Segmentation techniques for Brain tumor from MRI - A Survey

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Abstract. In the medical science, Biomedical images are the core. Generally, Magnetic Resonance Imaging(MRI) scan is the most usual procedure followed. Radio waves and strong magnetic flux were used to determine comprehensive images of tissues and organs inside the body. The enhancement in MRI scan has become a large milestone in the medical world. Generally, the brain is segmented into White and gray matter, and cerebrospinal fluid(CSF). Various segmentation techniques have been proposed with promising results. Still, they all have their own pros and cons. Deep neural networks(DNN) have established good performance in segmentation and classification task via Deep Wavelet Autoencoder(DWA). In this study, by using a pairwise Generative Adversarial Network(GAN) model, it addresses the problems in brain tumor detection using MRI from various scanner modalities T1 weighted, T2 weighted, T1 weighted with contrast-enhanced and FLAIR images.

Keywords. Magnetic Resonance Imaging(MRI), Biomedical images, WM, GM, CSF, Deep Neural Networks(DNN), DeepWavelet Autoencoder(DWA), GAN.

1. Introduction

Magnetic Resonance Imaging(MRI) scan is a non- and painless procedure which is first established by Raymond Damadian. This machine has been named Indomitable by him as he designed the first-ever full body MRI scanner. A fundamental scanner is about $150,000, however it goes on some million dollars. Japan is the country which the has the largest number of MRI scanners, with 48 per 100,000 people. A man wouldn't be able to undergo an MRI if he has any metal objects inside his body, like bullets or any other foreign metallic bodies.

Individual who undergoes an MRI requires an injection of intravenous(IV) distinct liquid to enhance the exposure of a specific tissue related to the scan. A radiotherapist, who is a medical imaging specialist, will speak to the individuals, who are going through the MRI scanning procedure and will reply any queries the patients have about the procedure. While undergoing an MRI scan, the patient must stay still as it will disturb the images like a camera capturing a moving object. The MRI artisan can only speak to the patient via an intercom in the scanner. The procedure starts only when the patient is ready. The patient can stop the procedure if he is feeling uncomfortable during the procedure by informing via the intercom to the MRI technician. After an MRI scan, this image will be examined by the radiologist to check whether any more images are needed

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The radiologist will make a report out of these images for the requesting doctor. It is extremely rare that after an MRI scan a patient can experience any side effects. Functional magnetic resonance imaging or functional MRI(fMRI) utilizes MRI technology to assess cognitive activity by measuring blood flow to specific brain regions. For areas where neurons are involved the blood flow increases. It gives an insight into neuronal activity within the brain.

MRI scans typically range from 20 to 60 mins, based on which region of the body is being examined, and images required. If the first attempt does not make the MRI scan clear enough for the radiologist, then a second scan may be needed. In the case of braces and fillings, they can distort those images even if they are unaffected by the scan. If additional images are needed the scan can take longer. The body's MRI uses radio waves, strong magnetic field, and a device to produce comprehensive images of the body's inside. It may be used to help diagnose or track care for a variety of chest, abdominal, and pelvic conditions.

A CT scan is generally the combination of X-ray images took from various angles; the CT uses a personal computer to generate pictures from those X-rays. An MRI is a type of scan which uses radio waves and magnetic flux to generate a comprehensive picture of soft bones and tissues in the body. CT scans generally use X-rays to create images of the human body's interior whereas MRI uses strong RF pulses and magnetic fields to generate comprehensive images of the organs and other internal body structures. CT scan uses radiation while MRIs don't use radiations. MRI provides a more comprehensive information about internal organs like reproductive system, brain, skeletal system, and other organs than a CT scan does.

