Comparative Analysis of Different Algorithms For Brain Tumor Detection

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Abstract: ***Brain tumor is one of the major causes of death among people. It is evident that the chances of survival can be increased if the tumor is detected and classified correctly at its early stage. The segmentation of brain tumors in magnetic resonance images (MRI) is a challenging and difficult task because of the variety of their possible shapes, locations, image intensities. In this paper, it is intended to summarize and compare the methods of automatic detection of brain tumor through Magnetic Resonance Image using Histogram Thresholding with FCM, Region growing, K-mean and Watershed segmentation. The proposed method can be successfully applied to detect the contour of the tumor and its geometrical dimension. MRI brain tumor images detection is a difficult task due to the variance and complexity of tumors. This paper presents three techniques for the detection purpose; first one is Histogram Thresholding, Second K-mean, third is FCM, fourth is Region growing technique and fifth is Watershed segmentation. In this paper, the purposed method is more accurate and effective for the brain tumor detection and segmentation for MRI (DICOM) images. For the implementation of this proposed work we use the Image Processing Toolbox under MATLAB Software.***

Keywords: Histogram Thresholding, region growing, FCM, K-mean and Watershed segmentation

1. Introduction

Brain has a very complex structure and is considered as a kernel part from the body. Nature has tightly safeguarded the brain inside a skull that hinders the study of its function as well as makes the diagnosis of its diseases more intricate. But, brain is not prone to diseases and can be affected by the abnormal growth of the cells in that change its normal structure and behavior; a disease generally known as a brain tumor. Brain tumors either include tumors in the central spinal canal or inside the cranium. Automatic defects detection in MRI is quite useful in several diagnostic and therapeutic applications computed tomography and MRI are two imaging modalities that help researchers and medical practitioners to study the brain by looking at it non-invasively. Most of the time, the tumor segmentation and classification become harder due to quantity of MR images and blurred boundaries. Since brain is safeguarded by the skull, therefore, an early detection of brain tumor is only possible when diagnostic tools are directed at intracranial cavity. MRI is a medical imaging technique, and radiologists use it for visualization of the internal structure of the body. MRI can provide plentiful of information about human soft tissues anatomy as well as helps diagnosis of brain tumor. MR images are used to analyze and study behavior of the brain. A powerful magnetic field is used to align the nuclear magnetization of hydrogen atoms (or protons) of water in the body. In the presence of RF (radio frequency) electromagnetic fields, hydrogen nuclei produce a rotating magnetic field which is detectable by the scanner. Since protons can absorb energy at specific frequency and have the ability to reemit that energy; therefore, a transmitter coil is normally fitted around the human skull to measure the net magnetization. The transmitter coil functions in the following way: first, it produces electromagnetic waves and transmits these waves inside the brain, and then a receiver coil measures the intensity of the emitted electromagnetic waves. Moreover, an additional gradient coil is used for spatial localization of the signal. Lastly, the recorded signals (or electromagnetic waves) are reconstructed into an image by a specialized computer program. Early detection and classification of brain tumors is very important in clinical practice. Many researchers have proposed different techniques for the classification and detection of brain tumors based on different sources of information. In this paper we propose a process for brain tumor classification and detection, focusing on the analysis of Magnetic Resonance (MR) images. The performance of these approaches usually depends on the accuracy of the segmentation technique.

Brain Tumor Detection Using Neural Network [1] brain tumor segmentation in magnetic resonance imaging (MRI) has become an emergent research area in the field of medical imaging system. Brain tumor detection helps in finding the exact size and location of tumor. An efficient algorithm is proposed in this paper for tumor detection based on segmentation and morphological operators. Firstly quality of scanned image is enhanced and then morphological operators are applied to detect the tumor in the scanned image. Brain Tumor Detection and Segmentation Using Histogram Thresholding [2] in this study a technique to detect presence of brain based on thresholding technique have been developed. The segmentation of the brain is also being done while detecting the presence of the tumor. The physical dimension of the tumor which is of utmost importance to the physicians can also be calculated using the present technique. In [3] purposed an optimized fuzzy logic application for MRI brain images segmentation. In this research, we use optimized fuzzy logic technique based on FCM clustering that Incorporates the spatial information into the membership function to improve the segmentation Results. The membership functions of the neighbors centered on a pixel in the spatial domain are enumerated to obtain the cluster distribution statistics. These statistics are transformed into a Weighting function and incorporated into the membership function.

