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A new Method on Brain MRI Image Preprocessing for Tumor Detection

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ABSTRACT

Medical imaging is a vital component of a large number of applications. MRI is the state-of the-art medical imaging technology, which allows cross sectional view of the body with unprecedented tissue contrast. The information that MRI provides has greatly increased knowledge of normal and diseased anatomy for medical research, and is a critical component in diagnosis and treatment planning. In this paper, I had planned to develop an approach to brain MRI image preprocessing for tumor detection. In preprocessing steps, we need to perform Skull Stripping & Image Enhancement. Skull Stripping is required to produce better results. Image Enhancement is for adjusting digital images for future analysis.

Keywords: Brain Tumor, Magnetic Resonance Image (MRI), Preprocessing and Enhancement, Segmentation, Feature Extraction, Classification

I. INTRODUCTION

Brain tumor detection in magnetic resonance images (MRI) is essential in medical diagnosis because it provides information associated to anatomical structures as well as potential abnormal tissues necessary to treatment planning and patient follow-up.

Medical imaging is a vital component of a large number of applications. The imaging modalities can be divided into two global categories: anatomical and functional. Anatomical modalities, employed can be divided into two global categories: anatomical and functional. Anatomical modalities, depicting primarily morphology, include X-ray, CT (Computed Tomography), MRI (Magnetic Resonance Imaging), US (ultrasound), portal images, and (video) sequences [1]. MRI is the state-of the-art medical imaging technology, which allows cross sectional view of the body with unprecedented tissue contrast [2]. MRI plays an important role in assessing pathological conditions of the ankle, foot and brain. MRI is a noninvasive procedure that has proven to be an effective tool in the study of the human brain. The information that MRI provides has greatly increased knowledge of normal and diseased anatomy for medical research, and is a critical component in diagnosis and treatment planning [3]. An equally impressive technology, MRI, has greatly improved the sensitivity and specificity (accuracy) of diagnostic imaging, particularly in structures such as the liver, brain, spinal cord, and joint spaces.

Diagnosis tests include different kinds of information, such as medical tests (e.g. blood tests, X-rays, MRI), medical signs (clubbing of the fingers, a sign of lung disease), or symptoms (e.g. pain in a particular pattern). Doctor's decisions of medical treatment rely on diagnosis tests, which makes the accuracy of a diagnosis is essential in medical care. Fortunately, the attributes of the diagnosis tests can be measured. For a given disease condition, the best possible test can be chosen based on these attributes. Sensitivity, specificity and accuracy are widely used statistics to describe a diagnostic test.

Tumor Detection in brain MRI image:

With the increasing size and number of medical images, the use of computers in facilitating their processing and analysis has become necessary. Segmentation becomes more important while typically dealing with medical images where pre-surgery and post surgery decisions are required for the purpose of initiating and speeding up the recovery process. Computer aided detection of abnormal growth of tissues is primarily motivated by the necessity of achieving maximum possible accuracy [4]. Many neurological diseases and conditions alter the normal volumes and regional distributions of brain parenchyma (gray- and white matter) and cerebrospinal fluid (CSF). Such abnormalities are commonly related to the conditions of hydrocephalus, cystic formations, brain atrophy and tumor growth. There are also age-related differences in volumes of brain parenchyma and CSF. Brain tumor is one of the major causes for the increase in mortality among children and adults. A tumor is a mass of tissue that grows out of control of the normal forces that regulates growth [5]. The incidence of brain tumors is increasing rapidly, particularly in the older population than compared with younger population. Brain tumor is a group of abnormal cells that grows inside of the brain or around the brain. Tumors can directly destroy all healthy brain cells. It can also indirectly damage healthy cells by crowding other parts of the brain and causing inflammation, brain swelling and pressure within the skull [6]. Early detection and correct treatment based on accurate diagnosis are important steps to improve disease outcome. Brain abnormalities comprise a wide spectrum of conditions ranging from developmental errors to vascular accidents. This variability results in innumerable possibilities of findings on prenatal ultrasound, which could create some diagnostic dilemmas.

II. METHODS AND MATERIAL

OBJECTIVE OF THE PRESENT WORK

In the proposed technique, initially the input MRI image is pre-processed in order to eliminate the noise and make the image fit for rest of the processes. Here I use the skull stripping and image enhancement in the preprocessing stage. The research mainly consists of four steps which includes i) Preprocessing ii) segmentation using Modified fuzzy C-means algorithm iii) Feature extraction of the region like mean, standard deviation, range and pixel orientation and iv) Final classification using the support vector machine. The present work is focused only pre-processing based on Skull Stripping & Image Enhancement.

MRI IMAGE DATASET DESCRIPTION

The MRI image dataset that we have utilized in our proposed tumor detection technique is taken from the publicly available sources. This image dataset contains 75 brain MRI images like with tumor and without tumor. The Brain image dataset are divided into two sets such as, (1) Training dataset (2) Testing dataset. The training dataset is used to segment the brain tumor images and the testing dataset is used to analyze the performance of the proposed technique. In this, the 60 images are utilized for the training purpose and the remaining 15 images are utilized for testing purpose. The figure 1 shows some of the sample MRI images with tumor images and non-tumor images.

