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Prognostic Study of Malignancy in Brain Tumor Using Fuzzy Image Processing Algorithm

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ABSTRACT

It is a medical challenge how to quickly and accurately diagnose brain tumor. In many cases the lesions of benign and malignant are difficult to differentiate. Physical examination and history of affected individual is recorded. CT, MRI and angiography are variety of brain imaging techniques. So far there are many imaging algorithms approaches that are used for brain lesion recognition but effective recognition is always remains a challenge. In this paper fuzzy min-max image processing algorithm is proposed. Image processing is usually a four step process mainly includes preprocessing, segmentation, feature extraction, accuracy detection. These stages are used to detect exact location of brain tumor. Study revealed that age, blood supply, Oedema, post contrast enhancement, signal intensity of T-1 weighted image etc. were the important investigation parameters. There were more than 20 fields which can be taken into consideration while performing image algorithm. Experiment result has been evaluated based on accuracy, specificity, sensitivity & dice similarity index. As studied the propose method will achieve accuracy of about 85% by considering six-seven features. Current approach is a review on advantages and disadvantages of medical imaging applications.

Keywords: Brain Lesions; Segmentation Methods; MRI; Image Processing; Fuzzy Algorithm

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INTRODUCTION

Commonly tumor can be categorized as: 1) Benign; 2) Pre-Malignant; 3) Malignant (cancer can only be malignant) [1]. At present, brain tumors can be considered to be primary or metastatic brain tumors. In former, tumor begin and stay in the brain and in later, tumor begin as malignant elsewhere in the body and spreading to the brain[2].

The two key elements involve for cancer cell growth is qualitatively given by the equation:

Rate of change of tumors cell density= diffusion (invasion) of tumors cells+net proliferation of tumors cells.

To judge whether a tumor is low or high grade benign or malignant and primary or metastatic is always challenging. The effectiveness in the cure of tumor lies in the diagnosis, i.e. how precisely and effectively tumor has diagnosed but the task to distinguish between these tumors is difficult, therefore for precise diagnosis gross tumor resection or stereotactic biopsy is required. Another biggest problem is preoperative grading of glial tumors by noninvasive techniques. Major problem faced is finding regular and interpretable patterns (like round, ellipse and irregular).In order to describe the relationship between features extracted from imaging technology and degree of malignancy , some parameters must be taken into consideration.

i) Accuracy: mostly by experts, accuracy of regular pattern to be considered is over 80%.

ii) Robustness: all the patterns like round, ellipse and irregular are considered as adjectives of other. Exact analyses of shapes are usually impossible. Any regular pattern must be as robust as possible to the kind of uncertainty. [3].Pathology report may include the results of genetic information and molecular diagnostic of the cell. Such investigations may give results for the presence or absence of cancer cells, and the abnormalities present in the chromosomes (as broken, missing or extra) in the specimens. Even though there have advantages, but to predict brain tumor with high accuracy is the most challenging task. The purpose of this study is to combine image analysis algorithms with the mathematical calculations in order to attain brain tumor detection with higher accuracy using image processing tools and identified tumor image as benign, pre-malignant or malignant in the least possible computation time.

