

Generation of Three Dimensions Image of Tumor Regions in Sagittal and Coronal Orientations MRI of Brain

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Abstract:

The anatomy information that provided by MRI made it an indispensable tool for diagnosis purposes in present. There are three orientations of acquiring the sliced images of brain in MRI, which are: sagittal; coronal and axial. So it is a vital task to find out an effective and adequate technique for processing and segmenting MRI sliced images of the three orientations modalities to detect and extract tumors in these images. In this work, a simple and effective technique that, it adequate to segment sagittal and coronal orientations, is proposed. This technique is one of the enhancement methods that based on the histogram of the image. Besides, morphological operations were proposed to isolate and extract the tumor regions adequately from successive sliced MRI images of brain of a patient suffer from brain tumor, to utilize them later in generating three dimensions image of the extracted tumor. In addition, the location of the tumor was determined and hold completely within the contouring map of the patient's head for the two adopted orientations. The importance of this work involving that, this process gives the surgeon a better view seen for the tumor from different orientations to enable him to find out an optimal path to reach the tumor with minimum damage of the surrounding tissues. This work was achieved by the aid of Mat Lab programming system..

Keywords: MRI, brain tumor, morphological operations.

توليد صورة ثلاثية الأبعاد لمناطق الورم في صور الرنين المغناطيسي ذات المقاطع الجانبية والأمامية الإتجاه للدماغ

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الخلاصة:

إن المعلومات التشريحية الغنية التي يحصل عليها من التصوير بالرنين المغناطيسي جعلها طريقة لا غنى عنها لأغراض التشخيص في الوقت الحاضر. توجد ثلاثة اتجاهات للشرائح الصورية المستخلصة من التصوير بالرنين المغناطيسي للدماغ وهي: الجانبية، والأمامية، والعرضية. لذا فمن المهم التوصل إلى طرق معالجة وتقسيم صورية تكون كفاءة في الكشف عن واستخلاص الأورام في الشرائح الصورية بالرنين المغناطيسي المختلفة الاتجاهات والأنماط. في هذا العمل اقترحت طريقة تقسيم مبسطة وكفاءة تصلح لمعالجة الاتجاهات الجانبية والأمامية المقطع للشرائح الصورية. وتعد هذه الطريقة أحد تقنيات التحسين المعتمدة على المخطط التكراري للصور. كما اقترحت بعض العمليات المورفولوجية لغرض المساعدة وبكفاءة في عزل واستخلاص مناطق الورم من شرائح صورية متسلسلة لدماغ أحد المرضى يعاني من

ورم في الدماغ، لغرض استخدامها فيما بعد لتوليد صورة ثلاثية البعد لهذا الورم. بالإضافة الى ذلك لقد حدد مكان الورم وأسقط حجم الورم كاملاً داخل الخارطة الكتتورية لرأس المريض وللاتجاهين المتبنيين. وتكمن أهمية هذا العمل في كونها تساعد الطبيب الجراح في امتلاك رؤية واضحة للورم ومن جميع الاتجاهات ليتمكن من إتباع أمثل الطرق وصولاً إلى منطقة الورم وبأدنى ضرر ممكن بالأنسجة الدماغية المحيطة. لقد أنجز هذا العمل بالأستعانة بالنظام البرمجي الماتلاب.

الكلمات المفتاحية: التصوير بالرنين المغناطيسي، أورام الدماغ، العمليات المورفولوجية.

1. Introduction

Image processing is a crucial element in science and technology due to the immense impact of digital images on modern community. The fast progress in computed medical imaging, and the related evolution in analysis methods and computer-aided diagnosis, has prompted medical imaging into one of the most essential sub-fields in scientific imaging [1]. In present, medical imaging is an essential part of medicine. Pathologies can be monitored directly. A doctor can non-invasively observe the recovery of damaged tissues or the growth of tumors in brain or other part of the body and determine a proper medical response. Medical imaging techniques can be used also for planning to, or when performing surgery [2].

