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Manual Image Segmentation Using Dicom Format to Examine and Analysis Brain Magnetic Resonance Imaging (MRI) Tumor

[1]Marwan Alshipli, [2]Mohammad Marashdeh, *[3]Ammar A. Oglat

[1]*Medical Imaging and Radiography Department, Aqaba University of Technology, Aqaba, Jordan.*
[2]*Department of Physics, College of Science, Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia*
[3]*Department of Medical Imaging, Faculty of Applied Medical Sciences, The Hashemite University, Zarqa, 13133, Jordan, ammar.oglat@yahoo.com*

Abstract

Background: One of the most significant missions in medical imaging analysis is imaging segmentation and is the most important part in a lot of clinical applications. For analysis of the brain MRI and its changes, describing pathological areas, and for surgical processing, the segmentation is often applied for visualizing and measuring the anatomical parts of the brains. The aim of this study is to do manual segmentation because automatic brain tumor segmentation has various challenges. Methods: A 3 Tesla MRI scanner with gadolinium contrast medium was used for imaging the patient's brain and discovering the tumor. Moreover, manual segmentation (3D slicer program) was applied on the tumor directly to get the best identification and special information. Finally Measure the size of the tumor in MRI through MRIcro program for allows efficient viewing and exporting of the brain image. Results: The proposed Dicom (DCM) model was considerable to segment the brain with valid accuracy. Manual image segmentation showed the best identification of the special information of tumor and displayed separate healthy tissue from tumor region to give accurate results for diagnosis and treatment planning. Conclusion: The proposed method (Manual image segmentation) is good for segmenting the brain in 3D MR images with perfect accuracy. Furthermore, it requires the radiologist to use the multi-modality information presented by the MRI images along with anatomical and physiological knowledge gained through training and experience and segmentation results are subject to large intra and inter rater variability.

Keywords: Brain tumor, MRI, Manual segmentation, 3D MR images.

Introduction

MRI is a non-invasive method used to examine organs, tissues, and the skeleton (Serup, Jemec et al. 2006, Pagani, Bizzi et al. 2008, Brown and Semelka 2011, Lauridsen, Hansen et al. 2011, Currie, Hoggard et al. 2013, Ahmad, Suardi et al. 2019, Ahmad, Suardi et al. 2020, Ahmad, Suardi et al. 2020, Ahmad, Suardi et al. 2020, Oglat and Chemistry 2020, Dheyab, Khaniabadi et al. 2021). It produces high-resolution images inside of the body which help diagnose different types of diseases. Therefore, MRI is the most widely used technique in brain imaging because of its ability to distinguish brain diseases by making measurements of some molecules that distinguish tumors from brain abscesses. So, MR technology able to detect the presence of tumors in the brain, as the physician can obtain information to estimate blood flow in a specific area, for example, an increase in blood flow, as in tumors, and also helps to detect brain tumors which distinguish the multiplying cells within tumor (Vernooij, Ikram et al. 2007, Balafar, Ramli et al. 2010). Functional MRI examines the location of specific centers such as the speech center and the centers that move the body (motor centers) and their relationship to the tumor (Bookheimer 1996, Detre and Floyd 2001, Faro and Mohamed 2006), Specific MRI modalities such as , MRI perfusion and diffusion MRI may also be essential to the treatment plan, as they may be helpful in the patient's diagnosis (Le Bihan and Warach 1995).

Some MRI scans use contrast materials to enhance scans and increase the quality of the image. For example, gadolinium is the most common contrast material used in MRI applications to improve the image by injecting it and accumulating it within the abnormal tissues in the tumor itself, which leads to providing a large contrast in the image in normal and abnormal tissues (Makhamrah, Ahmad et al. 2019, Ahmad, Makhamrah et al. 2021, Athamnah, Oglat et al. 2021). Thus, it is easier to locate the growth of abnormal cells (Rohrer, Bauer et al. 2005, Grabherr, Grimm et al. 2015, Behzadi, Farooq et al. 2018).

Brain tumor is an abnormal growth of cells that occurs in the brain and it likes other tumors can be benign or malignant. Malignant tumors grow much more rapidly than benign tumors, and frequently spread into surrounding brain tissue, whereas benign tumors tend to grow slowly and do not typically spread. Only malignant tumors are considered cancerous, but a benign brain tumor can still be problematic as its growth can impact neighboring brain tissue. The symptoms of brain tumors vary depending on what part of the brain is impacted and thus from case to case. However, some common symptoms include headache, nausea and vomiting; sensory disturbance like blurred vision loss of balance, confusion change in personality, and seizures (Charles, Holland et al. 2011, Mabray, Barajas et al. 2015). There are several types of brain tumors; the common type is Gliomas; which are a category of brain tumors that begin in glial cells, and the most common glioma is an astrocytoma, which arises from the glial cells called astrocytes. Glioma has a different classification system based on grade (four different grades) which is a measure of how aggressive the tumor appears under the microscope (Zhan and Lu 2012).