2. Proposed Technique

This section illustrates the overall technique of our proposed detection and identification of brain tumor through Magnetic Resonance (DICOM) Image using Histogram Thresholding, Region growing and K-mean segmentation. There purposed techniques are given below:

2.1 Histogram Thresholding

In image processing, the Histogram Thresholding method (HT) is a very simple method used for automatic image Thresholding. Like 'Otsu's Method' and the 'Iterative Selection Thresholding Method', this is a histogram based Thresholding method. This approach assumes that the image is divided in two main classes: The background and the foreground. The HT method tries to find the optimum threshold level that divides the histogram in two classes. Histogram thresholding is used by the Object Extraction, Background and Image Factory (segmentation) tools to select a range of pixel values that should match to what you want to select in the image. Thresholding is a technique for converting a grayscale or color image to a binary image based upon two threshold values. The histogram presents the frequency of intensity values of a channel in an image. The threshold values (min and max) can be applied by moving the arrows above the histogram or by using an automatic threshold method.

2.2 K-mean

K-means is a method of vector quantization, originally from signal processing, that is popular for analysis in segmentation. K-means aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster. This results in a partitioning of the data space into Voronoi cells. The problem is computationally difficult; however, there are efficient heuristic algorithms that are commonly employed and converge quickly to a local optimum. These are usually similar to the expectation-maximization algorithm for mixtures of Gaussian distributions via an iterative refinement approach employed by both algorithms. Additionally, they both use cluster centers to model the data; however, k-means clustering tends to find clusters of comparable spatial extent, while the expectation-maximization mechanism allows clusters to have different shapes.

2.3 FCM

In fuzzy clustering, every point has a degree of belonging to clusters, as in fuzzy logic, rather than belonging completely to just one cluster. Thus, points on the edge of a cluster may be in the cluster to a lesser degree than points in the center of cluster. An overview and comparison of different fuzzy clustering algorithms is available. Clustering approach is widely used in biomedical applications particularly for brain tumor detection in abnormal magnetic resonance (MRI) images. Fuzzy clustering using fuzzy C-means (FCM) algorithm proved to be superior over the other clustering approaches in terms of segmentation efficiency. But the major drawback of the FCM algorithm is the huge computational time required for convergence. The effectiveness of the FCM algorithm in terms of computational rate is improved by modifying the cluster center and membership value updating criterion.

2.4 Region growing

Region growing is a region-based image segmentation method. It is also classified as a pixel-based image segmentation method. This approach to segmentation examines neighboring pixels of initial seed points and determines whether the pixel neighbors should be added to the region. Region growing methods can correctly separate the regions that have the same properties we define. It provides the original images which have clear edges with good segmentation results. The concept is simple. We only need a small number of seed points to represent the property we want, and then grow the region. We can determine the seed points and the criteria we want to make.

2.5 Watershed

Watershed segmentation gets its name from the manner in which the algorithm segments regions into catchment basins. If a function *f* is a continuous height function defined over an image domain, then a catchment basin is defined as the set of points whose paths of steepest descent terminate at the same local minimum of f. The choice of height function (input) depends on the application, and the basic watershed algorithm operates independently of that choice. For intensity-based image data, you might typically use some sort of gradient magnitude calculation as input. The watershed algorithm proceeds in several steps. First, an initial classification of all points into catchment basin regions is done by tracing each point down its path of steepest descent to local minima. Next, neighboring regions and the boundaries between them are analyzed according to some saliency measure (such as minimum boundary height) to produce a tree of merges among adjacent regions. These merges occur at different maximum saliency values. The collective set of all possible merges up to a specified saliency "flood level" is referred to in this documentation as a 'merge tree'. Metaphorically, the flood level is a value that reflects the amount of precipitation that is rained into the catchment basins. As the flood level rises, boundaries between adjacent segments erode and those segments merge. The minimum value of the flood level is zero and the maximum value is the difference between the highest and lowest values in the input image. A grey-level image may be seen as a topographic relief, where the grey level of a pixel is interpreted as its altitude in the relief. A drop of water falling on a topographic relief flows along a path to finally reach a local minimum. Intuitively, the watershed of a relief corresponds to the limits of the adjacent catchment basins of the drops of water. In image processing, different watershed lines may be computed. In graphs, some may be defined on the nodes, on the edges, or hybrid lines on both nodes and edges. Watersheds may also be defined in the continuous domain. There are also many different algorithms to compute watersheds.