Many imaging techniques were developed. These techniques depend upon different physical principles. So they can be more or less suited to a particular organ rather than others. There are different imaging techniques which are:

Anatomical techniques: that supply insight into the anatomical morphology and they include: Radiography, Ultrasound or Ultrasonography (US), Computed Tomography (CT), Magnetic Resonance Imaging (MRI), besides many several derived modalities like Magnetic Resonance Angiography (MRA, derived from MRI), Digital Subtraction

Angiography (DSA, from X-rays), Computed Tomography Angiography (CTA, from CT) etc.

Functional techniques: which describe the metabolism of the underlying tissues and organs. They consist of three nuclear medicine modalities called, Scintigraphy, Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET) and Functional Magnetic Resonance Imaging (fMRI) [2,3,4]. For more details see [5].

In this work, sets of sagittal and coronal orientations of MRI modality brain images were adopted to be processed in order to extract tumor regions from successive sliced images to utilize them later in generating 3D image of the tumor and then localize its position within the patient head. The axial orientation was processed to extract tumor in three successive images to construct 3D image in our previous works [6, 7]. The present work is to figure out a complete view of the tumor volume as a whole for comparison. The proposed segmentation technique is a simple enhancement method based on the histogram of the processed images.

2. Brain Tumors

Human body is made up of cells. In infants and children bodies, new cells are created to complete the development of their bodies in besides those cells needed for repair. While in adults, new cells are

normally formed in their bodies only when they are needed to replace old or damaged cells. A tumor develops when normal or abnormal cells multiply out of control and with no need for new cells [8].

Brain consists of groups of cells. The brain is a soft and spongy mass of cooperative and supportive tissues (similar cells in appearance and function) and nerve cells that are connected to the spinal cord. Brain is protected by bones of the skull, three thin layers of tissues called (meninges) and watery fluid called (cerebrospinal fluid). The brain and spinal cord together constitute the central nervous system [8, 9].

A brain tumor is a mass of unwanted cells that grow in the brain or central spine. There are two principal kinds of brain tumors: primary tumors and metastatic tumors. Primary tumors start and tend to stay in the brain. Metastatic tumors begin as cancer in other parts of the body and extend to the brain. Brain tumors may be benign or malignant. Those two descriptions refer to the degree of aggressiveness or malignancy of the brain tumor. Primary tumors may be benign or malignant while metastatic tumors are always malignant. Benign tumors do not contain cancer cells while malignant tumors contain cancer cells. It is sometimes difficult to classify a brain tumor as benign or malignant because there are many factors rather than pathological features contribute to the diagnosis [8, 9].

3. Histogram Based Enhancement Method:

In this work, histogram based enhancement technique was implemented to investigate the gray values range of the tumor region to emphasize it, by extending it to be the whole range of the brain image. This process involves improving the appearance of the processed image by modifying its contrast in a way such that, the tumor region is highlighted to vacillate isolating it from other brain tissues. The theory and details of this technique are found in [10, 11, 12].

4. Adopted Datasets:

The experiments of this work were implemented on two sets of MRI images acquired from Al-Hilla Surgical Hospital for a patient of eight years old suffer from brain tumor. The first set of images is of sagittal orientation (from ear to ear), and the second one is of coronal orientation (from front to back). The two sets of orientations are shown in the Fig. (1) and the characteristics of these orientations are presented in Table (1).

Fig. (1) demonstrates the complete sets of sagittal and coronal orientations. Sagittal set contains 20 sliced image as shown in (a), while coronal set contains 27 sliced image as shown in (b). Tumor regions are in white color.