Brain MRI segmentation is a crucial mission in various clinical imaging applications due to it impacts the results of the whole analysis. These impacts due to the various processing steps depend on precise segmentation of anatomical parts. For example, MRI segmentation is often applied for analysis of the brain MRI and its changes, describing pathological areas, and for surgical processing, and for visualizing and measuring the anatomical parts of the brains. The applications variety of image processing has led to the development of different segmentation techniques of various precision and degree of complexity (Vernooij, Ikram et al. 2007, Akkus, Galimzianova et al. 2017, Athamnah, Oglat et al. 2021).

2. Methods

2.1 Patient history and MRI imaging

In this study, only one case MRI image was analyzed using manual image segmentation (Dicom). However, this case belongs to a 64 year-old male patient with weight of 74 kg, and he has a glioma tumor which was discovered by imaging through a 3 Tesla MRI scanner and with a slice thickness of 3 mm. Moreover, the patient was given gadolinium as a contrast medium to increase the region enhancement and accuracy; this was to allow detection and segmentation of the tumor. Also, the post-gadolinium axial fast spin-echo sequence was applied (Figure 1.). The sequence parameter that was used to produce the image was time repetition (TR of 4,000 milliseconds), time echo (TE of 106 milliseconds), and number of slices of 54. Note: the patient Id was anonymized and hidden to keep privacy for the patient. The dataset for the image include a 240*240 pixels (256*256), 256 columns, 256 row, the phase encoding direction is the short axis of anatomy, and the orientation of the images is axial slices (Figure 2.).

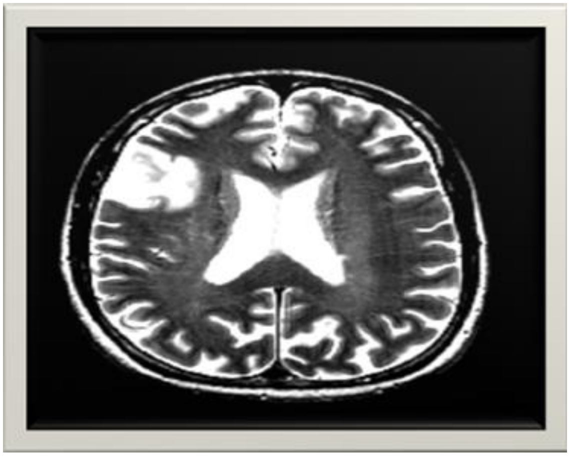

Fig.1: MRI brain tumors post gadolinium axial FSE.

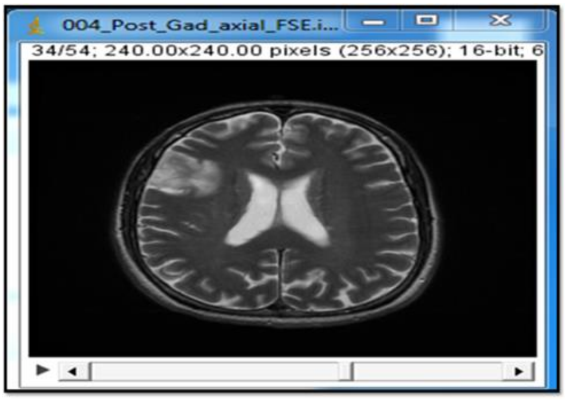

Fig. 2: Image dataset and data anonymization using Dicom Cleaner.

Firstly, the data anonymization done for the images to preserve the privacy of the patient by using Dicom Cleaner, then applying several programs such as MRI converter and MRIcroGL to convert the image from one type to another type, moreover, an image J and MRIcro programs are used to make different measurements on the image and determines region of interest (ROI) of the tumor, and the 3D slicer was used to apply the manual segmentation. The Dicom (DCM) image compatible with the operating system Windows 2010 and several types of windows which makes dealing with image easier and more practical since the work will be on a program that uses Windows 10 as an operating system.

After that it was noticed the extension for this image is (.img/.hdr) which was before the conversion (.dcm). The next step is that the image was converted from Dicom format to Analyze 7.5 through the MRIConvert program.

