

Brain Tumor Detection in Real MRI Images Based on Otsu and K-means Cluster Algorithms

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المخلص

في هذه الورقة قمنا بتصميم وتنفيذ منهجية للكشف واستخراج الكتلة المصابة بورم الدماغ (اما ورم حميد او خبيث) من صور الرنين المغناطيسي MRI باستخدام برنامج الماتلاب. هذه الصور تم جمعها من المركز القومي للأورام ومستشفى مصراته المركزي والبالغ عددها (50) صورة، 35 صورة لورم الدماغ نوع (خبيث) و15 صورة (ورم دماغ حميد). جميع صور الرنين المغناطيسي كانت من النوع (T2 weighted). تمت معالجة الصورة المدخلة وهي من النوع الرمادي وذلك بتغيير حجمها لتصبح 200*200 بكسل من دون أن يؤثر هذا الاجراء على جودة الصورة. وكذلك استخدمت تقنية التقطيع لاستخراج الكتلة المصابة من الصورة وعزلها عن باقي الخلايا السليمة وذلك بدمج خوارزمية OTSU لتحويل الصورة للنظام الثنائي وخوارزمية K-means cluster لتجزئة الصورة إلى ثلاثة أجزاء، حيث أعطت هاتان الخوارزمتان نتائج دقيقة وممتازة في عملية الكشف عن المنطقة المصابة بلغت 100%.

Abstract :

In this paper, we designed and implemented a methodology to detect the mass affected by brain tumor for Magnetic Resonance Images (MRI) using MatLab program as a tool. These MRI images were collected from National Cancer Center (NCC) and Misurata Central Hospital (MCH), the total number of images used for testing stage are 50 images. All MRI images were the type of T2 weighted. The input image has been processed, which is of gray type, by changing its size to become 200*200 pixels without affecting on the image quality. Also the segmentation technique was used to extract the infected area from the image and isolate it from the rest of the healthy tissues by integrating two algorithms, Otsu algorithm to transform the image into the binary system and K-means cluster algorithm to split the image into three parts, these two algorithms gave accurate and excellent results in the detection. The accuracy rate in the detection process has reached 100% where the output image represents exactly the tumor cells that were pointed from the healthy cells.

Keywords: Image Detection, Tumor Classification, Otsu, K-means Cluster, MRI.

1-INTRODUCTION

Although many clinical experts or radiologist are well trained to identify tumor and other abnormalities in the brain. The identification, detection and segmentation of the infected area in the brain is absorbed to be a tedious and time-consuming task. MRI has been a conventional and resultant image processing technique to visualize structures of the human body. It is very difficult to visualize abnormal structures of the brain using simple imaging techniques MRI technique uses many imaging modalities that scan and capture the internal structure of the human brain. Even with the use of these techniques, it is a difficult and tedious task for a human eye to be always sophisticated in detecting brain tumors from these images. With emerging technology, we can provide a way to ease

the process of detection. Brain tumor detection and segmentation is one of the most challenging and time consuming task in medical image processing. In this paper, an idea is presented to design approach helping to detect infected tissues of brain tumor in real MRI patient images. There are many types of cells in the human body, every cell has a particular function. New cells produced when they are division in an orderly and healthy manner, and these new cells help in terms to keep the human body healthy and properly working. When some cells lose their capability to control their growth, they are reproduced without any control. Whereas these extra cells called a tumor. It is a disease known as abnormal tissue growth [1]. The human brain is responsible for all activities within the body; it is the center for managing the nervous system and receiving signals from the body [2]. A brain tumor is an abnormal mass of tissue inside the brain where cells grow and multiply randomly [3]. It is one of the main causes of the increasing death rate among children and adults. Tumors that grow in the brain cause life-threatening disease. The tumor has two main categories, benign and malignant. The cells in benign tumors rarely invade tissues around them and do not spread to other parts of the body, but malignant brain tumors are cancerous and grows near the healthy brain tissue, and grow faster than benign tumors [4]. Brain tumor is considered as one of the most dangerous diseases. That requires high accuracy and expertise by specialists in determining its type. Therefore, the use of automated and modern medical image processing techniques to detect and classify the stages of brain tumors with efficient diagnosis has become important [5].