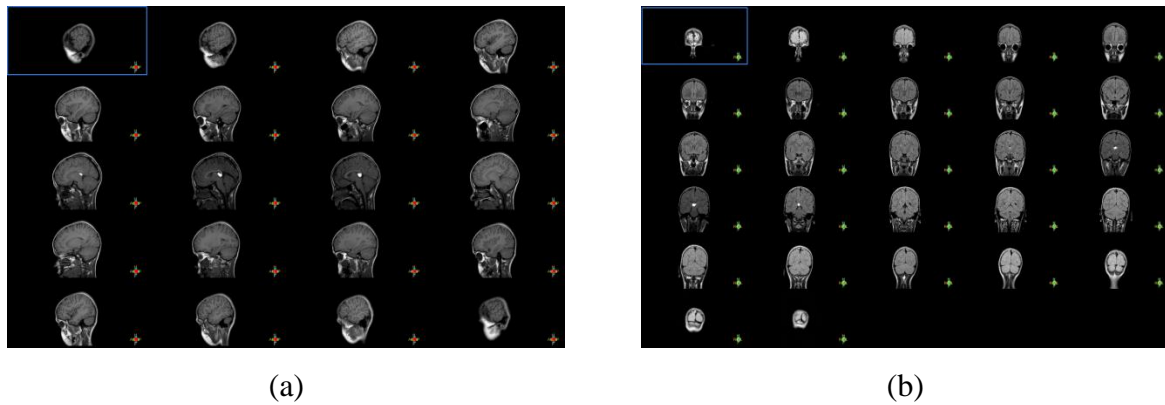


Fig. (1): The complete sets of MRI images, (a) for sagittal orientation, (b) for coronal orientation. (Tumor regions are in white color).

Table (1): The characteristics of the adopted datasets

Dataset Number	Orientation	Modality	Slice Thickness	Pixel Spacing	Matrix Size
First	sagittal	T1W_SE	5 mm	0.79861 x 0.79861	288 x 288
Second	coronal	T2W_FLAIR	5 mm	0.89844 x 0.89844	256 x 256

5. Experiments and Results:

By inspection of Fig.(1) and depending on our experience in medical images, the images that contains tumor (white regions) were selected which are: sliced images number 9, 10 and 11 for

sagittal orientation set; and sliced images number 15, 16 and 17 for coronal orientation set. Fig. (2a and 2b) demonstrate the selected sliced images that contain tumor before and after cutting background for sagittal and coronal orientation sets.

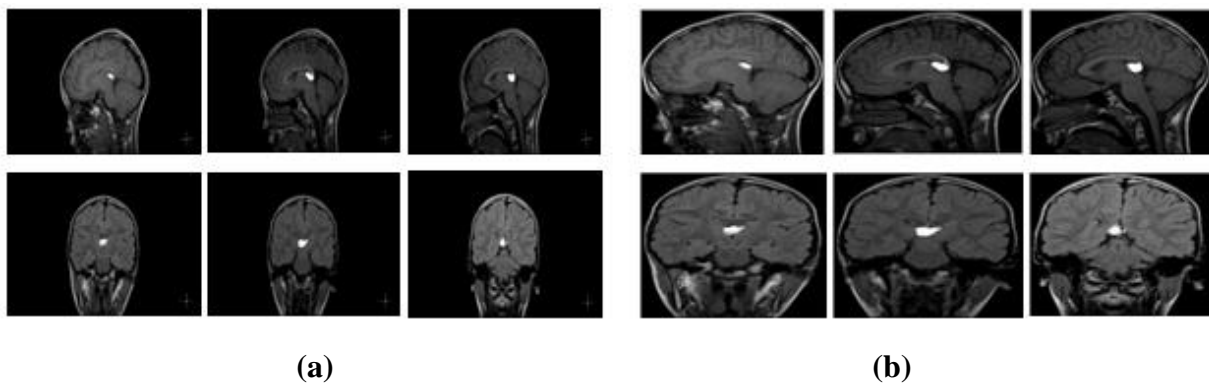


Fig. (2): The selected images that contain tumors, (a) before cutting background [each image of (618x1050) size] and (b) after cutting background [each image of (538x480) size for sagittal and (522x416) size for coronal]

In Fig. (2), first line represents the selected sagittal sliced images that contain tumors while the second line represents the coronal sliced images. Group (a) of images

are for images with background, while group (b) are for images after cutting background by implementing an automatic

technique depending on images' moments that adapted by [12].

5.1 Isolating and Extracting Tumor Regions

In this stage of work many steps were applied:

1-In this step, a simple technique based on the histogram of the adopted images was implemented. After investigating the histogram of all the experimental images, the intensity range [0.8 0.9] of the normalized images was selected to be emphasized (highlighted) by enforce this range to be in [0 1] range.