The main improvements in our work are Histogram Thresholding. This approach assumes that the image is divided in two main classes: The background and the foreground. With the help of this we can easily detect and segment the MR images. The improvement is based on automatic utilization of specified regions of interest within the tumor area in the MRI images using HT, region growing and K-mean segmentation.

3. Evaluation and Result

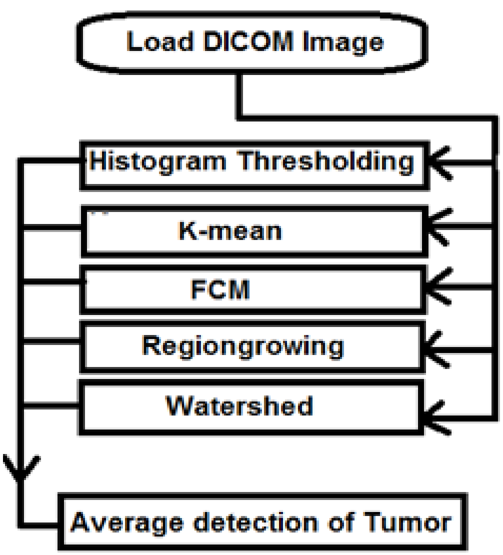
To verify the effectiveness (qualities and robustness) of the proposed brain tumor detection technique, we conduct several experiments with this procedure on several MRI images.
There are some steps of our proposed technique are given below:

1) Firstly we develop a particular GUI for this implementation. After that we develop a code for the MRI image in the Matlab database.
2) Develop a code for the Histogram thresholding and apply on the loaded image.
3) After that we develop code for the K-mean and apply on the MRI image. After that develop the code for the detection of the tumor present in MRI image.
4) We develop the code for the FCM for the segmentation purpose.

Develop a code for the region growing segmentation. Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. So we apply the segmentation on the MRI image.

1) After that we develop the code for the Watershed segmentation and apply on the loaded image.
2) At the last we develop the code for average detection of tumor from the results of all five algorithms.
3) In our proposed method we implement detection and identification of brain tumor through Magnetic Resonance (DICOM) Image using Histogram Thresholding, Region growing and K-mean segmentation.