LITERATURE REVIEW

For evaluating exact results various promising physiological imaging technologies are present but these require further calculation and calibration before being integrated. A segmentation method for MRI-based brain tumor was discussed by Jin Liu et al. A new method is proposed, which preliminary provides approach for physician based on diagnosis, tumor monitoring, and therapy planning. The brain tumor automatic segmentation technology predicts disease outcome and recovery chances and optimizes treatment options [2]. In the field of medical image analysis, most of the cases of brain tumor segmentation and lesion recognition algorithms generate reasonably good results, but still clinicians rely on manual segmentation for brain tumor in several cases because of the lack of communication between researchers and clinicians. Existence of plenty of tools aims to do useful research but it is hardly useful for clinicians. As most of the researches are theory based. Therefore, in future it will be the matter of research, to effectively merge the developed tools into more user friendly environments. Imaging methods used for detection of tumors, preprocessing of MRI images and brain tumor segmentation methods i.e. Edge-based Segmentation, Pixel-Based Segmentation, Segmentation Using Histogram Thresholding [4]. Other technique used for segmentation of tumor is a whole-brain diffusion tensor imaging (DTI) segmentation (D-SEG) to delineate tumor volumes of interest (VOIs) for subsequent classification of tumor type. D-SEG, a fast segmentation and visualization technique [5]. There are varieties of technologies used for imaging brain tumor and for detecting response. Emerging techniques such as Diffusion MRI, Na MRI and CEST require more validation. Now a days recommendations and suggestions are given for pre and post contrast, Volumetric acquisition of T1-weighted images and PET imaging[6].To detect the degree of malignancy fuzzy functions based on image processing approach will be used. LSM (Least Square Estimates) function identification method to determine fuzzy function. Another technique used for diagnosis of the tumor which requires less computation steps with less computational complexity is Type-2 fuzzy image processing expert system, also there is no need to apply fuzzification and defuzzification for this methods [7]. Researches are always worked to get better results, but still there exist need for improvement in transformation techniques, for accurately detecting the location of brain tumor. The necessity for improvement of transform lies in the fact that some images are very noisy, so image processing becomes a very complex task [8]. Noise is removed first from the image and then pixel values are adjusted so that they will help to obtain the well segmented image, which is a close, smooth and accurate final contour with low computational complexity. Another method is used which combines data pre-processing using wavelets with classification using Artificial Neural Network. [9]. Using the combination of Biortogonal (3.3) wavelet and Rigsure-Sln-Hard, we get better result without loss of relevant information. Higher accuracy is achieved by MLP-multilayer perceptron network with error back propagation (BP) algorithm but this algorithm is difficult to understand [10]. The pre-operative assessment used to detect degree of malignancy in brain tumor is based on MRI imaging and clinical data but due to the uncertainty in data and missing value the result obtain are not accurate, so a fuzzy extraction algorithm based on fuzzy min max neural network(FMMNN) was used[11,12,13].

PROPOSED FUZZY ALGORITHM

Clinical report study is subjective findings, which uses conventional study methods by a human observer, due to human intervention inaccuracy and uncertainty unavoidably exist in some cases. To deal with them, symptoms of the same feature should use a fuzzy imaging algorithm. Assuming that set containing possible symptoms contain more than one valid element maxi and minj, where maxi> minj.

A medical case can be recorded as

{(s1,s2,s3,….sn),(a1,a2,a3,…..am),d,Id}…(i) Here s1…sn are symptoms on different features Fi ($1 \leq i \leq p$); si ϵ Vi ($1 \leq i \leq p$)….. (ii)

Where Vi is the set containing all possible symptoms on Fi; d denotes the result of diagnosis; and Id is the identity of the case. Taking the symptoms all valid descriptions can be sorted according to the shape/size of the tumor, in ascending order, to form the list: For example taking six medical symptoms sij ($1 \leq j \leq 6$); the sub parameters can be further mapped.

After mapping these value will be presented numerically as (x1, x2, x3….xp).

The parameters which differentiate a normal cell and a cancerous cell are-

a) Irregular shape and size of cell, in cancer cell nuclear membrane pores are increases (s1)

b)Temperature is high near cancerous cell and blood flow (s2)

c)Increase in free ribosomes & polysome, responsible for higher production of proteins for the cell growth process (s3)

d)Golgi apparatus is poorly developed in malignant cells (s4)

e)Peroxisomes involved in various metabolic reactions are only found in tumors formed by cells. Malignant cells change their enzyme content, such as the reduction of acid or alkaline phosphatase, distance of cell from center and so on (s5…….sn).

In this paper, a novel fuzzy image approach is proposed for detection of degree of malignancy. The proposed algorithm can be given as-

Steps for Mathematical Calculations

1. Medical symptoms (s1, s2 …sn) are recorded on different features.
2. All the parameters given above along with gender & age of the person under medical supervision is taken into account.
3. Calculate the value of count, for all fuzzy regions,
4. Find maximum count region of each term.
5. Find Vi which is the set containing all possible symptoms
6. Taking the feature Fi ($1 \le i \le 2$) malignant and Benign, all its valid descriptions can be sorted accordingly.
7. Now the sub parameters can be mapped to sijk ($1 \le k \le r$) where 'r' is the total no. of sub parameters. After mapping these values will be presented numerically as (x1, x2, and x3… xp).
8. The sensitivity parameter considered in the case is 1, sensitivity parameter analyze how fast the response of the model changes i.e. when the normalized distance between Vij and Vik increases, how quickly membership value goes down to zero.

For example values of ellipse and irregular to round are 0.5 & 0 respectively.

Table 1. Represents features described numerically to extract fuzzy rule.

