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Density Estimation of Brain Tumour using Markovian Random Function in Magnetic Resonance Images

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Abstract: Tumour is a mass of tissue that grows out of control of the normal forces that regulates growth. Brain tumour is abnormal and uncontrolled proliferations of cells. Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) are the two most common tests undertake to confirm the presence of brain tumour and to identify its location for selected specialist treatment options. Brain tumour in MRI has been recent area of research in the field of automated medical diagnosis as the death rate is higher among humans due to brain tumour. In automated medical diagnostic systems magnetic resonance images (MRI) gives better results than computed tomography (CT) as magnetic resonance imaging provides greater contrast between different soft tissues in our human body. Therefore MRI is much efficient in brain and cancer imaging. There is number of methods already presented for brain tumour segmentation. But these methods have so many disadvantages on the SNR ratio and efficiency. The method of brain tumour segmentation is nothing but the differentiation of different tumour area from Magnetic Resonance (MR) images. There are number of methods already presented for segmentation of brain tumour efficiently. However it's still critical to identify the brain tumour from MR images. The algorithm proposed here for segmentation is focuses to segment the image depth wise usually colour segmentation. The density can be calculated by considering the area of the tumour.

Keywords: depth estimation; markovian segmentation; k means clustering; density estimation.

I. INTRODUCTION

Brain tumour in MRI has been recent area of research in the field of automated medical diagnosis as the death rate is higher among humans due to brain tumour [1].

According to International agency for research on cancer approximately, more than 126000 people are diagnosed for brain tumour per year around the world with more than 97000 mortality rate [3]. Magnetic Resonance (MR) imaging and computer tomography (CT) scanning of the brain are the most common tests undertake to confirm the presence of brain tumour and to identity its location for selected specialist treatment options. Magnetic Resonance Imaging is high quality medical imaging, particularly for brain imaging. MRI inside the human body is helpful to see the level of detail. In automated medical diagnostic systems magnetic resonance images (MRI) gives better results than computed tomography (CT) as MRI provides greater contrast between different soft tissues in our human body. Therefore MRI is much efficient in brain and cancer imaging [2].For the early detection of brain tumours there are many imaging methods for diagnostics purpose are presented. These imaging techniques are Positron Emission Tomography (PET), magnetic Resonance Imaging (MRI), and computed Tomography (CT). Among all this imaging technique, MRI is most efficient for the research of brain tumour detection and classification as compared to other imaging techniques. This is because of high contrast of soft tissues, high spatial resolution as well as it does not produce any harmful radiation reliable and fast detection and classification of brain tumour. Currently there are different treatment options available for brain tumour. The treatment option depends on the size, type and grade of the tumour. Under certain conditions, brain cells grow and multiply uncontrollably because for some reasons, the mechanism that control normal cells is unable to regulate the growth of brain cells. The abnormal mass of brain tissue is the brain tumour that occupies space in the skull and interrupts the normal functions of brain and creates an increasing pressure in the brain. Due to the increased pressure on the brain, some brain tissues are shifted, pushed against the skull or are responsible for the damage of the nerves of the other healthy brain tissues [4].

The brain tumour can be classified according to the location of the tumour, type of tissue involved. It is classified as primary and secondary tumour cells. Primary brain tumours are the tumours that originate in the brain. They can be benign (non-cancerous) and malignant (cancerous). Benign tumours grow slowly and do not spread on surrounding tissues but malignant tumours can grow more quickly and spread to other tissues. Secondary brain tumours originate from another part of the body that has spread to the brain. Magnetic Resonance Imaging is an