Both MRI and CT scans are usually relatively safe. There may be some issues though. MRI scans must never be conducted on the patients with aneurysm clips(vessel clips inside the brain) unless these clips are proven to be MRI-safe, as all those clips can be removed and the patient may die because of bleeding inside the brain. Another issue with the MRI is the existence of certain defibrillators or cardiac pacemakers as the magnets in the battery-operated machines can trigger malfunctions. The magnetic field will force out any metal objects that interfere with the magnetic flux, such as the existence of metal shavings in the organ, eye, or extremity. In addition, other metal canisters have to be seperated from MRI machines, as they will be drawn to the magnet and kill or injure the person. CT scans doesn't have these problems; but, even though it is a comparatively low dose, they subject the patient to radiation.

2. Related Works

2.1. Segmentation techniques for MRI brain tumour

Harsimranjot Kaur [1] surveyed brain tumor segmentation and detection technique for different MRI scans. Thresholding-based intensity differences provide simplicity and good results. Histogram thresholding acquires larger computational time.By dividing the images pixel intensity edges get changed due to that it causes abrupt changes in edge-based segmentation. Uniform contrast distribution is proposed in the watershed technique it produces dull results in weak edges. Without using any previous information, the images divide pixels into classes and it also classifies the pixels perfectly.

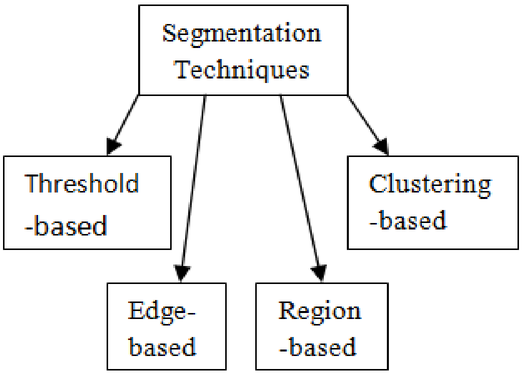

Figure 1. Various methods on the basis of pixel density [1]

2.2 *Brain image segmentation using IIFC Algorithm*

Hanuman Verma et. Al [2] proposed an Improved Intuitionistic Fuzzy C-means (IIFCM) for segmenting the images its main intention is to diminish the noise and boundary problems between the various tissues from the brain scan. Statistical analysis is proposed to provide better performance. A novel fuzzy approach is proposed for noise uncertainty. This method is compared with the existing methods and it provides better results in square images.

The test statistic is defined by

$$F_{ID} = \frac{(N-1)\chi_F^2}{N\,(K-1)\chi_F^2} \qquad (1)$$

2.3 *DWA-DNN model for cancer detection*

[3] Pradeep kumar malliack et.al. proposed a technique with Deep Neural Network to improve treatment and early detection and it produces the better performance by compressing the image using Deep wavelet Auto encoder (DWA). The splited tiny images is exploited in the proposed method and the encoded images is exploited in Deep Neural Network this technique reduces the feature classification there by the proposed method is compared with the existing classifiers. It provides higher accuracy (96%) than the existing non deep learning techniques. The computed statistical equation is defined by

$$MN_{ij} = \frac{mn_{ij} - mn_{ji}}{\sqrt{mn_{ij} - mn_{ji}}} \qquad (2)$$

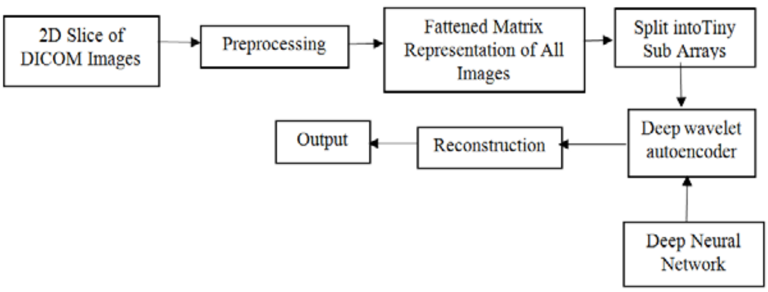

Figure 2. DICOM image classifier based on DWA-DNN model [3]