2-After highlighting the tumor regions in the images as a whole, thresholding process was applied on the resultant images of step 1 to get BW image utilizing (graythresh) function.

3- Applying morphological opening process with disk shaped element of 2 pixel radius to get the tumor region only without any pixel belongs to other tissues of the brain.

The results of this stage are presented in Fig.(3a and 3b) for sagittal and coronal orientations respectively.

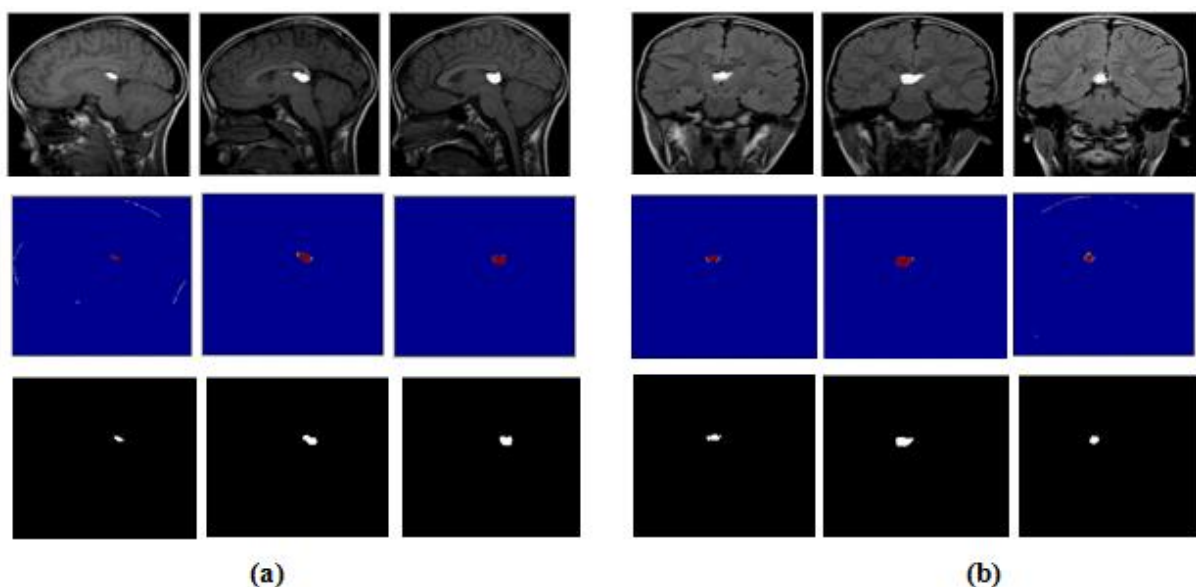


Fig. (3): The results of isolating and extracting tumor regions from sagittal orientation set in (a) and coronal orientation set in (b).

The first line in Fig.(3) represents the background removed input images, the second line shows the highlighted tumor regions images, while the third line shows the BW extracted tumor regions images. Group (a) is for sagittal orientation images and group (b) for coronal orientation images.

5.2 Generation of Three Dimensions image of Tumor

In this stage of the work, the extracted tumor regions from the previous

stage, and for the two orientation sets, were utilized to generate 3D image of the tumor and determine its location within the head of the patient by applying the following steps:

1-Constructing array with the same dimensions of tumor images to involve the tumor region images and for the two adopted sets of images.

2-Generating 3D contours map of the tumor regions and then filling it and choosing a color for it (red color was

chosen here). The results of this stage are presented in Fig. (4a and 4b) for the two

