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Contrast Level Test-based Methodology for Speed-Up MRI Brain Tumor Detection and Localization Approach

Adil Al-Azzawi

Dept. of Electrical and Computer Engineering, University of Missouri-Columbia, MO, United States

ABSTRACT:A tumor is a growth in the abnormal tissue which can be differentiated from the surrounding tissue by its structure.A tumor also may lead to cancer, which is a major leading cause of death and responsible for around 13% of all deaths world-wide. Cancer incidence rate is growing at an alarming rate in the world. Great knowledge and experience on radiology are required for accurate tumor detection in medical imaging. Automation of tumor detection is required because there might be a shortage of skilled radiologists at a time of great need. This paper reviews the processes and techniques used in detecting tumor based on medical imaging results such as mammograms, x-ray computed tomography (x-ray CT) and magnetic resonance imaging (MRI). MRI image which is the Magnetic Resonance Imaging is also could be used for diagnosisand discover which is the type of the human brain that has been tested is normal or abnormal. Moreover, the MRI images give an observation and useful information that will help the doctors and surgeries to avoid some mistakes that will happen during the testing and the diagnosis process. Also, MRI characteristics are used for avoiding human error in manual interpretation of medical content. One of the most popular and useful application that the medical system in need is the MRI brain image classification approach. In this paper, we proposed a new clustering algorithm which relies on the differences between the contrast level of the tumor in the MRI. We depend on new approach for image clustering which is based on the difference between the construct (which is the intensity level) between the tumor region and the whole MRI image. In contrast, other algorithms like k-means, Fuzzy c-means, or probabilistic c-means depend on typical approach which is based on the distance majority between each point (pixel) and its mean. Our work consists some preprocessing steps like smoothed and enhanced the MRI by using enhancement techniques such as Gaussian kernel, median filter, high-pass filter, and Morphological image operation. Mainly, the proposed clustering algorithm in this work uses for segmentation of the image to detect the suspicious region of the tumor in brain MRI image. In this paper feature our results have been compared with the traditional clustering algorithm such as k-means and watershed.

KEYWORDS: MRI, Contrast Level Test, K-means clustering, Fuzzy C-means clustering.

I. INTRODUCTION

With the growing scope of aging population, cancer has become a global public health problem. In the worldwide every year, twelve million and seen handed publics are diagnosed with cancer, and about seven and half million-people died of cancer [1]. Meanwhile, the yearly rate of cancer continues to rise. By 2003, in each year there will be twenty-six million new cases and the death number will reach to one million and seven hundred people. Since a tumor brain is growth of abnormal cells in the tissues of the brain, brain tumors can be benign or malignant. In other words, normal cells, cancer cells which is the result from uncontrolled cell that is outgrowth and it can grow into adjacent tissue. Although benign tumors can grow large and harm healthy organs and tissue, which can potentially affect their working, they rarely invade other tissue. Major brain tumors that is starting from the brain itself, while secondary brain tumors which is the metastatic tumors originate from other parts in the body [1].

MRI (Magnetic resonance imaging) of brain image diagnosis has very increased field of medicine by providing some different methods to extract information from medical data. Brain tumor clustering and segmentation is a very important and significant process to extract information from MRI of brain images. In other words, diagnostic imaging is a very useful method in medical today. MRI (Magnetic resonance imaging), (CT) computed tomography, digital mammography, and other imaging processes methods give an efficient tool for detecting different type of diseases. As pervious knowledge, automated detection methodology has deeply improved knowledge of normal and diseased

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investigation and examination for medical research and are an important step in diagnosis and treatment goal [2]. Clustering has spacious application which is applied in medical imaging field such as MRI of brain for analyzing of MRI brain, anatomical structures such as bones, muscles blood vessels, pathological regions, tissue types, such as cancer detection, multiple sclerosis lesions and for dividing an entire MRI image into sub regions such as the WM (white matter), GM (gray matter) and CSF (cerebrospinal fluid). Spaces of the brain automated delineation of different MRI image components are used. Therefore, in the field of MRI of brain tumor clustering from brain image is significant task of MRI which is particularly suitable for brain studies because of its excellent contrast of, noninvasive characteristic soft issues and a high spatial resolution. Brain tumor segmentation partitions a portion into mutually special regions such that each region of interest is spatially contiguous and the pixels within the region which are homogeneous with respect to the predefined criterion. Mostly, homogeneity conditions include values of concentration, color, range, texture, surface normal and surface curvatures.