3. Results and Discussion:

Image Segmentation:3.1

The tumor segmentation is done to represent the best identification of the special information of tumor, to separate the normal tissue from tumor region, and to get accurate results for diagnosis and treatment planning. Moreover, the manual segmentation was done to overcome the challenges are produced by automatic brain tumor segmentation such as, the tumor can appear randomly in the brain in different special information, and because the tumor can have any kind of shape, size and contrast which make it difficult to do the segmentation method automatically. So, the segmentation in this research study was applied manually through the 3D slicer program and it gives the best description for tumor boundaries in all slices.

The segmentation process is considered a necessary and very important requirement before starting radiotherapy sessions because that treatment requires locating the tumor with very high accuracy, moreover, the error is never acceptable because it's damaged the healthy and normal cells and maybe another tumor can occur because of the high radiation dose if we hit the wrong region.

The 3D slicer software was used as a computing platform, which is a free open source and multi-platform software package widely used for medical, biomedical and related imaging research.

Then, the image was imported from the CD and showed in three orientations (sagittal, coronal and axial). However, when the tumor segmentation is done in one orientation, the other two orientations will appeare (Figure 3.).

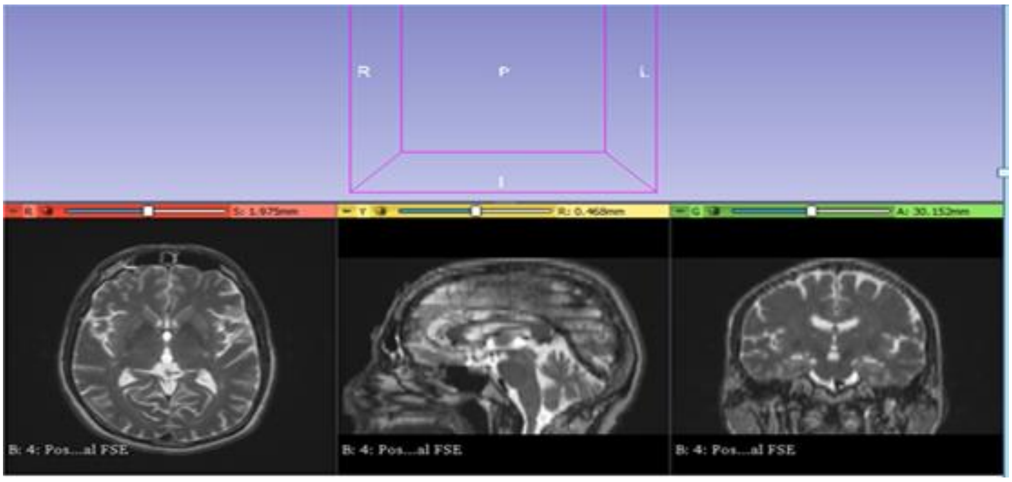

Fig. 3: Image orientations in three orientations (sagittal, coronal and axial) after imported from the CD.

3.2 Tumor volume rendering

Another step that applies to the image after finishing the segmentation is volume rendering for the tumor and the whole brain. This rendering is important for any manufacturer that produces a 3D data set for analysis including physics, medicine, radiotherapy, and the radiology field. Volume rendering enable a physician to understand medical data, other volumetric data that geometric surface are unavailable or too difficult, to overcome problems representing by surface rendering, and to visualization because of inclusions of a tumor inside the brain and complicated brain structure (Figure 4.).