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imaging is an imaging technique used primarily in medical settings to produce high quality images of the inside of the human body. In MRI signal processing considers signal emissions. The signal processing has three different images that can be achieved from the same body: T1-weighted, T2-weighted and PD-weighted (proton density). MRI is a clinical imaging modality effective for anatomical and functional imaging of diseased soft tissues, including solid tumours. MRI contrast agents have been routinely used for detecting tumour at an early stage. Gadolinium based contrast agent (CA) are the most common used contrast agent in clinical MRI. By means of using gadolinium a radiologist can easily identify the contrast of an MRI. The diagnosis of brain tumour involves pre-processing, feature extraction, image segmentation and image classification. This paper presents an advanced techniques used during brain tumour detection. This approach is taken into consideration by image pre-processing followed by segmentation. The colour based segmentation is done by Markovian Random Field. Then goes to classification to check whether the tumour is benign or malignant. Finally the density of the tumour is calculated by considering whether the tumour is calculated by considering the volume of brain portion and tumour portion.

II. PROPOSED METHOD

Detection of brain tumour from MRI images involves various phases such as pre-processing, feature extraction, segmentation and classification. Pre-processing techniques are applied to improve the quality of image.MR image segmentation is based on set of measurable features which are extracted. Image segmentation group pixels into regions and hence defines the object regions. Classification is used to classify whether the image is benign and malignant.

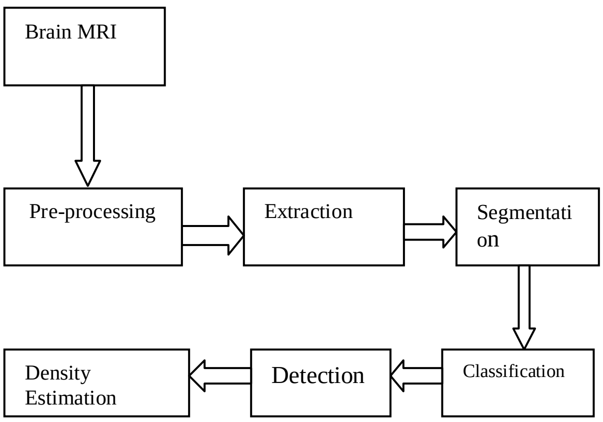

Fig 1: Block Diagram of proposed method

A. Pre processing
The input images are brain Magnetic Resonance Images in axial plane and 256*256 in-plane resolutions. Image processing is one of the preliminary steps which are highly required to ensure the high accuracy of the subsequent steps. Pre-processing of image is done to reduce the noise and to enhance the brain MR image for further processing. The pre processing part of digital MRI refers to the sweetening of MRIs intensity and distinction manipulation, effect of noise reduction, unwanted background removal, edge sharpening and filtering. The purpose of this step is basically to improve the image quality.

$$F(x,y) = \text{median}\{g(s,t)\} \quad (1)$$

Median filter is applied on brain MR image in order to remove the noise. Median filters are quite popular because, for certain types of random noise, they provide excellent noise-reduction capabilities, with considerably less blurring than linear smoothing filters of similar size.

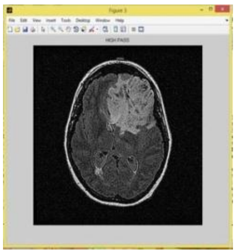
Fig 2: actual image

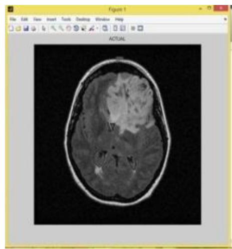
Fig 3: filtered image

Median filters are particularly effective in the presence of both bipolar and uni polar impulse noise. The obtained image is then passed through a high pass filter to detect edges. The edge detected image is added to the original image in order to obtain the enhanced image.

B .Feature extraction
The main portion or region of interest is been detected for further process and are done based on thresholding. This method is done to find the actual area of tumour spreaded throughout the brain images. Normal and simple method that is canny edge detection is done to find the edge features so that the outline of the tumour is obtained and through which the area of spreading of fibro-glandular is detected. Edge detection refers to the process of identifying and locating sharp discontinuities in an image.