3.1 Flow chart



Flow chart 1: Our Proposed method

3.2 Result

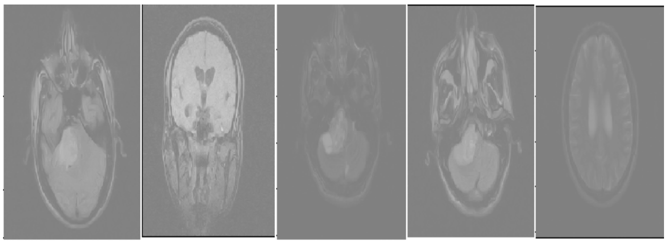


fig 1. Four abnormal and one normal images

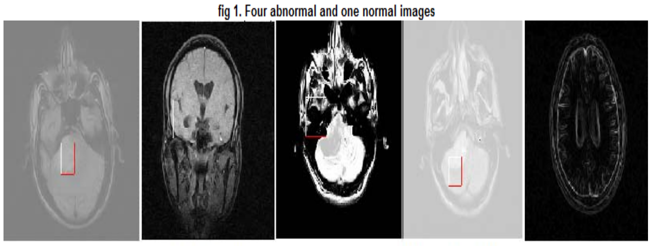


fig 2. Detection of tumor in images using different Algorithm

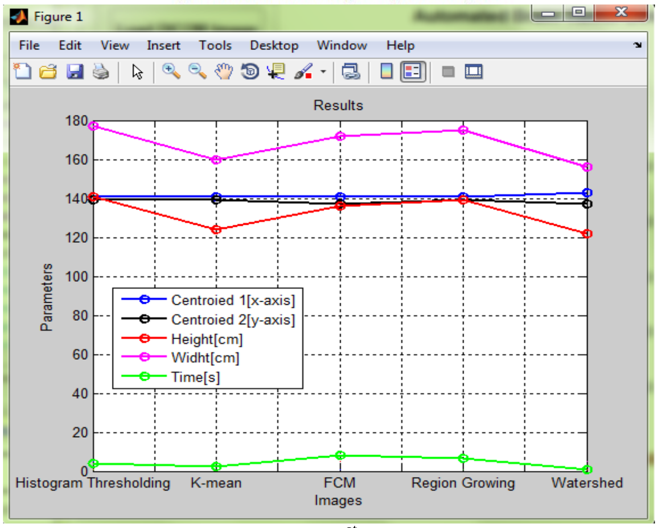


Figure 3: Result of 1st abnormal image

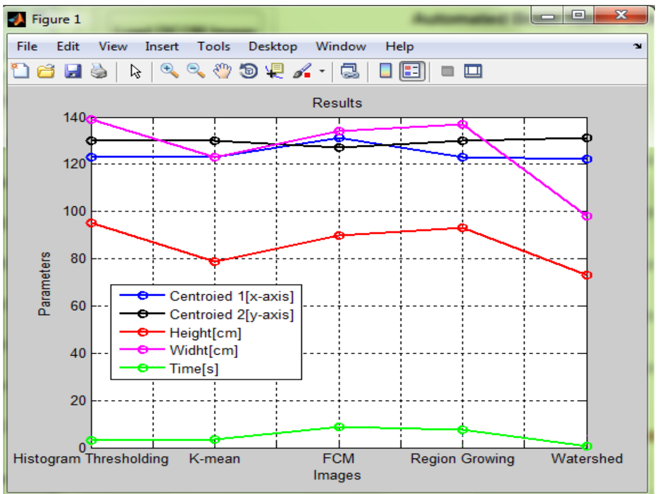


Figure 4: Result of 2nd abnormal image

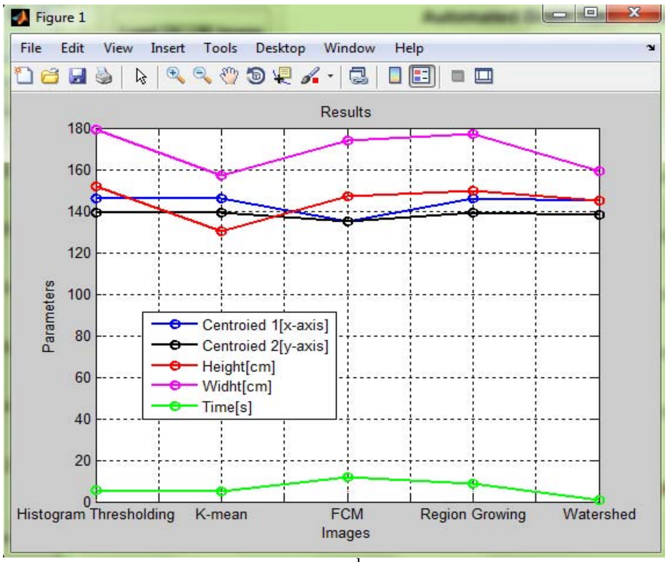


Figure 5: Result of 3rd abnormal image

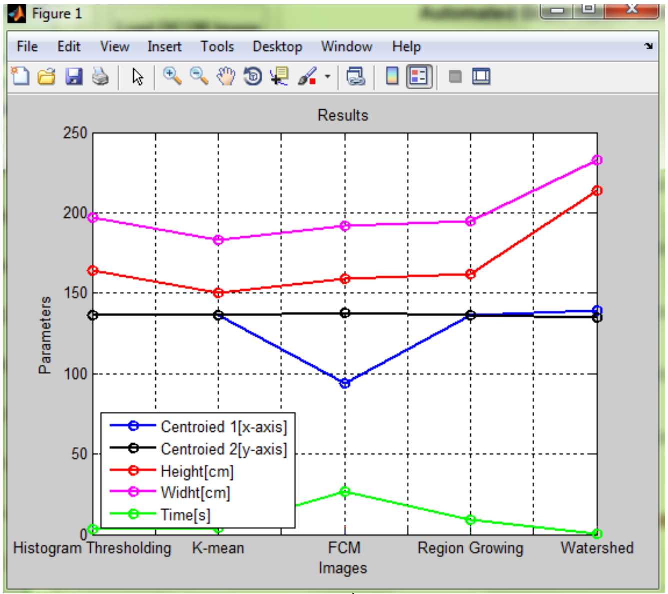


Figure 6: Result of 4th abnormal image

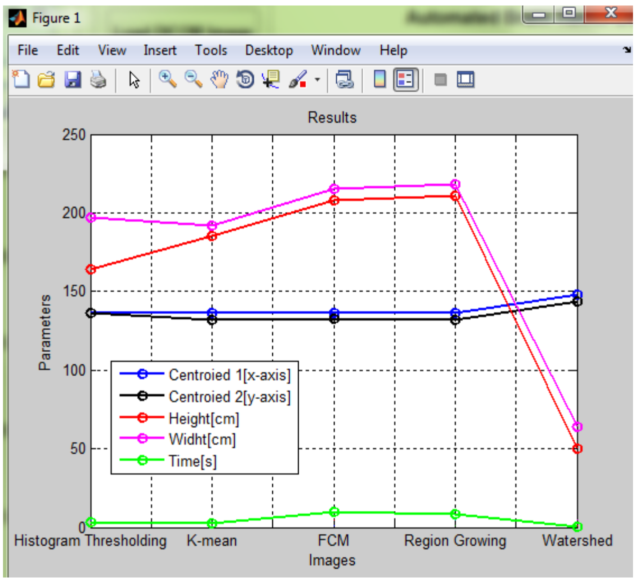


Figure 7: Result of normal image

We proposed detection and identification of brain tumor through Magnetic Resonance (DICOM) Image using Histogram Thresholding, K-mean, FCM, Region growing and Watershed segmentation. The comparison of our proposed work and its result is given below in the table. Histogram Thresholding-based methods are very efficient when compared to other image segmentation methods because they typically require only one pass through the pixels. In this technique, a histogram is computed from all of the pixels in the image, and the peaks and valleys in the histogram are used to locate the clusters in the image.

3.2 Tables

Parameter	Hist_Thr	K-mean	FCM	Region growing	Watershed segmentation	Average Case
1st case						
Centroid[x]	141	141	141	141	143	141.4000
Centroid[y]	139	139	137	139	137	138.2000
Height	141	124	136	139	122	132.4000
Width	177	160	172	175	156	168
Time	4.3587	3.5447	9.4856	9.1243	0.7971	7.1507
2nd case						
Centroid[x]	123	123	131	123	122	124.4000