Through past many researchers have prepared important research in the field of brain tumor clustering, but still now it is very important research fields. Medical history, biopsy–whereby a small amount of MRI brain tissue is excised and analyzed under the microscope–and imaging studies are all important to reach a diagnosis of MRI brain tumor. Standard x-rays and computed tomography (CT) can initially be used in the diagnostic process. Therefore, MRI is generally more useful because it provides more detailed information about tumor type, position and size. For this reason, the MRI is the imaging which study of choice for the diagnostic work up for surgery and monitoring treatment outcomes [3].

New clustering algorithm has been proposed and used in this work. Our Algorithm relies on a new approach by depending on differences in the intensity level (contrast improvement, and mid-range stretch) of the tumor region of the MRI image. Then, result of our clustering algorithm has been passed to other steps just to improve our result. Morphological image operations have been used in this steps to improve our result such as image erosion, dilatation, and closing. Finally, we compare our result with traditional clustering and segmentation approaches like k-means and watershed approach. By depending on computing the tumor area we calculate the difference between our results and the other approaches.

II. RELATED WORK

MRI Tumor cancer detection approaches has been proposed in many methods, and algorithms for to detect brain tumor or find stroke and other Kinds of abnormalities.

Ming-Ni Wu [4] In this paper a color-based segmentation method which is based on using K-means clustering technique is proposed to detect tumor objects in magnetic resonance (MR) brain images. This work uses a color-based segmentation algorithm with K-means to convert a given gray-level MR image into a color space image. Then, it separates the position of tumor objects from other items of an MR image using a combination between K-means clustering and histogram-clustering. AmitavaHalder [5] In this paper K-means algorithm followed then by object labelling algorithm is proposed. An efficient brain tumor detection method is proposed which can locate and detect tumor in the brain MRI images. Some pre-processing steps (median filtering and morphological operation) are used for tumor detection purpose. Parveen [6] In this paper data mining methods are used for classification of MRI images. By using a new hybrid technique which is based on the support vector machine (SVM) and fuzzy c-means for brain tumor classification. This works proposes a hybrid technique for prediction of brain tumor which a combination of support vector machine (SVM) and fuzzy c-means. In this algorithm, the pre-processing of the MI image is enhanced by using enhancement techniques. Double thresholding and morphological operations are also used for skull striping. Then, fuzzy c-means (FCM) clustering is used for the segmentation of the image to detect the suspicious region in brain MRI image.RaselAhmmed. [7], presents a robust segmentation method which is the integration of Template based K-means and modified Fuzzy C-means (TKFCM) clustering algorithm that, reduces operators and equipment error. In this method, the template is selected based on convolution between gray level intensity in small portion of brain image, and brain tumor image. K-means algorithm is to emphasized initial segmentation through the proper selection of template. Updated membership is obtained through distances from cluster centroid to cluster data points, until it reaches to its best. This Euclidian distance depends upon the different features i.e. intensity, entropy, contrast, dissimilarity and homogeneity of coarse image, which was depended only on similarity in conventional FCM. The performance parameters show relevant results which are effective in detecting tumor in multiple intensity based brain MRI image.

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III. BACKGROUND AND MOTIVATION

Medical imaging is the technique and process used to create images for clinical research, diagnosis and treatment. It is now one of the fastest-growing areas of medical technology. The modalities usually used to obtain medical images are X-rays, Computed Tomography (CT), Magnetic Resonance Imaging (MRI) [3]. In medical imaging, MRI is one of the scanning devices which uses magnetic fields to capture images onto films. According to its outstanding soft tissue contrast and detailed resolution, MRI is used in anatomical assessment of human brain structures [8].