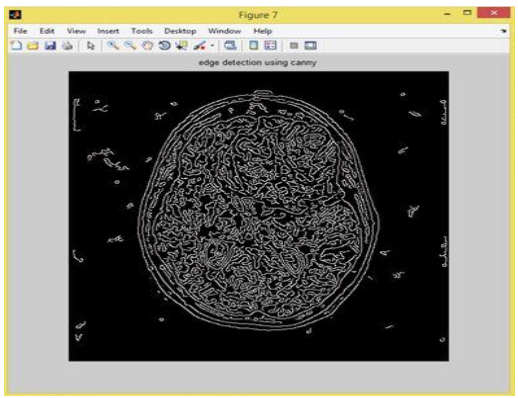

Fig 4: canny edge detection

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The discontinuities are abrupt changes in pixel intensity which characterize boundaries of object in a scene. There are an extremely large number of edge detection operators available, each designed to be sensitive to certain type of edges. The purpose of edge detection in general is to reduce the amount of data in an image, while preserving the structural properties to be used for further image processing. An edge in an image may point in a variety of direction, so the canny algorithm uses four filters to detect horizontal, vertical and diagonal edges. The edge direction operator (Robert, prewitt, sobel) return a value for the first derivative in the horizontal direction (G_x) and the vertical direction (G_y).Thus edge gradient and direction can be determined

$$G = \sqrt{Gx^2 + Gy^2} \qquad (2)$$

Edge direction angle is determine,

$$\theta = \arctan(Gy/Gx) \qquad (3)$$

C. Segmentation

Segmentation refers to the process of partitioning a digital image into multiple segments. Image segmentation is typically used to locate objects and boundaries in image. Image segmentation can also be defined as a technique which partitions a given image into a finite number of no-overlapping regions with respect to some characteristics. K-Means Clustering partition the n observations into k clusters in which each pixel belongs to the clusters by minimizing an objective function in a way that the within cluster sum of squares is get minimized. It starts with initial K cluster centres and it reassigns the observations to clusters based on the similarity between the observations and cluster centre. Automation of detection and segmentation of brain tumours in MRI images is a very challenging task due to occurrence of high degree of gray-level similarity in the image. In the first step, skull stripping is performed by generating a skull mask from the MRI image and in the second step, an advanced K-means algorithm improvised by two-level granularity oriented grid based localization process based on standard local deviation is used to segment the image into gray matter, white matter and tumour region and then length and breadth of the tumour is assessed. K means method is the simplest methods in un-supervised classification.

It does not require training data and also an iterative procedure. It clusters data by iteratively for each class and segmenting the image by classifying each pixel in the class with the closest mean.

D. Markovian Random function

Markov random fields (MRFs) have been widely generated in the field of image processing is for computer vision problems, like image segmentation [3], surface reconstruction [4] and depth inference [5]. Different steps of algorithm are convert the image to 2D gray-level, finding the intensities based on the Gaussian distributions and segment are labelled:

EM- Algorithm: Used to find the parameter set, this algorithm consists of E- step and M –steps.Where E-step is based on the iterations and M-steps is based on the energy functions.

MAP- Estimation: Used for finding the sum of energy function and to minimize the energy value. The difference between MRF and HMRF is that, in HMRF, the parameter set is affected in an unsupervised manner. Un supervised means there is no training set, and assumption for no prior knowledge is known about the foreground, background intensity distribution. Thus a natural proposal for solving a HMRF problem is to use the EM algorithm, where parameter set and label configuration are learned alternatively. It is a mathematical symbol model and can be computed efficiently. This method only uses the intensity parameter for segmentation. This estimation is done for the detection of the prior energy function and also which issued for the final step of the algorithm. This is based on the neighbourhood pixel comparison just like in the case of median filter. In GMM Based HMRF Gaussian mixture model (GMM) made to make a powerful enhancement modelling the complex distributions than one single Gaussian distribution. The M-step of the EM algorithm the changes to a Gaussian mixture model fixes a problem. The GMM fitting problem itself can be solved using an EM algorithm.IN E step we determine which data should belong to which Gaussian component; in the M step; re-compute the GMM parameters.

