

Brain Tumor Identification Using Hybrid Genetic Algorithm with OTSU Segmentation

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Abstract

A brain tumour is an abnormal mass of tissue in which cells grow and multiply uncontrollably, seemingly unchecked by the mechanisms that control normal cells. The symptoms of a brain tumour rely upon tumour size, type, and location. Image processing (IP) is a technique to convert an image into digital form and do some operations in order to get an improved image or to extract some useful data from it. Various effective and efficient techniques are employed for automatic segmentation of an image for better performance of segmented image in the early detection and diagnosis of tumour part. This brain tumour dataset contains pre-processed contrast-enhanced MRI images with five kinds of brain tumour. Acoustic Neuroma, Chordoma, CNS Lymphoma, Craniopharyngioma, Pituitary Tumour. The superiorities of the proposed methods can be observed in terms of both visual perception and objective metrics. The MRI Images Hybrid Genetic Algorithm with Otsu proposed in this thesis will be a better contribution to the medical image segmentation for improving the quality of medical images and for pre-clinical and clinical activities.

Keywords: JACCARD, DICE, RFN (Rate Of False Negative), RFP (Rate Of False positive), Otus Segmentation, hybrid genetic algorithm.

I. INTRODUCTION

The brain is the most complex organ in the human body. The human brain is an extraordinary complex and fascinating organ that human species. It produces every thought, action, memory, feeling and experience of the world. This jellylike mass of tissue, weighing around 1.4 kilograms contains staggering one hundred billion nerve cells or neurons. Each neuron can make contact with thousands and ten thousands of others via tiny structures called synapses. The "Gray matter" is the cell bodies of the neurons while the "white matter" is the branching network of the thread like dendrites and axons that spread out from the cell bodies to connect to other neurons. T1 and T2 weighted image scan can be easily differentiated by looking at the CSF. CSF is dark on T1 weighted imaging and bright on T2 weighted imaging [1]

Today brain tumour segmentation approaches can be organized into different groups based on various principles. In the clinic, brain tumour segmentation approaches are usually categorized into three main categories including manual, semi-automatic and fully automatic segmentations based on the degree of required human interaction. The dataset contains pre-processed contrast-enhanced MRI images with five kinds of brain tumour. Acoustic Neuroma, Chordoma, CNS lymphoma, Craniopharyngioma, Pituitary Tumor. The paper organised into five sections. The brief introduction and literature review is presented in section I and II. Section III focus Hybrid Genetic Algorithm with Otsu and section IV discuss the experimental results. Conclusion of the research is discussed in section V.

II. Literature Review

Asra Aslam et al. [2] proposed an Improved Edge Detection calculation for cerebrum tumour division is introduced. It depends on Sobel edge recognition. It consolidates the Sobel technique with picture subordinate thresholding strategy and finds diverse districts utilizing shut form calculation. At long last tumours are removed from the picture utilizing power data inside the shut forms. The calculation is executed in C and its execution is measured dispassionately and in addition subjectively. Reenactment comes about to demonstrate that the proposed calculation gives better execution over regular division strategies. For a similar examination, different parameters are utilized to show the prevalence of proposed strategy over the regular ones.

Sahil J Prajapati and Kalpesh R Jadhav [3] characterized that thresholding is the basic way to deal with acquaint with the morphological operations which are valuable for the identification of the tumour however not all tumour can be particularly distinguished by this procedure so locale developing is another strategy which gives seed guide approach toward the segmented ROI area so the tumour is effectively recognized and furthermore additionally utilized for the arrangement reason.

Primary tumours are again divided into two types. They are Benign and Malignant. Benign are non-cancerous tumours and they seldom grows back. Whereas, malignant tumours are cancerous and they grow faster. Whatever the type or category of the tumour, there is a need to identify the tumour in early stages in order to start the treatment and for saving the life of the patient [4, 5]. Pre-processing and enhancement techniques are used to improve the detection of the suspicious region from MRI. This section presents the gradient-based image enhancement method for brain MRI images which is based on the first derivative and local statistics. Zhou et al. [6]. The Proposed method deals with the learning of the nonlinear image data distribution. It performs two steps

learning and segmentation. Experimentation was done by considering the 24 MRI images. They found the expected accuracy rate in finding the brain tumour.

T.Logeswari and M.Karnan et al. [7] implemented a fuzzy based segmentation process to detect brain tumour. In that performance of the MRI image in terms of weight vector, execution time and tumour pixels detected.