The brain MRI images may contain both normal or defective abnormal slices. Normal and abnormal brain image are determined by its symmetry at the axial and coronal images [8]. Asymmetry which is beyond a certain degree that is a sure indication of the diseased brain and this has been exploited in our work for initial classification at a gross level. Therefore, further examination involving MRI brain classification on the images is required [9].

Tumor cancer of brain tumor in MRI is basically called Computer-Aided Diagnosis (CAD) system. The CAD system can provide highly accurate reconstruction of the original MRI image i.e. the valuable outlook and accuracy of earlier brain tumor detection. It consists of two or more pre-stage. In the initial stage pre-processing, has required after that stages post-processing i.e. segmentation is required. Then detection strategies and other information, feature extraction, feature selection, classification, and performance analysis which are compared and studied. Pre-processing techniques are used to improvement of image quality and remove small noise for the accurate detection of the undesired regions in MRI. Post-processing is used to cluster with different strategy the brain tumor from the MRI of brain images [2].

The main purpose of the tumor detection which has been done by using clustering approach is to focus on the appearance of tumor in MRI images, the grad, type of tumor and some additional and useful information which will be useful in the detection, segmentation and interpretation of brain tumor from MRI images. [9].

A. Dataset

MRI is one of the helpful methods and a safe modality for medical diagnosis [2]. The most important advantage of the MRI is its ability to provide good contrast between various organs and tissues. With its dependence on the more biologically variable parameters, proton density (PD), longitudinal relaxation time (Tl) and transverse relaxation time (T2) variable image contrast can be achieved using different pulse sequences and changing the imaging parameters. There are three types of images PD, Tl and T2 are formed and their signal intensities relate to specific tissue characteristics in the database. Each image is a 250×250 jpg [9] [10] [11] and example of the MRI image is shown in Fig.1, (a).

IV. PROPOSED ALGORITHM

Our proposed system method consists of multiple stage such as a pre-processing phase which consist many steps such that grayscale converter, skull remover, noise removing, and edge detection. Additional to clustering stage where the Brain tumor is detected. Finally, post processing stage which consist a morphological image operation, non-circular shape removing, tumor detection by drawing a candidate box on and cropped just the tumor image from the original MRI, labelled the tumor region, and dimension calculation.

V. DETECTION AND LOCALIZATION METHODS

A. PREPROCESSING

The first step of our proposal for the preparation the dataset is to so some pre-processing steps to enhance the MRI images and preparing them to the second step which is the brain tumor detected.

Step 1: Skull Masking

Skull masking means the removal of non-brain tissue like skull, scalp, fat, neck, eyes, etc., from MRI brain image. That helps to improve the speed and accuracy of diagnostic and Tumor detection in our application. This procedure is also called Brain-Extraction/SkuU-Stripping [11]. Morphological image operation (dilation and erosion) are two fundamental morphological operations. An opening is erosion followed by dilation with the same structuring elementis calculated by using eq. (1) [12]:

$$A \circ B = (A \ominus \mathrm{B}) \oplus B \tag{1}$$

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Erosion removes pixels on object boundaries and dilation adds pixels to the boundaries of objects in an image [12]. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image.

Step 2: MRI images filtration for Noise Removing.

All MRI brain images are inherently noisy according to errors associated with image acquisition [5]. Compounding the image acquisition errors [13]. There are some errors which caused by image registration and segmentation. It is necessary to smooth out and enhanced the segmented images before any statistical analysis is performed to boost statistical power [13] [14]. We used two methods. Median filter is the first [15], Gaussian filter is the second [14].Median Filter remove the noise with high frequency components from the MRI without disturbing the edges. It is used to reduce the noise that it caused by. This technique calculates the median values which set median value pixels' values of the surrounding pixels to determine the new de-noised value of the pixel [15]. The main idea of median is calculated by sorting all pixel values by their size, then select the median value which is the new value for the pixel.

The basic function for doing median image filtering is written in eq. (2) [15].

$$\hat{f}(x,y) = \underset{(x,y)\in N}{\text{median}}\{g(x,y)\} \tag{2}$$

where *f(x,y)* output median and*g(x,y)* is the original values [15].