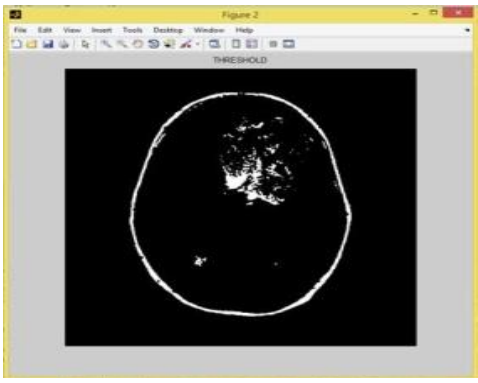

Fig5: Threshold image

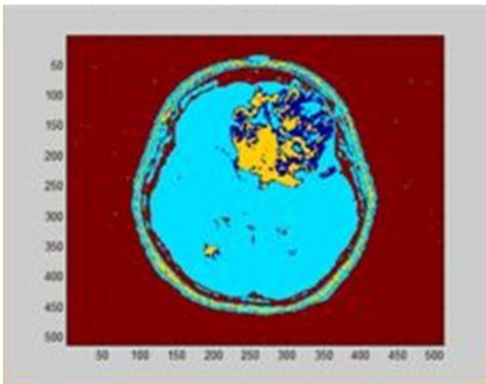

Fig 6: Markovian Segmentation

E. Density Estimation

This mainly refers for the volume detection. Density can be estimated by taking difference between the total volumes of the brain with volume of tumour part estimated by MRF

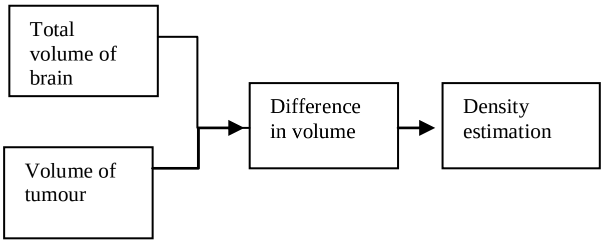

Fig 7: Block Diagram of Density Estimation

III. RESULTS AND DISCUSSION

Here, it is seen that brain tumour can be extracted using markovian random function. Image is segmented depth wise. The response showing sum of iterations and energy is shown below.

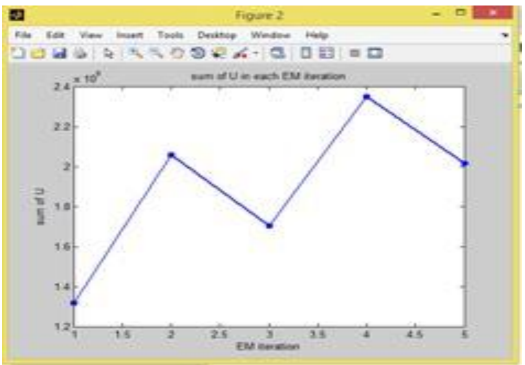

Fig 8: Response showing sum of energy versus iteration

Table 1: Comparison of Density

Comparison of Density	
SI No	Density
Patient 1	6.625
Patient 2	9.004
Patient 3	9.954

Table 2: Comparison of various methods

Comparison of results	
Method	Accuracy (%)
Proposed method	96.88
K-SVM	95.79
SVM	92.89
KNN	94.78

IV.CONCLUSION

A general introduction of the potential and challenges of brain tumour detection was given. With digital imaging taking part in a progressively outstanding role within the diagnosis and treatment of diseases the matter of extracting clinically useful data has become vital. The segmentation of those brain MRI features becomes a key challenge for correct analysis, visualization and quantitative comparison. The images that suffered from non-uniform illumination and poor contrast were subjected to pre processing before they are subjected to segmentation. This algorithm focuses to segment the image depth wise. Here the identification of malignant and benign cells is done more easily and also to increase the efficiency of the Brain magnetic resonance images .A k-mean clustering in a modified way is also called markovian function method.

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