A. Padma et al. [8] presented an automated segmentation of brain tumours in computed tomography images (CT) using a combination of Wavelet Statistical Texture features (WST) obtained from 2-level DWT low and high-frequency sub-bands and Wavelet Co-occurrence Texture features (WCT) obtained from two level DWT high-frequency sub-bands. The removal of high frequency components using a weighted median filtering technique. It gives high resolution MRI compare than median filter, Adaptive filter, and a spatial filter. The performance of the proposed method is also evaluated by means of peak single-to noise ratio (PSNR), Average Signal-to-Noise Ratio (ASNR) [9]. Hamamci et al. demonstrated cellular automata based seeded method. In this paper, author used the T1 weighted magnetic images. The cellular automata method is used to find the shortest path in graph theory [10]. Roy et al. [11] calculated the tumour affected area for symmetrical analysis. They showed its application with several data sets with different tumour size, intensity, and location. They proved that their algorithm can automatically detect and segment the brain tumour. In the year 2013, K.Elavarasi, A.K.Jayanthi conducted a work "Soft sensor based brain tumour detection using CT-MRI" [12]. In this paper, author has applied various image processing techniques and various morphological operations on CT and MRI images of brain and output of both image set are then compared.

P. Dvorak et al. [13] proposed the completely robotized obsessive region extraction from

multiparametric 2D MR pictures of the cerebrum. The proposed strategy depends on multi-determination symmetry investigation and programmed thresholding. Mr. Ahmed_kharrat exhibited the work for the automatic classification of the Magnetic resonance Imaging he proposes the hybrid approach with the GA and SVM [14]. From the above study, it is determined that the work performed in the classification to classify the images in two different classes first on is the normal and second abnormal [15]. Garima Singh, Dr. M.A. Ansari [16] proposed a novel technique which includes Normalization of Histogram and K-means Segmentation.

III. Hybrid Genetic Algorithm with Otsu

Brain tumor segmentation partitions a portion into commonly special and pooped regions such that each region of interest is spatially contiguous and the pixels within the region are homogeneous with respect to a predefined criterion. Generally homogeneity conditions include values of concentration, texture, color, range, surface normal and surface curvatures. The automatic segmentation has excessive potential in clinical medicine by freeing physicians from the burden of manual labeling; while only a quantitative measurement allows to track and modeling precisely the disease. MRI is commonly more sensitive in identifying brain abnormalities during the early stages of disease, and is excellent in early detection of cases of cerebral infarction, brain tumors, or infections. In this anticipated model, the Otsu's thresholding is integrated with the genetic algorithm to identify the outer region of the brain tumor.

In image processing, segmentation is frequently the first step to preprocess images to extract objects of interest for further analysis. Segmentation methods can be generally categorized into two frameworks, edge-based and region based approaches. As a segmentation technique, Otsu's technique is extensively used in pattern recognition, document binarization and

computer vision. Otsu's technique searches for a threshold that minimizes the intra-class variances of the segmented image and can achieve good results when the histogram of the original image has two different peaks, one belongs to the background and the other belongs to the foreground or the signal. The Otsu's threshold is found by searching across the entire range of the pixel values of the image until the intra-class variances reach their minimum. As it is defined, the threshold determined by Otsu's technique is more profoundly determined by the class that has the greater variance, be it is the background or the foreground. Hybrid Genetic Algorithm with Otsu is mentioned in algorithm 1.

GA is a natural inspired Meta heuristic algorithm. In GA each solution is signified as chromosome and each chromosome is built up from genes. The best generated solutions will be added to the next iteration while the bad solutions will be excluded. Although the algorithm iterates its solutions, these solutions are enhanced up to a point where a converge to near optimal solution is achieved. In common a GA has five stages: initialization of population, evaluation of fitness function, selection, crossover, mutation and termination. Initial population is formed randomly which can be done by setting genes to random values. After the initialization process, fitness function of each chromosome is estimated.

In the selection process, the fittest members in the current population are selected for reproducing the new solutions in crossover process two is chromosomes are chosen and exchange genes by some point.