Step 3: Image Sharpening using High-Pass Filter

The main working activities of this filter is to passes high frequency and keep unchanged and block low frequency signal. The elements of the mask contain both positive and negative weights as it given byeq. (4)andeq. (5). [16]

$$H(u,v) = \begin{cases} 0 & D(u,v) \leq D_0 \\ D(u,v) & D(u,v) < D_0 \end{cases} \tag{2}$$

where

$$D(u,v) = \left[\left(u - \frac{M}{2}\right)^2 + \left(v - \frac{M}{2}\right)^2\right]^{\frac{1}{2}} \tag{3}$$

The result of image sharpening on the MRI image is shown in Fig 5, b and Fig 7, b.

B. CLUSTERING ALGORITHMS

Image clustering is the approach and techniques that is widely used of separating an image into multiple slices and object region. In term of extract accurate features, we proposed new clustering algorithm as a segmentation method to split the tumor region on the rest of the MRI image. This provides good result for tumor segmentation and for detect the ROI (region of Interest) for feature extraction algorithm.

1. Distance-based Methodology using (K-means) clustering

In the clustering problem, we are given a training set $\{x^{(1)} \ldots x^{(m)}\}$ andwant to group the data into a few cohesive "clusters." Here, $x^{(i)} \in \mathbb{R}^n$as usual; but no labels $y^{(i)}$ are given. So, this is an unsupervised learningproblem [7].

The k-means clustering algorithm is as follows in Algorithm (1):

Step 1: Initialize cluster centroids $\mu_1, \mu_1, \ldots, \mu_k \in \mathbb{R}^n$. Here we have chosen K=5 depend on the most analysis study [18], which showed that the most significant K that is should be chosen with the range from k=5...10.

Step 2: Repeat until convergence: {

Step 3: For every i, set, using eq. (6).

$$c^{(i)} := \text{agr}\min_j \left\|x^{(i)} - \mu_j\right\|^2 \tag{4}$$

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Step 4: For every j, set, using eq. (7).

$$\mu_j := \frac{\sum_{i=1}^{m} 1\{c^{(1)} = 1\}x^{(i)}}{\sum_{i=1}^{m} 1\{c^{(1)} = j\}} \tag{5}$$

Step 8: End

2. Contrast Test-based clustering

Our proposed algorithm depends on the idea on the difference in the contrast level in the clustering area, this principle allows us to determine the optimal cluttering region. Our idea needs a pre-processing step to improve the contrast level in the cluster area [16] [17].

- Contrast improvement, and mid-range stretch using Image Adjustment: Here only the brightness of the images was increased to enhance perceptibility. This was complete to improve the quality of the brain MRI images [16] [17].
- Contrast improvement- converted MRI image to gray scale images from RGB images, which called intensity images. Here intensity values are mapped to a low and high intensity values using image adjustment technique.
- Mid-range Stretch- this is also an enhancement tool that is used to the middle range of MRI image. MRI image intensity values are stretched as results of -range stretch, so it improves the quality of brain MRI images. We depend on gray scale image pixels which are mapped between 0 and 1 value by dividing 255 intensity values [16]

$$X_{ij} = \frac{Input\ Image}{255} \tag{6}$$

as shown in eq. (8).

where
$i$is for row index of brain image matrix and j for column [16] [17].

To compute the function f(x) on the X matrix obtained from eq. (8). The function f(x) is defined as follows eq. (9) [16].

$$f(x_y) = \begin{cases} 0.5 * x_y & ,x_y < 0.1 \\ 0.1 + 1.5 * (x_y - .1) & ,0.1 \le x_y \ and \ x_y \le 0.88 \\ 1 + 0.5 * (x_y - 1) x_y > 0.88 \end{cases} \tag{7}$$

Subsequently applying the above function $f\ (x_{ij})$ which is the gray-scale images converted to indexed images then the output images are obtained after applying all the operations has been done to improve the quality of images.

3. Our Proposed clustering algorithm

In the clustering problem, which is an unsupervised learningproblem. By given a training set which is $\{x^{(1)} \dots x^{(m)}\}$ andwant to group the data into a few consistent "clusters." Here, $x^{(i)} \in \mathbb{R}^n$as usual and no labels $y^{(i)}$ are given.