S.No	Feature consideration	Numerical representation
1	Age	Used directly
2	Gender	0: female
		1: male
3	Oedema (i.e. fluid retention ,in tumor images it is an area surrounding the tumor with hypo & hyper intense signal on a T1 and T2 weighted images respectively)	0: absent
		1: light
		2: middle
		3: heavy
		Width of the area varies from 2cm to ½ width of the hemisphere at the same side.
4	Hemorrhage	0: absent
		1: acute
		2: chronic
5	Capsule of tumor (ring around tumor on weighted images). If capsule is absent it probably denotes benign status.	0: absent
		1:intact
		2: partially intact
6	Cyst generation	0: absent 1: present
7	Blood supply (abnormal flow i.e. Angiogenesis formation of new blood vessel)	1: normal 2: middle(one or two flow voids) 3: affluent(flow voids in cluster)
Many other features like-mass effect, calcification, signal intensity on T1 & T2 weighted images, post contrast enhancement etc. can be taken into consideration to do better analysis.		

Feature description Steps for Post processing of MR images

Post processing of MR images is necessary to obtain noiseless, smooth and enhanced region of interest.

1. Preprocessing is the first step in order to analyze brain MR images.

Pre-processing stage includes image acquisition of MRI brain images; resize the image, region localization (RL) and region localization enhancement.

a) Image is converted into grey image.

b) Fig1depicts grey scale image

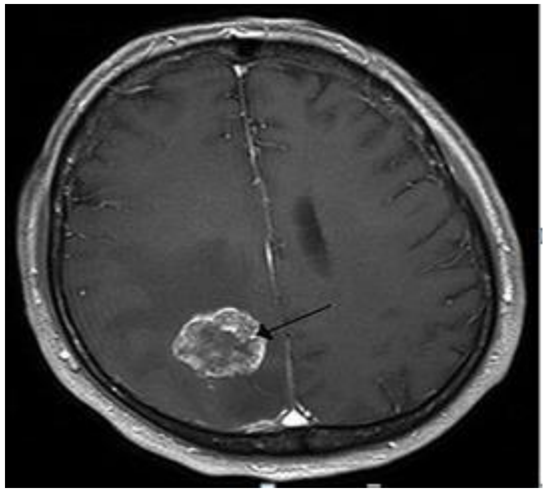

Figure 1: Grey scale image

a) To enhance images histogram equalization is used as pre-processing. Canny and Sobel operators are used for edge detection and gradient computation.

Fig 2 & 3 are image histogram of pre & post processing images.

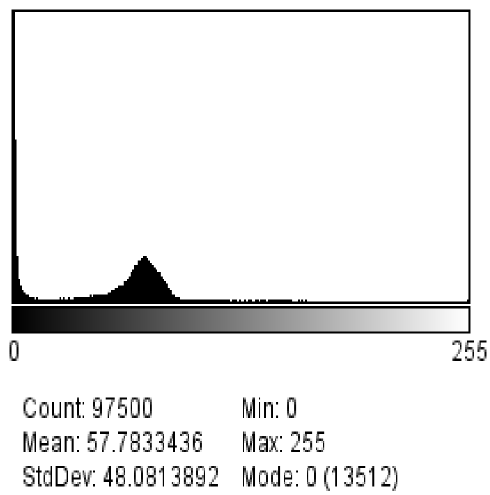

Figure 2: Preprocessing image histogram

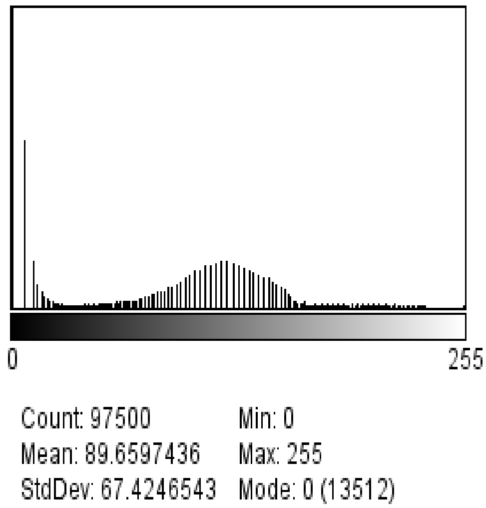

Figure 3: Post processing image histogram

a) Contrast enhancement involves converting the original values so that more of the offered range is used, thereby enhancing the contrast between targets and their backgrounds. Image histogram is used to understand the concept of contrast enhancements. Fig 4 & 5 are original gray scale image and image after contrast enhancement