Algorithm 1: Hybrid Genetic Algorithm with Otsu

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1: Read Input Image Inp
2: Resize to standard size
3: Apply denoising Filter WT_CWM(Inp)
4: Read Enhanced image Inp_Filter
5: Apply Edge Operator Zerocross(Inp_Filter)
6: Let the pixels of a given picture be represented in L gray levels
7: The number of pixels at level i is denoted by  $n_i$ 
8: Now classify the pixels into two classes  $C_0$  and  $C_1$ 
9: background and objects by otsu threshold at level t
10:  $C_0$  denotes pixels with gray levels  $[1, 2, \dots, t]$ 
11:  $C_1$  denotes pixels with levels  $[t+1, \dots, L]$ 
12: Initialize Population
13: Evaluate fitness of population members
14: Select best individual from population
15: For  $k=1$  to population-size
16: Compute cross-over and mutation of the individual
17: End for
18: Select best pixels from the population from the region
19: Obtain the segmented pixels
}
    
```

the roulette choice, it usually lead to loss of diversity of the population, genetic algorithm will prematurely lost its evolutionary ability. The fitness ratio method is chosen; it is the size of the fitness for the proportion of the genetic process of the parent selection, the higher the fitness of the individual, the greater the probability is chosen. The population structure not only guarantees that the outstanding individuals enter the next generation, but also ensure the diversity of the population, so that the probability of similar individuals is reduced in the population, the efficiency of genetic operation is enhanced, and the convergence of the whole algorithm is enhanced. The general process flow of the Hybrid Genetic Algorithm with Otsu is represented in

In mutation process a gene is chosen randomly and its value is altered. In last termination of the iteration is done when a certain criteria is met. Generally termination is done by number of iterations. Traditional genetic algorithm utilized in

Figure 1:

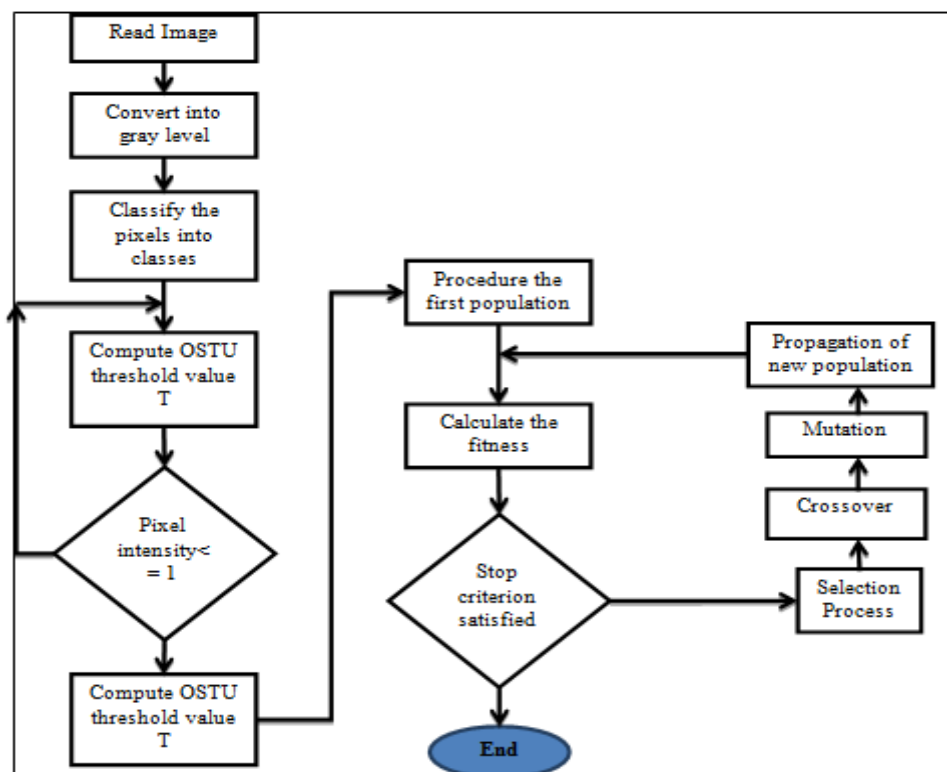


Figure 1: Flow Diagram of Hybrid Genetic Algorithm with Otsu

IV.RESULTSANALY
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The performance analysis of different filter for different types of segment is quantized through Jaccard, Dice, RFN (Rate Of False Negative) and RFP (Rate Of False positive) value.

(i) Jaccard

Jaccard Co-efficient is used to calculate the similarity between the two set of images and it also measures the variation or dissimilarity between two images. It is calculated using the Equation.

$$JC = \frac{M \cap N}{M \cup N} \quad \text{Equ (1)}$$

(ii) Dice

Dice co-efficient is a similarity measure mostly used in the medical image processing to evaluate the performance of segmentation algorithms and it is calculated using the Equation 2.

$$DC = \frac{2|M \cap N|}{|M| + |N|} \quad \text{Equ (2)}$$