The contrast-based clustering algorithm is as follows in Algorithm (2):

Step 1: Do image conversion from 2D → 1D_length, using eq. (10)

$$Lenth = row \times column \tag{8}$$

Step 2: Do Parameters Initialization $Cluster_{Number}$
Generate cutler's vectors $(1D_{Clusternumber})_{1\times length}$
$Max_{value} = \max(grayscale)$ and $Min_{value} = \min\ (grauscale)$

$$ange = Max_{value} - Min_{value} \tag{9}$$

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$$Step_{value} = \frac{Range}{Cluster_{number}} \quad (10)$$

Step 3: Do Initialize $cluster_{centriods} \mu_1, \mu_1, \ldots, \mu_k \in \mathbb{R}^n$. Here we have chosen K=5 depend on the most analysis study [18], which showed that the most significant K that is should be chosen with the range from k=5...10.

$$icrement_{value} = Step_{value} \quad (11)$$

Step 4: For i=1 to $Cluster_{Number}$ {

$$Cluster_{center}(i) = icrement_{value} \quad (12)$$

$$icr_{value}(i) = Step_{value} + icr_{value}(i-1) \quad (13)$$

$$mean(i) = intial_{value} = 2 \quad (14)$$

$Update_i = 0$.

End for loop }

Step 5: Repeat until convergence: {

For every i, length set {

For every j Cluster number set {

$temp \leftarrow 1D[i]$

$$dif^{(i)} := \text{abs} \left\| temp^{(i)} - Cluster_{center_j} \right\| \quad (15)$$

End j Loop }

$$y^{(i)} := \text{agr} \min_j \left\| dif^{(i)} \right\| \quad (16)$$

If index (y)within $Cluster_{Number}$

Assign temp to clusteraccording to the index of the $y^{(i)}$

End iLoop}

Do counting for each $Cluster_{Number}$

Update mean values

$$\mu_j := \frac{\sum_{i=1}^{k} 1\{cluster^{(1)} = i\}}{\sum_{i=1}^{k} 1\{count^{(1)} = j\}} \quad (17)$$

Step 5: Update until $Cluster_{center_j}$

$$Cluster_{center_j} = \mu_j \quad (18)$$

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C. POST PROCESSING

1. Morphological Operations

For the tumor region extraction operators and the logical operator to tumor regions. In tumor regions, v edges and diagonal edges are distributed separately in non-tumor operator is used for filling the broken have continuities at the boundaries [18] as it shown in Fig.1, (c).

2. Tumor region detection and Localization

In this step, centroid of the irregular shape has been calculated after we remove the non-circular shape from the binary tumor image. Then we used the centroid shape point in the MRI tumor image to draw a boundary Box on the original image [19] [20] [21].Depending on the shape centroid we draw a boundary box around the irregular shape, as Fig.1, (b) shows and image cropping [22] to isolate the tumor sub image (d) shows.

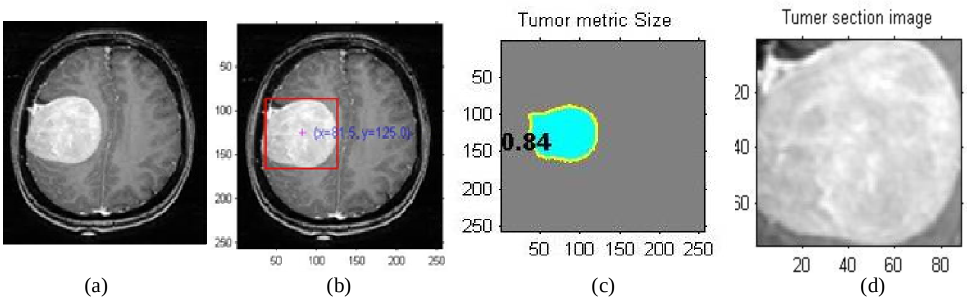

Fig. 14. MRI brain tumor region detectionand localization Approach, (a) Original MRI image, (b) Tumor detection and localization, (c) Tumor dimension, (d) Tumor Isolation

VI. RESULTS

The performance results of our proposed algorithm which is based on the contrast-based methodology approach that is shown in Tab. (1), we can notice that our proposal has been satisfied (97.4%) by using K=5which means using five clusters. By comparing with distance-based methodology approach (K-means algorithm)which is shown in Tab. (2). We can notice that our proposed algorithm has been satisfied (97.4%) by using K=5 against K-means algorithm which already has satisfied (96.4%) on the same dataset that has been used [18].

