to accurately identify tissue structure and perform correct diagnosis.

S Zhu et al. presented an image segmentation method using thresholding technique This is based on the assumption that adjacent pixels whose value lies within a certain range belong to the same class[1]. Manoj K Kowar and Sourabh Yadav described Brain Tumour Detection and Segmentation Using Histogram Thresholding. If the histograms of the images corresponding to the two halves of the brain are plotted, symmetry between the two should be observed along its central axis and if any asymmetry is observed, tumour is detected. This makes image histogram the choice for object delineation and finding an appropriate threshold between object and background fulfils the task of object identification [2]. Victor Chen et al. proposed that Graph based detection of tumour is one of the segmentation technique where tumour is detected based on graph. Graph cut leads to over partitioning of the image [3]. From the above discussion, it can be said that, there is no such technique which is perfect. To get best results we have to minimize the limitation of the individual methods. Therefore the self organizing map segmentation process is used.

PROPOSED METHOD

The proposed method is mainly divided into two stages as pre-processing and combination of image segmentation and classification. The pre-processing is done by tracking algorithm and median filter. Segmentation is carried out by self organizing maps followed by thresholding performed for classification. The block diagram of proposed method is given below:

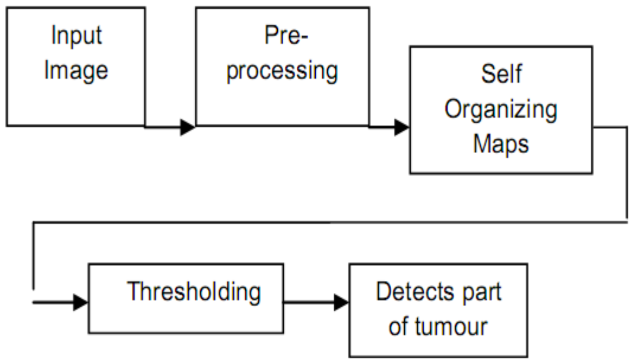

Fig. 1 Block diagram of proposed method

In this process image is segmented by self organizing maps and is classified by thresholding. The entire proposed system consists of mainly three modules under that different algorithms are used. Each module and its function are explained below:

Pre-processing

MRI image is taken as input image. For getting accurate results pre-processing is performed on MRI image. First MRI image is converted into gray scale image. Then pre-processing is done using tracking algorithm, morphological operators and also median filter. The algorithms and results for each method are explained below:

1) Tracking Algorithm:

Film artifacts such as patient's name, labels are removed using tracking algorithm. Here, starting from the first row and first column, the intensity value of the pixels is analysed and the threshold value of the film artifacts are found. The threshold value, greater than that of the threshold value is removed from MRI. The high intensity value of film artifacts are removed from MRI brain image [4].

1. Read the input image.
2. Select the peak threshold value for removing white labels.
3. Set flag value to 40.
4. If the intensity value is less than or equal to 40 then, that pixel is set to zero.
5. Otherwise skip to the next pixel.

Skull Removal Algorithm:

Removal of skull part using erosion and dilation morphological techniques is an effective and fully automated but inefficient way of stripping skull. Erosion and Dilation are two basic operators in the area of mathematical morphology. These are typically applied to binary images, but there are versions that work on greyscale images. Erosion is a technique that uses background and the foreground for the processing. In Brain MRI there is a particular intensity of the back-ground that appears before brain image. Unfortunately in brain MRI, the same intensity appears as a part of the brain. And this appearance is a false background. So that algorithm would be unable to distinguish between the original back ground and the false background.

1. Convert the film artifacts removed image into binary image.
2. Set the disk value to 7.
3. Apply the erosion followed by dilation.
4. Map the result obtained with input image.

3) Median filters Algorithm:

For removal of unwanted part, median filter is applied to remove noise from an image. It is used for removing high frequency components such as salt and pepper noise. Median Filter can remove the noise without disturbing the edges. This technique calculates the median of the surrounding pixels to determine the new value of the pixel. A median is calculated by sorting all pixel values by their size, and then the median value as the new value for the pixel is selected [5].

1. Read the image.
2. Extract matrix of size 3*3 from the given image and apply median filtering.
3. Intensity values of 3*3 matrix are compared with the given range of values.
4. Calculate median value for the above 3*3 matrix.
5. Replace the centre intensity value of the 3*3 matrix by the median value that was calculated.

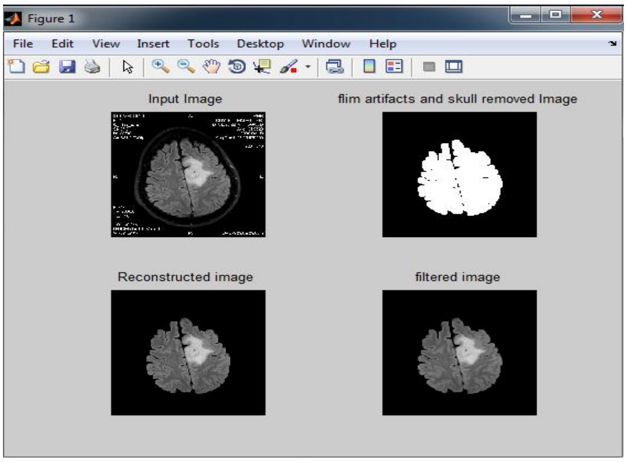

Fig. 2 Screenshot for Output of Pre-processing Stage

Fig.2 shows the output of pre-processing stage from that first image is input MRI image. Then film artifacts and skull part is removed using tracking algorithm and erosion dilation techniques respectively. Hence the reconstructed image is obtained at output. Then to remove noise median filtering is applied.

