Detection of Brain Tumour Using Statistical Features and Thresholding Algorithm

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Abstract: **A tumour is an uncontrolled growth of abnormal cells.Brain tumour is a very serious issue which has hazardous impacts worldwide which even causes death. Magnetic Resonance Imaging (MRI) gives important information about the internal structure of the human brain. This paper proposes an effective detection of brain tumour using thresholding and watershed segmentation algorithm. Thresholding is the simplest segmentation method through which thepixels arepartitioned depending on their intensity value.Watershed segmentation pays particular attention to the boundary situations. Statistical features are extracted from the segmented image. In the proposed work thresholding is applied on features to obtain the effective detection of brain tumour.**

I.INTRODUCTION

A tumour is an uncontrolled growth of abnormal cells. Tumours that are located within the brain are called brain tumours and can be classified into two categories such as Primary Brain Tumours and Secondary Brain Tumours.

Glioblastomamultiforme (GBM) is the most lethal and aggressive form of primary brain tumour. It is a grade IV type of brain tumour. Median survival for patients with glioblastoma is 12-15months. GBM is derived from the malignant transformation ofglialcells. Medical imaging plays an important role in the diagnosis of GBM. Typically post-contrast magnetic resonance(MR) imaging is used for diagnosis followed by biopsy for pathological validation. The current standard of care for patients with GBM is surgicalresection of the tumour followed by radiation therapy. Radiation therapy damages the genetic material (DNA)within tumour cells and limits their ability to successfully reproduce. Tumour cells areless able to repair DNA than healthy cells. Radiation injury (RI) is an undesirable but unavoidable side effect of radiation treatment.

Brain metastasis is common among patients with systemic cancer.Approximately 150,000 brain metastases are diagnosed. Brain metastasis (MET) is thought to occur when the primary tumour acquires the ability to migrate away from the primary site and travels to the brain.The most common origins of brain metastasis are breast cancer, melanoma and lung cancer. Metastasis often causes severe neurological symptoms.

Treatment assessment is critical for measuring tumour response to therapy. Thedevelopment of contrast-enhanced CT and MR imaging has allowed radiologists to assess therapeutic response more accurately and reproducibly in patients with brain tumours .Advanced CT and MRI techniques are currently being used in research settings as response assessment tools for brain tumour patients and are based on detecting cellular changes, and detecting changes in metabolic and hemodynamic activity.

The rest of the paper is organised as follows: Section II deals with related works of brain tumour detection. Section III describes the proposed work. Section IV discusses the experimental results. Finally, Section V concludes the work.

II.RELATED WORK

Komal Sharma and Akwinder Kaur proposed the work on brain tumour detection system based on machine learning algorithms. The texture features of the image considered in this proposed work include energy, contrast, correlation, homogeneity.The maximum accuracy 98.6% and 91.6% is achieved by considering 212 samples of brain MR images. This accuracy can probably be increased by considering a large data set [10][1]

*.Priyanka, Balwinder Singh*conducted a research for accurate detection of brain tumor using clustering techniques thus giving efficient end results for detection of tumors[8]

S. M. Ali, Loay Kadom Abood, and Rabab SaadoonAbdoon proposed the method which performs better than the existing works. Feature extraction was done by using gray level co-occurrence matrix(GLCM) and image was segmented using k-means clustering which gives effective results[2][7].

Nagesh Subbanna and Doina Precup presented a new iterative, multi-stage graphical model framework aimed at segmenting pathology Comparison of the segmentation results of the proposed method was presented on the live challenge website [6] for entire tumour, tumour core and enhanced tumour for real, clinical cases. Their technique outperformed the winner by about 25% for tumour cores, and by about 5% for enhancing tumours[3].

Arus, C., Celda, B., Dasmahaptra conducted an experiment for Diagnosis and consequently treatment of brain neoplasm's may greatly benefit from the introduction and utilization of intelligent systems in the form of automatic processing, classification, evaluation and representation of the spectroscopic data as part of the clinical routine. Major progress has been made in the last few years towards this direction, as several systems exist. The quantification of the imaging profile of neoplasm's by combining conventional MRI and advance imaging techniques are critical underlying pathophysiological information which seems to be the key to success.

III.PROPOSED WORK

Fig. 1depictsthe block diagram of the proposed work. The three main stages of this approach are pre-processing, feature extraction and image thresholding.

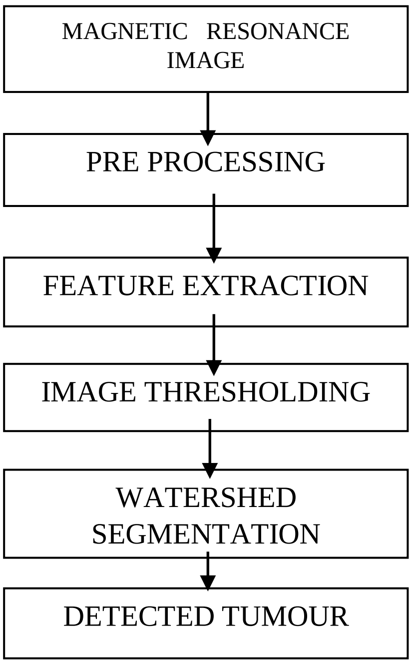


Fig.1 Proposed Methodology for the Detection of Brain Tumour

a) Pre-processing:

It is well known that the most noise in MR Images is random. Gaussian distribution is used to characterize it statistically.