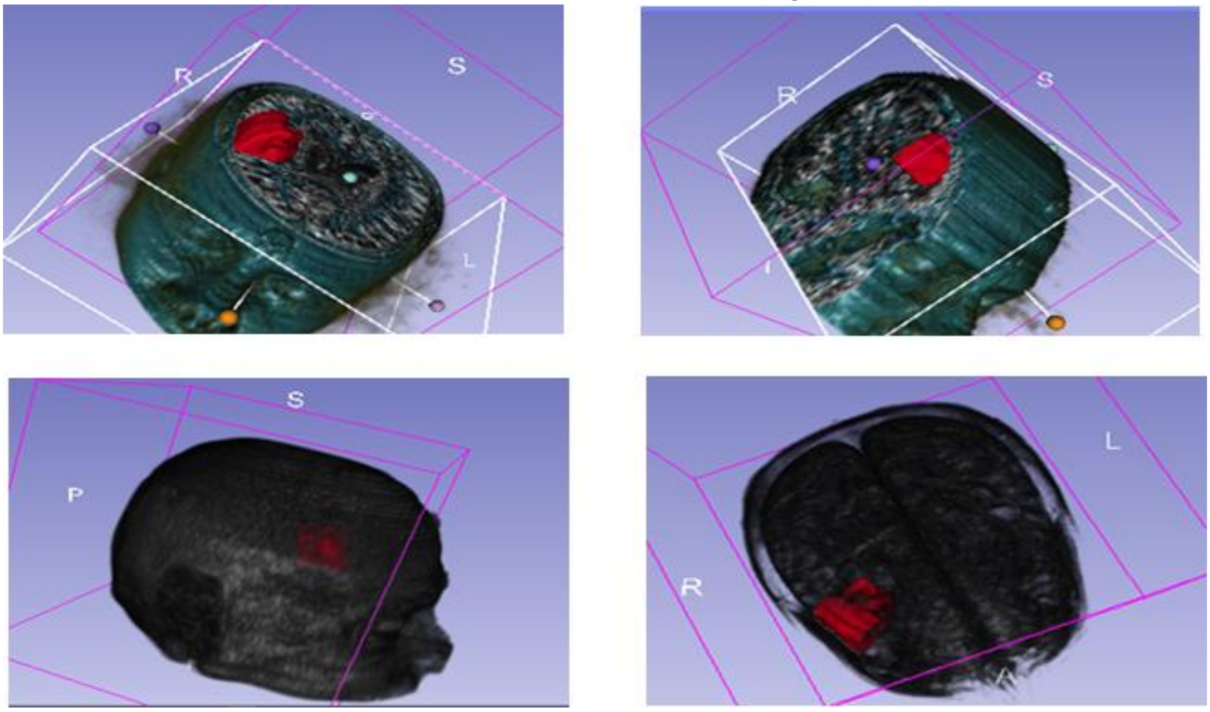

Fig.4: Volume rendering of tumor segmentation with the whole brain.

3.3 Brain tumor volume measurements

MRIcro program was used for measuring the size of the tumor by placing ROI through the MRIcro, then the ROI coverd by all slices that contain tumor (slice 32 to slice 41), further, a specific equation was applied to calculate the tumor size. However, after import the image to the MRIcro program, information at figure 5 will be resulted, after that, post-gadolinium axial fast spin-echo image was used to enhance the ROI and make it brightness, then to help in measuring the tumor size.

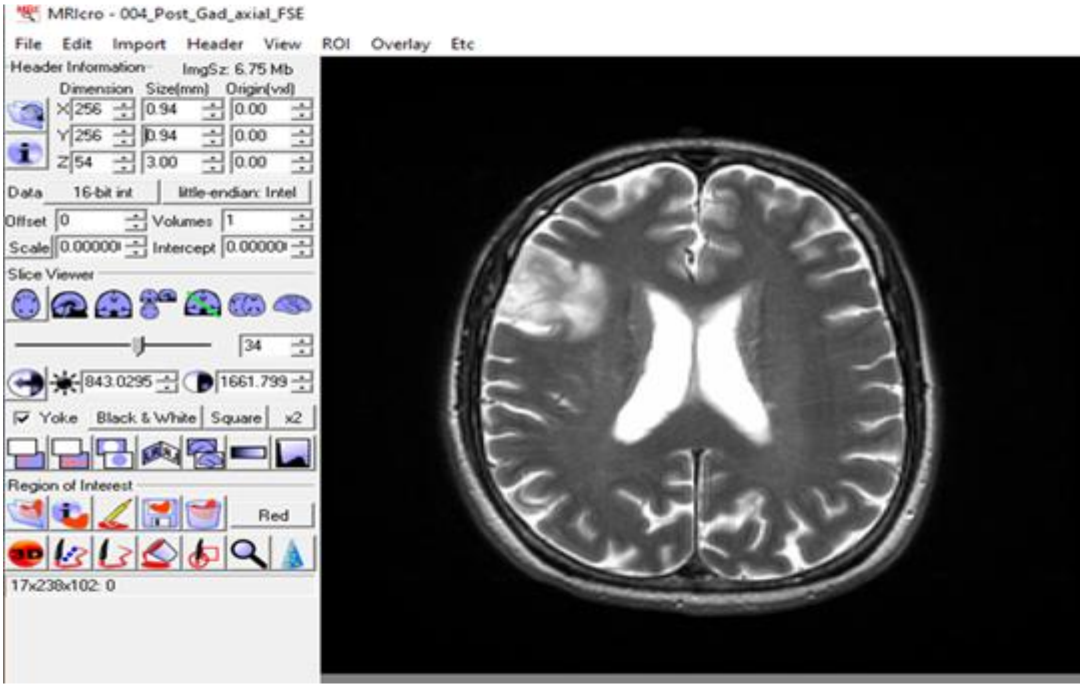

Fig. 5: MRIcro program after importing the image.