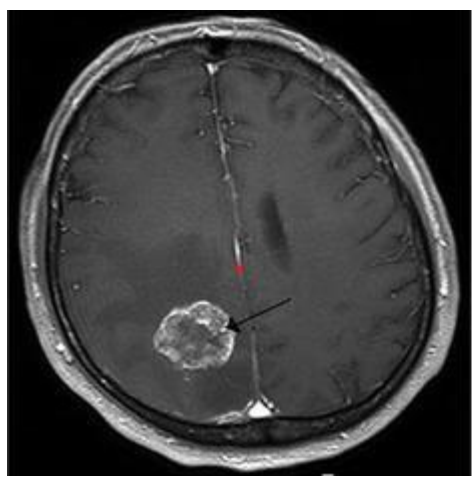

Figure 4: Grey scale image

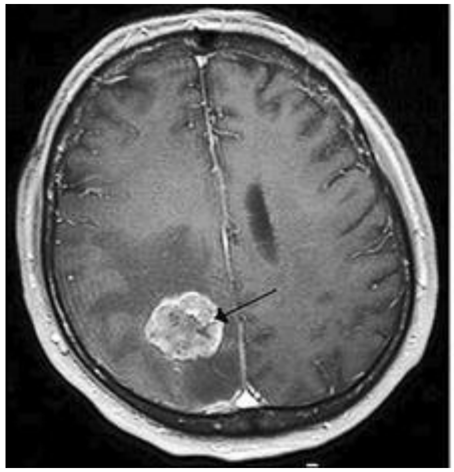

Figure 5: Enhanced image

1. Shape boundary representation and segmentation stage; include edge detection, locating region of interest and segmentation using spectral transforms. In this paper advanced Hough transform for circular region detection studied for detection and segmentation [14]. Fig 6 depicts image after edge detection.

Figure 6: Edge detection

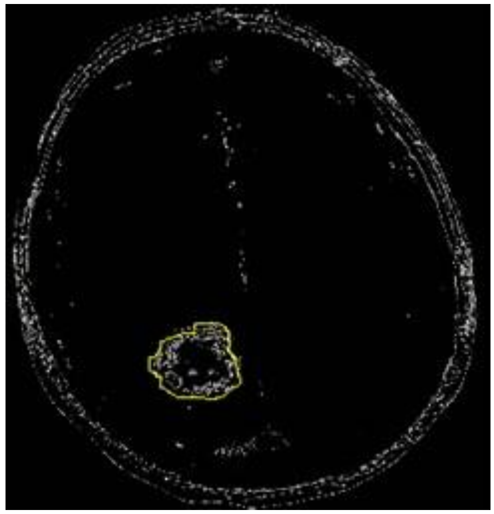

Figure 7: Region of interest

2. Feature extraction stage; include extraction of high intensity pixels to locate ROI and morphometric measurement-invariant features for indexing.
   Fig 7 & 8 includes extraction of high intensity pixels to locate ROI and its profile plot.

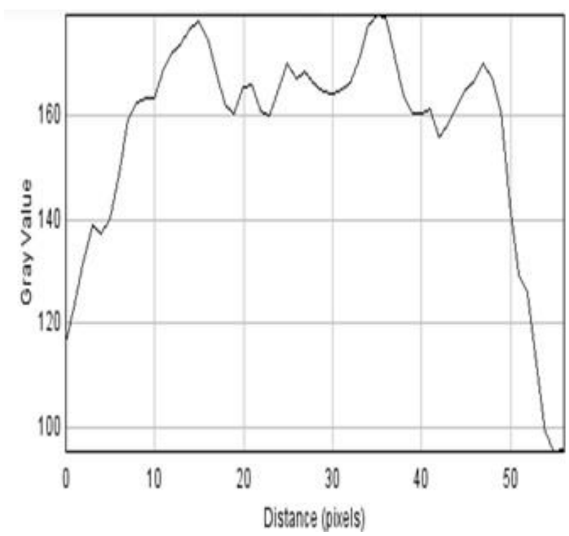

Figure 8: Profile plot of region of interest (ROI)