In this paper high pass filter is used for removing noise from the MR Image. A high-pass filter can be used to make an image appear sharper.

High pass filter is used to preserve the edges of the image and can often improve an image by sharpening.

The main objective of pre-processing is to remove the noise present in the images thereby reducing the chances of over segmentation.

b) Feature Extraction:

The most common first-order statistical features are the mean, standard deviation, skewness and homogeneity.

Mean of the histogram is the mean of the gray-levels in an image.

$$\bar{x}=\frac{1}{n}\sum_{i=1}^{n} x_i$$

x = gray levels

n = number of gray-levels

Standard deviation is a measure of how far from the mean the gray values in the

image are distributed.

$$s=\sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n}}$$

Skewness of the histogram refers to the asymmetry of the distribution of the grayvalues. A distribution is symmetric if the right side of the distribution is similar to the left side of the distribution. If the distribution is symmetric, then the skewness value is zero. A distribution with an asymmetric tail extends to the right is referred to as positively skewed, while a distribution with an asymmetric tail extend to the left is referred to as negatively skewed.

The skewness of a distribution is:

$$S_k=\frac{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^3}{n}}{\left[\sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n}}\right]^3}$$

Homogeneity is used to relate the information which extracts from an image and reflects the uniformity of a region . It plays an important role in image segmentation proccess. Homogeneity can be defined by the combination of two components namely, Standard deviation and discontinuity of the intensity value I=(R+G+B)/2. Homogeneity measures the local homogeneity of a pixel pair which are similar.

$$H=\sum_i\sum_j\left(\frac{p[i.j]}{(1+(|i-j|))}\right)$$

c) Image Thresholding:

The simplest property of the pixels in a region can share is intensity. So, a natural way to segment such regions is through thresholding, the separation of light and dark regions. This method replace each pixel in an image with a black pixel if the image intensity I is less than some fixed constant T (that is, I<T), or a white pixel if the image intensity is greater than that constant. The results occurs in the dark tree becoming completely black, and the white snow becoming completely white. Graythresh(I) computes a global threshold (level) that can be used to convert an intensity image into a binary image. The normalized intensity value lies in the range [0, 1].The graythresh function uses Otsu's method, which chooses the threshold to minimize the variance of the black and white pixels. The graythresh function ignores any nonzero imaginary part of I.The effectiveness metric is a value in the range [0 1] that indicates the effectiveness of the thresholding of the input image. The lower band is attainable only by images having a single gray level, and the upper band is attainable only by two-valued images.

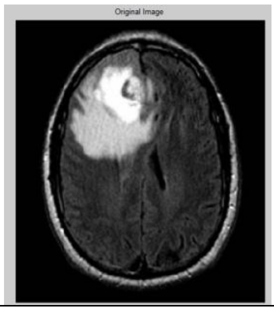
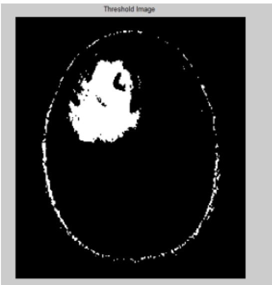
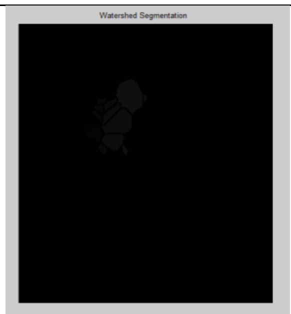
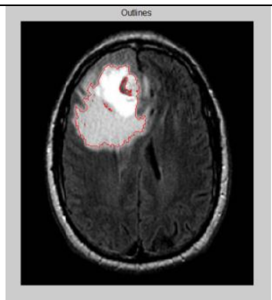
$$G(x,y)=\begin{cases}0 & f(x,y) \geq T \\ 1 & f(x,y) < T\end{cases}$$

d) Watershed Segmentation:

Watershed segmentation pays particular attention to boundary situations. Separating touching objects in an image is one of the most difficult image processing operations. Watershed segmentation is applied to this problem.The advantages of this algorithm are providing closed contours which appear in the image as obvious contours and finding the union of all the regions from the entire image region.It finds catchment basins and watershed ridge lines in an image by treating it as a surface where light pixels are high and dark pixels are low.Morphological operators are used to remove the dark spots and stem marks which results in good foreground markers.

IV.EXPERIMENTAL RESULTS

The experimental results of the various steps involved in the proposed method are shown in fig.1. The proposed segmentation results are compared with simple thresholding algorithm.It is observed from the results that the approach provides effective segmentation with better spatial resolution.

	ORIGINAL IMAGE
	PRE PROCESSED IMAGE
	THRESHOLD IMAGE
	SEGMENTED IMAGE
	DETECTED TUMOUR

The several parameters for the detected image is given in Table.1

S.NO	Perimeter (mm)	Centroid	Diameter (mm)	Elapsed Time (sec)
1	**351.7**	**85.4**	**66.0**	**11.4**

Area (mm^2)	Mean	Standard Deviation	Homogeneity
3425	**51.5**	**41.5**	**68.0**

V. CONCLUSION

This paper presents a novel approach for the detection of brain tumour using Thresholding and Watershed segmentation algorithms. Using statistical features such as mean, standard deviation and homogeneity, the tumour has been detected effectively. Compared to the previous works, the results obtained from thresholding and watershed segmentation is found to be promising.

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