Figure 6 shows the tumor as a red color slice (slice 32 to 41). From the results in this figure, it can be noted that slice 34 is the biggest region for the tumor and that slice 41 is the smallest region in the axial image. However, the coronal and sagittal images were not applied because the axial image is the higher resolution which makes it the best orientation to present the ROI.

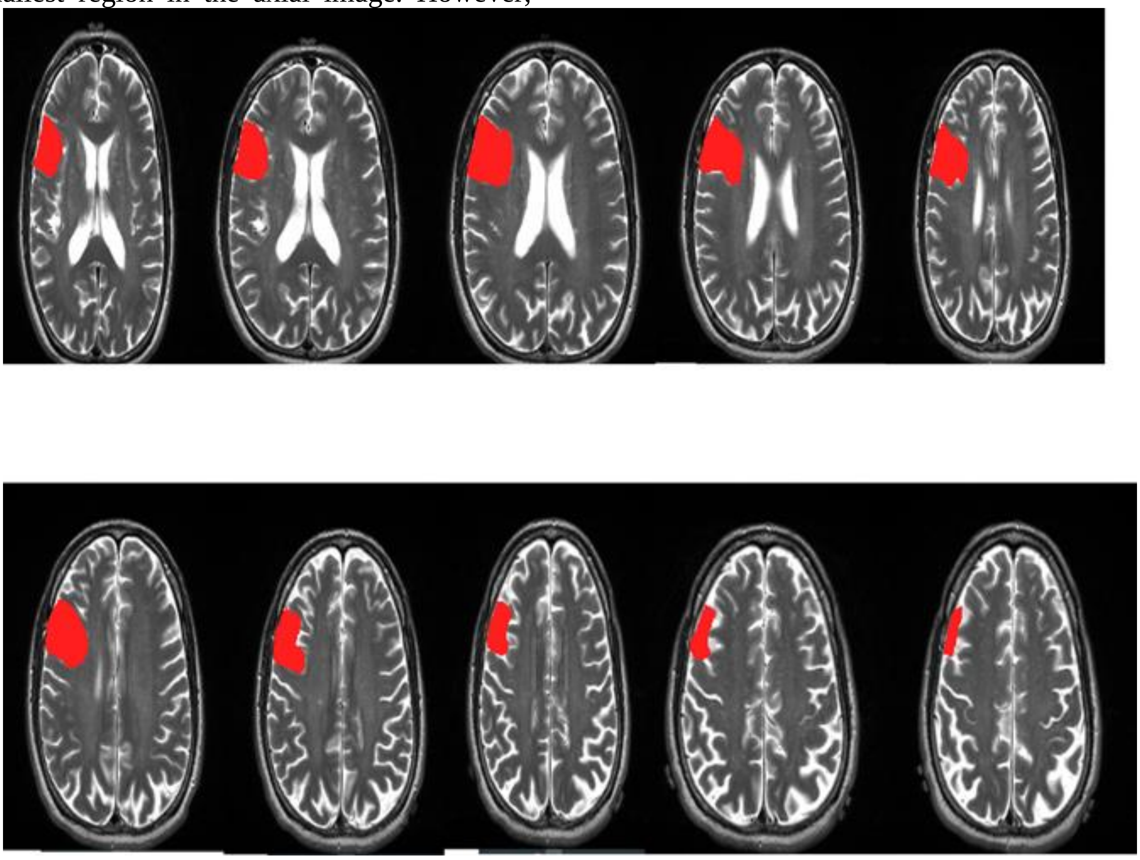

Fig. 6: Slices contain tumor as a red color.

The ROI it was saved after determining it. This is done to measure the size of the tumor. The information regarding the ROI includes image intensity and the number of the voxels, then an equation was applied to measure the tumor size. The results display image intensity with 3081 and the minimum value is 0, and the number of voxels is 7763 voxels. The equation for measuring the tumor size is (volume of ROI of the tumor = no. voxel *voxel size), the number of voxels in ROI =7763, and the voxel size in mm =(0.94*0.94*3.00) = 2.65 mm3.

The volume of ROI of the tumor is (no. voxel *voxel size) which is (7763*2.65).

The tumor size = 20571 mm.

4. Conclusion:

In glioma studies, it is important to evaluate and validate manual segmented structures. In this study, we have described a manual segmentation protocol by which such a dataset can be produced. We hope this protocol assists the development and assessment of automated segmentation procedures of further brain tumors. Furthermore, image segmentation showed the best identification of the special information of tumor and displayed separate healthy tissue from tumor region to give accurate results for diagnosis and treatment planning.

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Data Availability Statement:

Not applicable.

Conflicts of Interest:

The authors declare no conflict of in-terest.

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