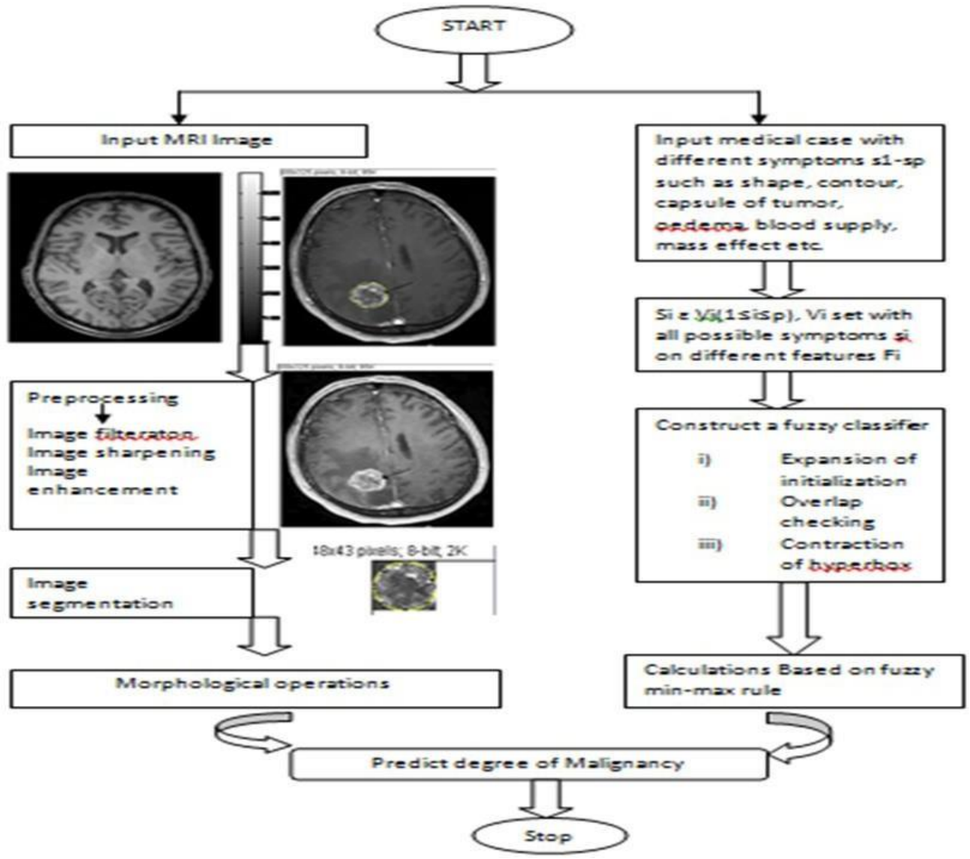

Figure 9 shows the flow of fuzzy min –max image analysis algorithm.

DISCUSSION & CONCLUSION

These approaches are direct medical application of image processing. In this paper various types of brain tumors, techniques of tumor pixels detection is reviewed. Studied properties of various image processing algorithms and its requirements in brain tumor detection.

MRI plays a critical role in the initial evaluation of brain glioma of patients under medical supervision. However, uncertainty and even missing values exist. To deal with them it was desirable to gather numerous cases to interpret relationship between MRI finding and degree of malignancy. For analyzing larger data set fuzzy rule extraction algorithm will be a better option.

Proposed method outperforms existing algorithms by using only six features as fuzzy rule make use of larger number of cases that are similar to each other to make more representative results. Many features are considered;

this improves the classification ability of a simple set of rule & constitutes an advantage over traditional decision rules.

As an example Cyst generation, when this feature is absent, the chances of both grades are very similar in MRI finding. Therefore its significance can be overwhelmed by considering other features like odema, post contrast enhancement and blood supply.

This implies that degree of malignancy can be predicted by using fuzzy set of rules in which presence or absence of combination of feature will decide the grade of brain glioma.

This paper proposed information about brain tumor detection using fuzzy rules. The marked area is fuzzy image processing and the algorithm. In future it will help researches in tumor monitoring.

FUTURE SCOPE

Future researches are going in the direction of image processing (edge detection and segmentation of images) which will lead towards improving the accuracy recognition, specificity and computational speed, as well as minimizing the amount of manual interaction. These can be enhanced by combining segmentation methods: discrete and continuous-based. In real-time processing applications computational effectiveness will be crucial aspect. Benign tumor can be converted into malignant; in future image analysis can be combined with fuzzy algorithm to detect the degree of malignancy in tumor cells, to obtain better results with higher accuracy rate.

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Conflict of Interest: The author declare that they have no conflict of interest

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