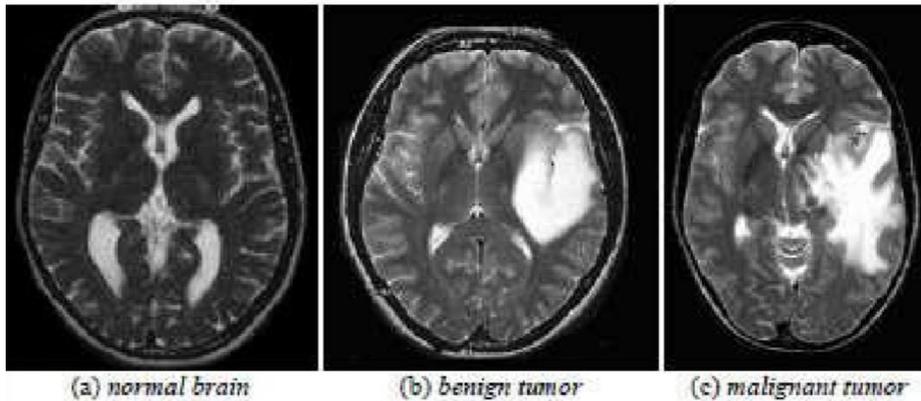


Figure (1) - MRI Brain Images

Nowadays, the diagnosis of brain tumor has become a very important and essential task. The process of tumor detection in the brain usually done via various medical imaging techniques such as Positron Emission Tomography (PET), X-ray, Computed Tomography (CT) scan, and MRI. A diagnosis of brain tumor in the medical field usually begins with MRI to visualize more accurate details of the internal structure of the human body, this technique mainly used to detect differences in tissues; it is a hot topic for research in recent years. Our work will focus on MRI images because the MRI scan does not affect the human body, it does not use any radiation, and it is more comfortable as compared to a CT scan for diagnosis [2]. One of the most important step in the tumor detection process called image segmentation, in which the tumor-affected area is isolated from the other healthy tissues, which makes it easier to analysis and determine its type [6]

II .The Problem

As mentioned earlier, the existing manually detection methods have high probability of risk in negative classification for the type of brain tumor, also, early detection of this disease increases the patient's survival rate by prescribing the necessary treatment or taking the necessary medical measures. Therefore, CAD system is a powerful tool used for early detection of brain tumor, and it is indispensable that can be helpful for radiologist in identifying and classifying brain tumors. but there are still some drawbacks in accuracy rate of brain tumor detection, therefore, the remarkable result has not yet been achieved. This leads to further research to enhance the accuracy rate an important factor in dealing with human life.

III. Literature works in brain tumor detection

Using MATLAB, the researchers in [7] proposed a new methodology designed to detect and predict only the tumor regions in human MRI images. The proposed methodology consisted of five stages started with converting the MRI image into a grayscale image. Then a median filter was applied to remove any noise from the image using contrast enhancement technique. After that, edge detection technique such as sobel, prewitt and canny algorithms are applied, then thresholding segmentation technique was used to distinguish tumor region in the image. The last stage was a segment the affected area with tumor based on the k-means cluster algorithm with number of $k = 4$ to cluster the tumor into four regions represent tumor location. The affected regions of brain tumor detected efficiently. In [8] researchers presents a new method using thresholding with morphological image analysis techniques to detect brain tumor from MRI image. First step was MRI converted to grayscale, then noises were removed by filtering techniques. The grayscale image was then converted to binary image adding 0.3 with the Otsu's threshold value. This method was tested on 72 FLAIR images of 72 patients taken from BRATS Brain Tumor database, out of which the proposed algorithm was able to detect tumor from 61 images successfully. Experimental result showed an accuracy rate of 84.72% in detecting 61 patients brain tumor.

IV. Methodology of proposed work

The methodology of proposed work is illustrated bellow in Figure (2).

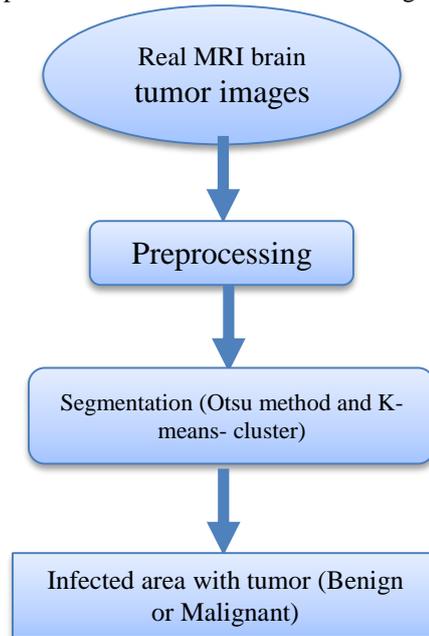


Figure (2) - Proposed Methodology

The research design of the proposed work shown in Figure (2) is summarized as follows:

1-DATASET

The proposed work starts firstly with collecting database contained benign and malignant tumor images. The dataset contained real brain tumor MRI images, they are all transverse relaxation time (T2) weighted, the collected images were then viewed using the Radiant software, to select the axial images suitable for the criteria set for the research, isolate one image per person as shown in Figure (3). The total number of dataset of this approach contains 50 MRI brain tumor images divided in two types (Benign = 15 images, Malignant = 35 images) from different gender (male, female and child). Voluntary patients are between the ages of 5 and 75. The images collected from NCC and MCH in Misurata city. Chosen images are categorized into two distinct classes as (confirmed benign and confirmed malignant tumor only). Images are grayscale level in (jpg) format stored in (MATLAB2013a) version.