2.4 FFPF approach for image clustering

[4] Mohammed Debakla proposed a method based on image clustering using Farthest Point First and fuzzy clustering. This technique is analyzed without having any previous knowledge about the clustering numbers. The segmentation is classified using the data by cerebrospinal fluid, white and grey matter. This method also overcomes the time consuming drawback from the existing methods. This method improves the clustering process by strengthening the Fuzzy Logic and FPF approach.
The analysis of FFPF segmentation is classified by 2 metrics

$$MCR = \frac{Total\ Number\ of\ Misclassified\ pixels}{Total\ Number\ of\ Pixels} \quad (3)$$

$$JS = \left|\frac{A_i \cap_i^B}{A_i \cap_i^B}\right| \quad (4)$$

2.5 Image segmentation techniques in MRI

Sepideh Yazdani et.al [5] proposed a technique to analyze the various kind of images. It requires the previous knowledge of cluster number. Thresholding technique is used for solving the issues in preprocessing the images. Fuzzy C method is focused on controlling the noises from various kind of images. Supervized technique exploit algebraic methods and probability to provide soft segmentation. Featured segmentation technique provides better quality of images with simplicity by using random metrics. Model-based methods focus on avoiding the issues of detective and incomplete contour causes by blood flow in MRI images.

2.6 Morphological tumor detection

Amlan Jyoti et.al [6] proposed Morphological Tumor Detection in which first the region to be detected is found and the boundary is set. Thresholding technique is employed for edge detection morphological operations. Gaussian filter is used for the results as it provides good performance than other techniques. First method is MSE, in which during smoothing, recreated image leads to distortion. Qualitative assessments stress the nature of the picture that is just too difficult, sophisticated and time consuming.

2.7 Performance analysis of various FCM clustering

Mahipal Singh Choudhary et.al [7] implemented that Conventional FCM doesn't produce good conclusions to intensity variations and existence of noise. But different FCM techniques are introduced to beat this problem. Here, two types are used namely fuzzy structure and partition in which fuzzy partition is based on degree of fuzziness.

2.8 Tumour detection using deep learning methods

Ali Isin et.al [8] proposed the current trends of deep learning methods especially Convolutional Neural Networks(CNN) which has the advantage of spontaneously studying representative hard features for the tumor tissues as well as the healthy brain tissues directly from multimodal images.

2.9 Seeded region growing and FCM

Harsimranjot Kaur et.al [9] proposed an automatic method for detection of tumor. First the region-based classification is done along with the wavelet-based decomposition on the original image. Then, it is reframed on the basis of soft-thresholding process and FCM clustering is applied along with the Seeded region growing method. This yields better performance than the Sobel method because it has less RUMA and SD values.

2.10 Classification of tumor using pairwise GAN

Chenjie Ge et.al [10] addresses the problems of brain tumor segmentation using MRIs from various scanner modalities such as T1 weighted, T2 weighted, T1 weighted with contrast-enhanced and FLAIR images. To handle the inadequate big brain tumor databases and irregular modality of image for deep learning methods, they proposed an augmented brain tumor images to enhance the training dataset by introducing a pairwise Generative Adversarial Network(GAN) model. It can handle the issue addressed above which is effective and strong. It is also helpful when the training dataset is not large enough for deep learning methods. This method has produced better results comparatively.

3. Conclusion

Here, various segmentation techniques for brain tumours has been listed and its advantages and disadvantages are discussed. Though many techniques are available, the scope of the techniques are enlarging as technology grows. In this paper, among all the techniques, the Generative Adversarial Network(GAN) model has been obtained results on the testing dataset as effective and robust and provides an average of 88.82% of precise test for subtypes of gliomas. GAN is efficient and reliable, and is helpful to increase MRIs when the size of the brain tumor testing database is not big enough for profound learning. At last, comparison with the several existing technologies, though based on multiple datasets, revealed that the proposed system using mixed real and GAN-enhanced training databases has achieved similar performance to the state-of-the-art.

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