Centroid[y]	130	130	127	130	131	129.6000
Height	95	79	90	93	73	86
Width	139	123	134	137	98	126.2000
Time	3.6264	3.8710	17.0676	7.0217	0.7823	3.9431
3rd case						
Centroid[x]	146	146	135	146	145	144.8000
Centroid[y]	139	139	135	139	138	135.8000
Height	152	130	147	150	145	144.8000
Width	179	157	174	177	159	169.2000
Time	3.1406	3.3813	9.8593	7.0976	0.7101	4.5551
4th case						
Centroid[x]	136	136	94	136	139	130.2000
Centroid[y]	136	136	138	136	135	136.8000
Height	164	150	159	162	214	167.4000
Width	197	183	192	195	233	196.4000
Time	3.2940	3.4431	15.2404	7.0192	0.7387	4.6468
5th case						
Centroid[x]	136	136	136	136	148	138.4000
Centroid[y]	136	132	133	132	144	134.6000
Height	164	185	208	211	50	173.4000
Width	197	192	215	218	64	181.8000
Time	3.2182	2.7889	9.9939	8.6547	0.6325	4.5913

Table 1: Result of all cases

4. Conclusion and Future Scope

In this paper, we proposed five types of approaches for Brain tumor detection, identification and classification. We proposed detection and identification of brain tumor through Magnetic Resonance (DICOM) Image using Histogram Thresholding, K-mean segmentation, FCM, Region growing and Watershed Segmentation. The proposed image processing algorithm is based on a modified Histogram Thresholding algorithm and implemented using MATLAB Software. However, simulation results using this algorithm showed its ability to accurately detect and identify the contour of the tumor, its computational time and accuracy were much less than its corresponding algorithms. For future we enhance our result using other Algorithm and calculate more parameters also.

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