experimental sets

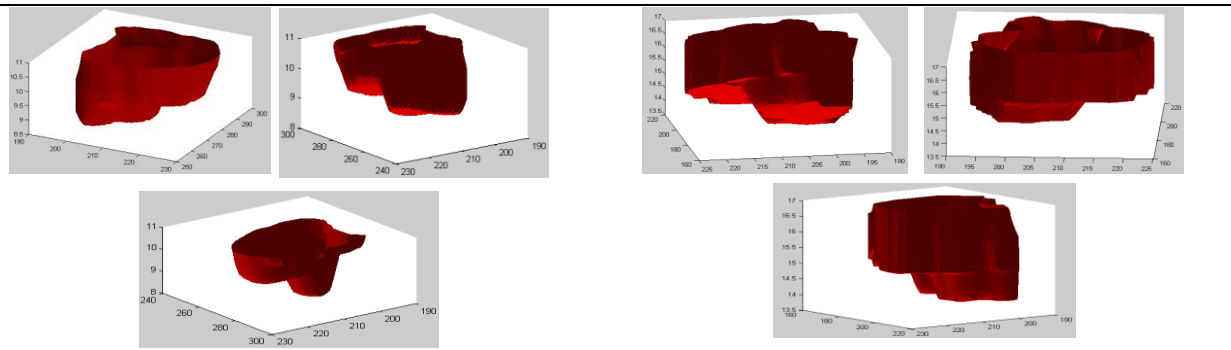


Fig. (4): The 3D generated image if the extracting tumor regions in different orientation views, (a) for sagittal orientation set and (b) for coronal orientation set.

5.3 Determining the Tumor Location within the Head

In this stage, the location of the whole tumor volume was determined

within the head after constructing contouring map of the head in the same way that was implemented for the tumor region and Fig. (5) presents the results of this stage.

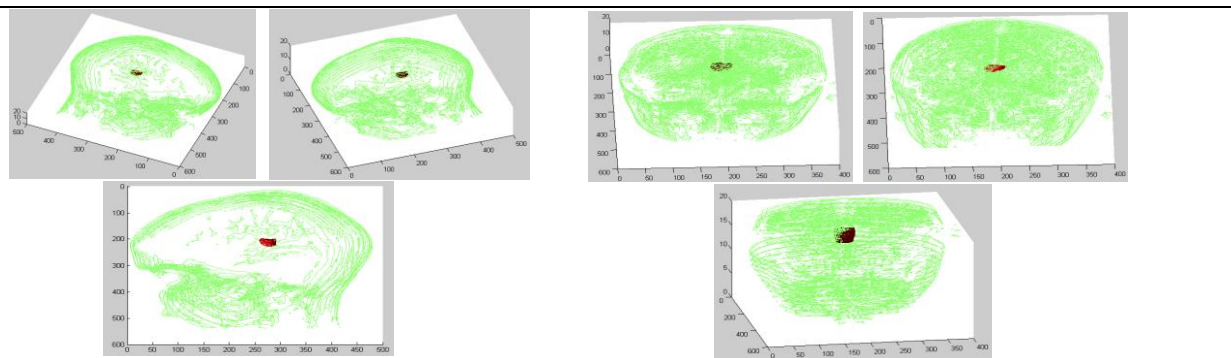


Fig. (5): The final results of 3D tumor regions within the head, (a)) for sagittal orientation set and (b) for coronal orientation set

5.4 Surface Area of the Tumor Regions

The surface area of the extracted tumor regions was calculated from BW images of them, and their values are presented in Table (2) in mm^2 depending on the spatial resolution values of each set which are presented in Table (1).

Table (2): The calculated surface area of the extracted tumor regions of the two adopted sets.

Sliced Image	Tumor Region Area (mm^2)	
	Sagittal Orientation	Coronal Orientation
1 st sliced image	183.04	411.66
2 nd sliced image	493.00	780.55
3 rd sliced image	566.14	364.85

6. Conclusions

In this work, two different orientations of MRI brain successive sliced images were adopted to process them in order to isolate and extract tumor regions by implementing simple segmentation technique. The proposed technique is histogram based enhancement method that aims to enforce the gray levels range of tumor region to be as the whole range of the brain image, to vacillate isolating tumor region. The results proved high quality performance of the proposed technique. In addition, 3D image of the extracted tumor regions was generated correctly and we succeeded to localize the tumor volume within the patient's head after constructing contouring map of the head. The importance of this work is that, the proposed technique gives the surgeon a better view seen for the tumor from different orientations to enable him to find out an optimal path to reach the tumor with minimum damage of the surrounding tissues.

7. Reference

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