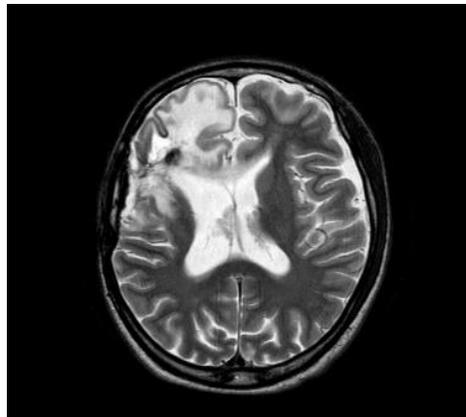


Figure (3) - Sample of Real MRI Images

1- PREPROCESSING

Usually, reducing size of the image an important factor to reduce processing time and to decrease the image complexity without losing any of its fundamental features. So, the first step is convert the each MRI brain tumor image to a fixed size (200x200 pixel) with the same extension (jpg).

2- SEGMENTATION

Image segmentation is a fundamental technique in image analyzing and processing filed. The purpose of this process is to separate the image into its components according to the homogeneity and correlation between each pixel and the adjacent pixel. The segmentation stage is performed in two steps: Otsu binarization and K-means clustering were the input image is converted in binary by fixed threshold value. The image pixels less than threshold are placed equal zero, whereas the image pixels larger than threshold equal to one. Segmenting the tumor region from MRI images is a complex, crucial and difficult task, but precise and accurate segmentation is essential for the detection and classification the tumor. To detect infected tumor tissues from MRI. In present case, brain tumor portion will be required to be segmented from MRI brain tumor image, which will become region of interest (ROI). Segmentation employed to separate the tumor tissues that represent in the (ROI) from normal brain tissues using combining Otsu binarization method and K-means cluster.

A. OTSU METHOD

In this step, the MRI image is converted to binary format by selected threshold value T via calculating the total intensity distribution of an image. Threshold value compared with individual pixel values, if the pixel value is higher than the threshold, then the pixel is becomes as foreground, it means set to be white. When the value is less than or equal to the threshold, it is becomes as background and set to be black.

$$T: g(x, y) = \begin{cases} 1, & \text{if } f(x, y) > T \\ 0, & \text{if } f(x, y) \leq T \end{cases} \quad (1)$$

B. Segmentation using K-means clustering method

This is the third basic and major step in the methodology. It applied on all MRI brain tumor input images to segment and extract the tumor area from healthy tissues in patient's MRI image. K-means algorithm partitions (n) observations into (k) clusters where each observation partitioned depending on the nearest mean value. Every time mean is updated with the centroid value and this process continues until convergence is reached. It depending on define the number of clusters, here we select the number of clusters $k = 3$, where first cluster for tumor area and second for background, last cluster for other healthy brain tissues one of the main advantages of this algorithm is uncomplicated and low computational cost, which makes it works efficiently on large datasets [9], Figure (4) show the segmentation process.

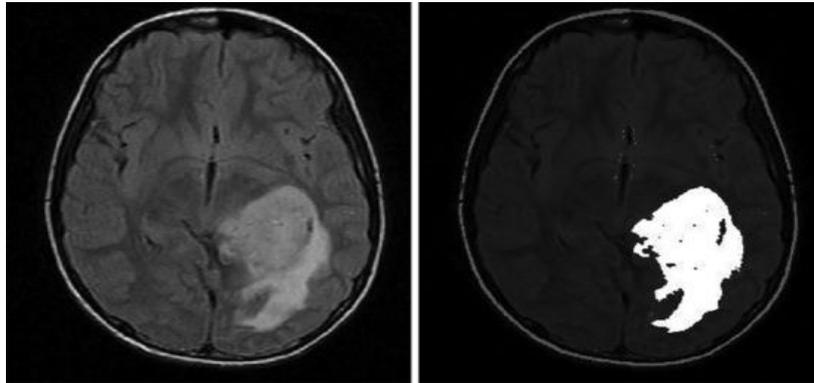


Figure (4) - Before and After Segmentation Process

VI. RESULTS AND DISCUSSIONS

After applying the proposed approach, we get excellent results indicate that system is helpful in detection of brain tumors automatically. The detection of brain tumor performed in two phases, preprocessing and segmentation. Preprocessing step involved just image resizing. The segmentation were done by using combination of Otsu method and K-means cluster. The process takes a brain image and produces a segmented image with a detected area of (ROI). Segmentation phase of the proposed system quite accurately extract the tumor region from the benign and malignant MRI brain tumor images as shown in Figures (5 – 8). K-means cluster algorithm has given a detection of ROI efficiency of 100% with the grayscale MRI images.