Image Segmentation

Image segmentation is a method of partitioning the image into different regions and each region contains the pixels of similar intensities. The goal of Magnetic Resonance (MR) Image segmentation is to accurately identify the principal tissue structures in these image volumes. In the specific case of brain MRI, the problem of segmentation is particularly critical for diagnosis and treatment purposes. In this paper image segmentation algorithm is applied to perform segmentation of MRI image which is explained in details below:

1) Self Organising Maps Method:

The Self-Organizing Map was developed by professor Kohonen. The SOM has proved useful in many applications. This is one of the most popular neural network models. It belongs to the category of competitive learning networks. Based on unsupervised learning, which means that no human intervention is needed during the learning and those little needs to be known about the characteristics of the input data. Use SOM for clustering data without knowing the class memberships of the input data. The SOM can be used to detect features [6].

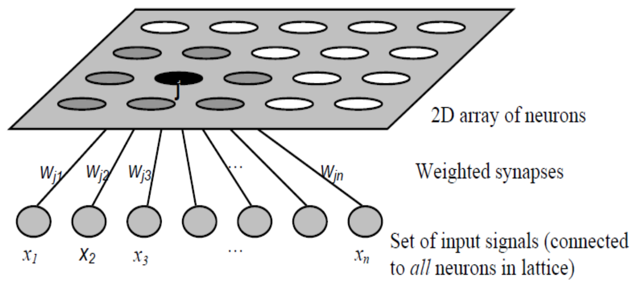

Fig. 3 Self Organising Map

Fig.3 shows the Self-Organizing Feature Map that provides a topology preserving mapping from the high dimensional space to map units. Map units, or neurons, usually form a two-dimensional lattice and thus the mapping is a mapping from high dimensional space onto a plane. The property of topology preserving means that the mapping preserves the relative distance between the points. Points that are near to each other in the input space are mapped to nearby map units in the SOM. The SOM can thus serve as a cluster analysing tool of high-dimensional data. Also SOM has the capability to generalize. Generalization capability means that the network can recognize or characterize inputs it has never encountered before. A new input is assimilated with the map unit it is mapped [7]. An important aspect of an ANN model is whether it needs guidance in learning or not. Based on the way they learn, all artificial neural networks can be divided into two learning categories- supervised and unsupervised. In supervised learning, a desired output results for each input vector and is required when the network is trained. An ANN of the supervised learning type, such as the multi-layer perceptron, uses the target result to guide the formation of the neural parameters. It is thus possible to make the neural network learn the behaviour of the process under study. In unsupervised learning, the training of the network is entirely data-driven and no target results for the input data vectors are provided. An ANN of the unsupervised learning type, such as the self-organizing map, can be used for clustering the input data and find features inherent to the problem [8].

2) Algorithm of Self Organising Maps Method:

Step 1: Training

1. Select output layer topology.

2. Train weights connecting inputs to outputs.

3. Topology is used, in conjunction with current mapping of inputs to outputs, to define which weights will be updated.

4. Distance measure using the topology is reduced over time; reduces the number of weights that get updated per iteration.

5. Learning rate is reduced over time.

Step 2: Testing

1: Randomize the maps nodes weight vectors.

2: Grab an input vector.

3: Traverse each node in the map

4: Use Euclidean distance formula to find the similarity between the input vector and the weight vector.

5: Track the node that produces the smallest distance (this node is the best matching unit, BMU)

6: Update the nodes in the neighbourhood of BMU by pulling them closer to the input vector.

Wv(t+1)=Wv(t)+ alpha(D(t)-Wv(t)) Increment t and repeat from 2.

Alpha = monotonically decreasing learning coefficient. It is 1 for neurons close to BMU and zero for others.

D (t) = input vector

Neighbourhood function shrinks with time. At the beginning, when the neighbourhood is broad, the self organizing takes place on a global scale. When the neighbourhood has shrunk to just a couple of neurons, the weights are converging to local estimates.

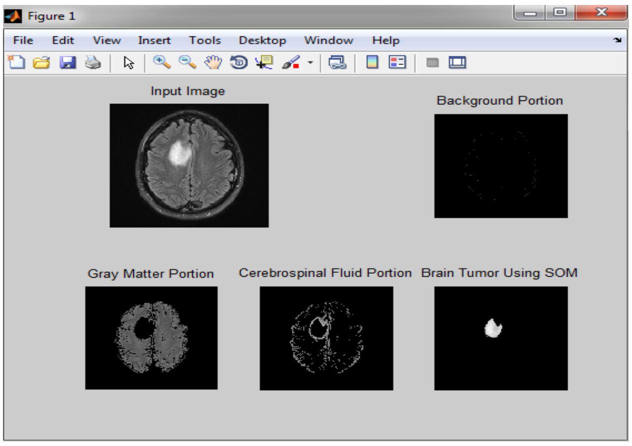

Fig. 4 Output of a Self Organising Maps Method

Fig.4 shows the output of self organizing maps method. This result shows background portion, gray matter, CSF portion and then finally separates exact tumour part from MRI image. The results are shown after performing the thresholding.

CONCLUSION

In this paper, we have performed image segmentation techniques viz. self organizing maps for detection of brain tumour from sample MRI images of brain and detect the location of the tumour. The output image clearly shows the tumour cells. The parameters used in thresholding are very difficult to determine because the factors used for one image may not work for other image. This parameter may be different for different images. If we have an image with noise, this will affect the segmentation. So we have not used it directly on input images. The use of median filter in pre-processing stage removes noise from the MRI image which was then passed for further processing. Thus self organizing maps give accurate result for identifying the location of brain tumour.

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