Table (1) The performance results of our proposed algorithm and K-means using K=5

Our proposed algorithm					**K-means**				
Time	**Sensitivity**	**Specify**	**Precion**	**Accuracy**	**Time**	**Sensitivity**	**Specify**	**Precion**	**Accuracy**
1.3603	72.4398	98.4036	56.0937	97.4014	5.6938	58.9019	99.1205	75.1737	96.4650

In another observation, we can notice that the difference between time consuming. Fig. 2 shows that our proposed algorithm is more accurate which is less time consumed against the the distance approach using (K-means) algorithm.

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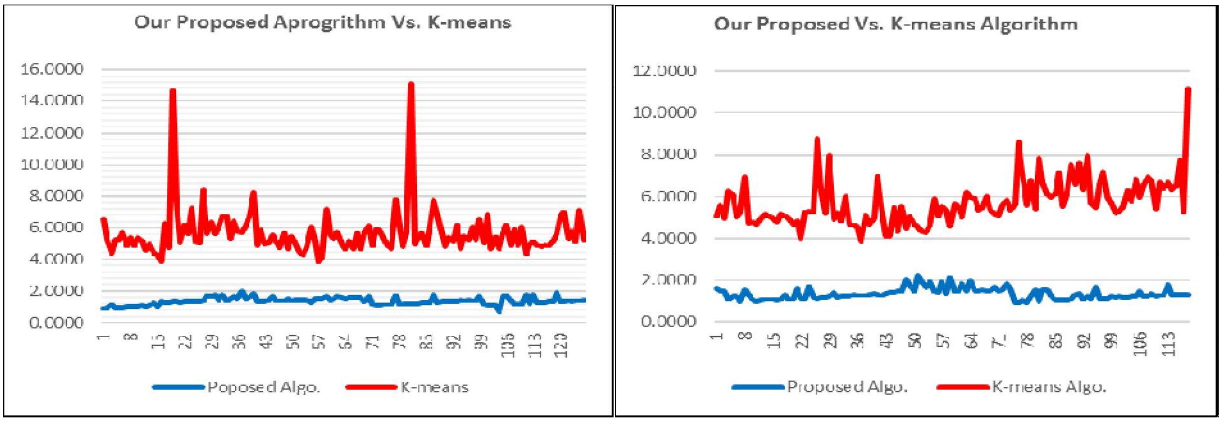

(a) (b)

Fig. 2. MRI brain tumor region detection time consuming using two labels datasets(a) Meningioma detection (b) Glioblastoma detection [18]

VII. CONCLUSIONS

In this paper, we propose a speed-up approach for brain tumor detection and localization that can detect and localize brain tumor in MRI (magnetic resonance imaging). The proposed approach for brain tumor detection and localization framework based on a new methodology. Contrast-based methodology is the new majority that has been proposed and used in this proposed approach for tumor detection. A speed-up approach for this proposal is based on using a new category for image clustering approach rather than using the distance-based approach like (K-means) algorithm. Contrast-based approach for tumor detection and localization contains five steps: image pre-processing, edge detection (sharpening), modified contrast level clustering and morphological operations. After morphological operations, tumors appear as pure white color on pure black backgrounds. The proposed tumor detection and localization system has could accurately detect and localize brain tumor in MRI. This system achieved an error rate of 3%. The preliminary results which demonstrate how a simple image-based features (contrast-based approach) can result in high classification and detection accuracy. The preliminary detection results also demonstrate the efficacy and efficiency of our contrast-test which is five-step brain tumor detection and localization framework. Itmotivates us to extend this framework to detect and localize a variety of other types of tumorsaccording to the (Benign and Malignant) in other types of medical imagery (MRI).

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