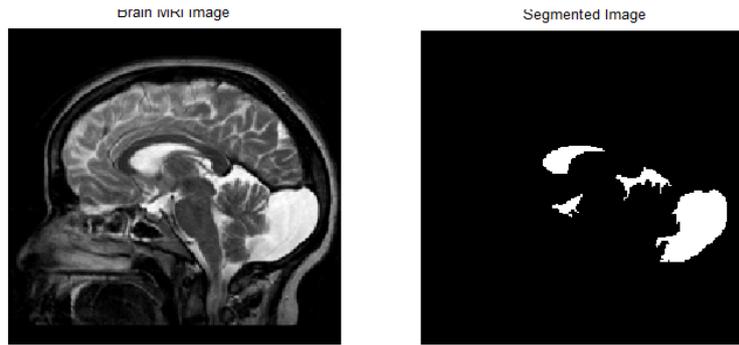


Figure (5) - Extract benign tumor tissues

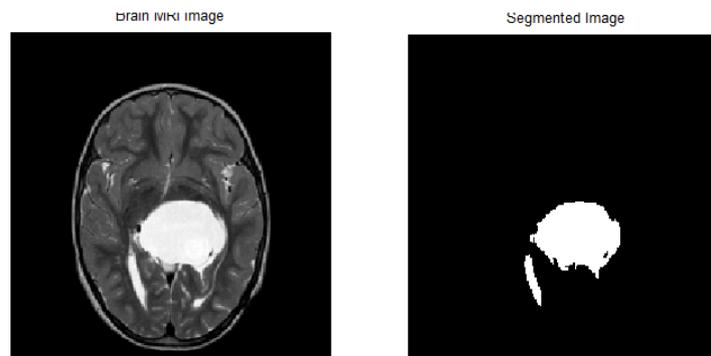


Figure (6) - Extract malignant tumor tissues

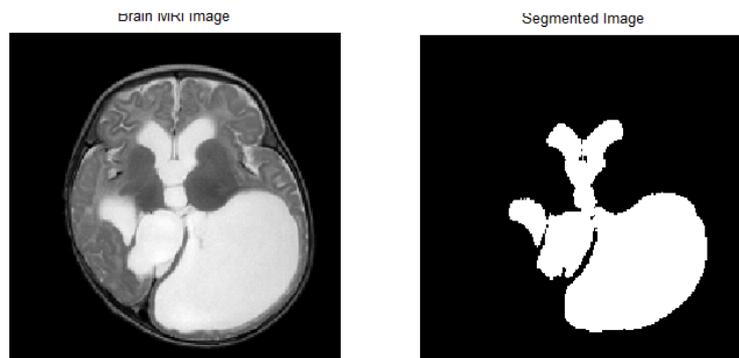


Figure (7) - Extract benign tumor tissue

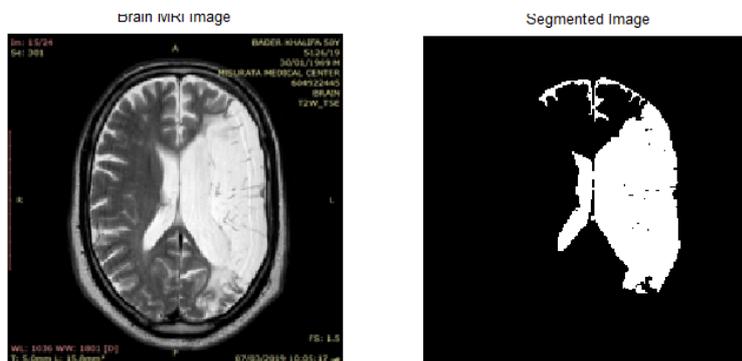


Figure (8) - Extract malignant tumor tissues

VII. CONCLUSION AND FUTURE WORK

This paper has discussed how to detect brain tumor through T2 weighted MRI brain tumor images. These images taken from patients affected with brain tumor. The images obtained from NCC and MCH are used in this paper. The total number of the images are 50 images, 35 images with malignant brain tumor and 15 images with benign brain tumor. The image processing techniques applied in our work used MATLAB2013a program Segmentation phase of the proposed system is the main core of our work. It quite accurately extract the tumor region from the benign and malignant MRI brain tumor images. In future work, dataset of brain MRI images with different stages of tumor can be collected and based on which a good classification system can be designed.

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