Where 'M' is the non zero pixel element in ground truth image and 'N' is non-zero pixel element is the segmented image.

(iii) Rate of False Positive (RFP)

The false positive rate is considered as the ratio between the number of negative events wrongly labeled as positive (false positives) and the total number of actual negative events (regardless of classification).

$$\frac{FP}{N} = \frac{FP}{FP + TN} \quad \text{Equ (3)}$$

(iv) Rate of False Negative (RFN)

The false negative rate is the ratio of positives which yield negative test results with the test, i.e., the conditional prospect of a negative test result given that the condition being looked for is present.

$$\frac{FN}{P} = \frac{FN}{FN + TP} \quad \text{Equ (4)}$$

The performance analysis of Hybrid genetic Algorithm with Otsu technique for different types

of MR images is quantized through Jaccard, dice, RFN and RFP value . This proposed techniques will improve the results of MR images. The further work on this modified proposed technique may let us to achieve 30-50 % increase jaccard and Dice and 10-20% reduce RFN and RFP values. The output of Hybrid Genetic Algorithm with Otsu is represented in Figure 2:

The brain tumour images results are not only evaluated with human vision but also by algorithm performance analysis focusing on Jaccard, Dice, RFP and RFN. The following table 3.3 shows the metrics of various edge techniques of various dataset images. From the evaluation, Fuzzy Clustering segmentation provides high rate for Jaccard and Dice parameters and decreased rates for RFP and RFN metrics.

Table 1: Performance analysis

Datas et	Methodolo gies	Jacca rd	Dice	RFN	RFP
IN_1	Otsu-GA	0.038	0.04	0.59	0.96
		7	74	34	13
IN_2	Otsu-GA	0.050	0.52	0.04	0.85
		98	98	67	31
IN_3	Otsu-GA	0.693	0.09	0.32	0.28
		8	47	89	74
IN_4	Otsu-GA	0.439	0.34	0.15	0.54
		0	45	87	78
IN_5	Otsu-GA	0.381	0.35	0.76	0.96
		9	78	87	67

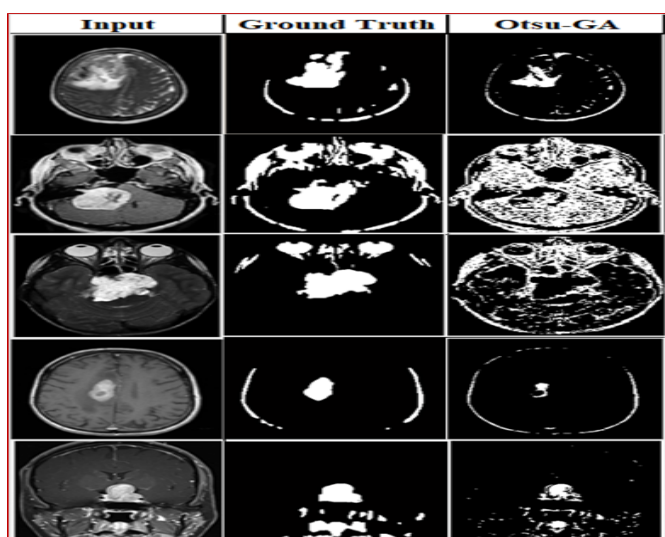


Figure 2:Hybrid Genetic Algorithm with Otsu.

V.CONCLUSION

This research makes a study and analysis of image enhancement techniques and concentrates in the development of algorithms to achieve highly enhanced and segmented images. The proposed methods will be able to provide better algorithms when compared to the existing systems to facilitate efficient image enhancement and segmentation of MRI brain tumour image. The algorithm was tested with real data using MATLAB software. The superiorities of the proposed methods can be observed in terms of both visual perception and objective metrics. The Hybrid Genetic Algorithm With Otsu Segmentation with MR Images, An Algorithm proposed in this paper will be a better contribution to the medical image segmentation for improving the quality of medical images and for pre-clinical and clinical activities.

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