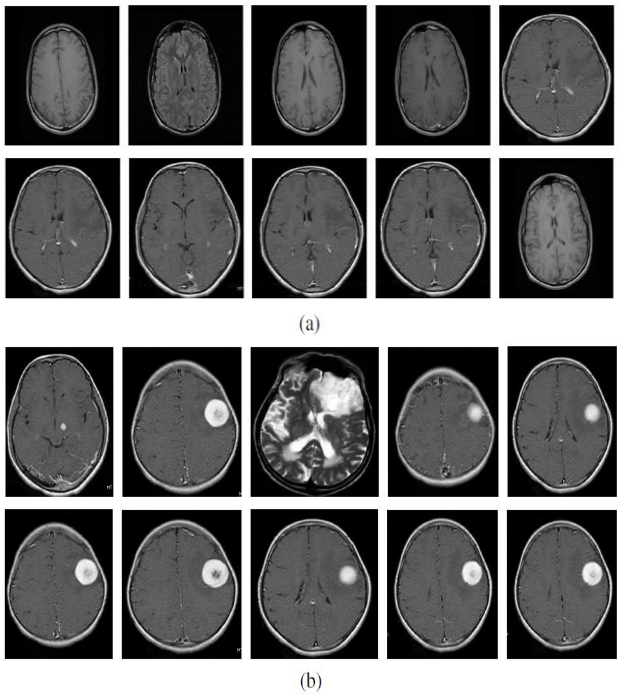


Figure 1: Sample MRI image dataset, (a) MRI images without tumor (b) MRI tumor images

PROPOSED TECHNIQUE FOR DETECTION OF TUMOUR USING MODIFIED FCM

Lots of researches have been performed for the segmentation of normal and abnormal tissues in

MRI brain images. Segmentation of medical imagery is a challenging task due to the complexity of the images, as well as to the absence of models of the anatomy that fully capture the possible deformations in each structure. Brain tissue is a particularly complex structure, and its segmentation is an important step for our proposed method. In our proposed method consists of four phases namely preprocessing, segmentation, feature extraction and final classification. Preprocessing phase is done using skull stripping and image enhancement. The proposed technique for detection of tumor using modified FCM is shown in figure 2.

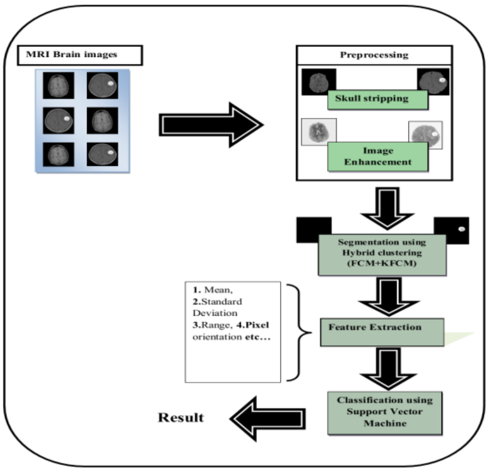


Figure 2: Overall block diagram of our proposed approach

PREPROCESSING

Various preprocessing methods have been proposed to deal with the MRI brain images used for segmentation. In preprocessing process, the MRI images are converted into grey images. Subsequently, the grey images are smoothed using contrast adjustment.

Skull stripping

This is pre-processing step which is required to produce better results. Skull is outer part of the brain surrounding it i.e. the removal of its non-cerebral tissues. The main problem in skull-stripping is the segmentation of the non-cerebral and the intracranial tissues due to their homogeneity intensities. So it may affect the result of seed point selection. Some observations are required to find the range of gray value of skull portion. Firstly, the contrast adjustment images are converted into binary images and find crop locations using this binary image. Consequently, the contrast adjusted image is cropped for the tumor part of the brain image. Select a low threshold value for converting cropped contrast adjusted image to binary. The cropped contrast adjusted image is converted to binary image. Subsequently, apply the morphological operation 'thicken' to the binary image once. Finally, brain region is extracted using region based binary mask extraction.

Region-based binary mask extraction:

Region-based extraction is performed by considering the properties of each block that satisfy some criteria. I have utilized one of two criteria. One criterion is to determine the max-min difference and the other is to find out the mean values of the blocks. Subsequently, the process results with a brain mask is applied to the original MRI data. Thus, I have obtained a brain MRI image with its brain cortex stripped.

Image Enhancement:

Image enhancement is the process of adjusting digital images so that the results are more suitable for display or further analysis. After skull stripping process, the brain cortex can be visualized as a distinct dark ring surrounding the brain tissues in the MRI images. The distinct dark ring surrounding the brain tissues are removed by image enhanced method. For example, you can remove noise or brighten an image, making it easier to identify key features. In our method, I use morphological operation 'thicken' to the binary image.

III. RESULTS AND DISCUSSION

MRI Image segmentation plays a major role in the field of biomedical applications as it is widely used by the radiologists to segment the medical images input into meaningful regions. In this section, I present experimental results from real MR brain images using Skull Stripping & Image Enhancement. The proposed technique is designed for supporting the tumor detection in brain images with tumor and without tumor. The obtained experimental results from the proposed technique are given in figure 3 and 4. In figure 3 and 4, the MRI image with and without tumor along with the intermediate results of original tumor image, skull stripped image.

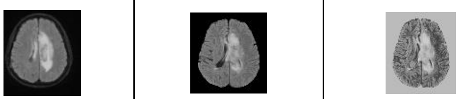
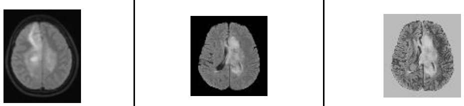
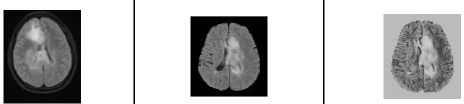
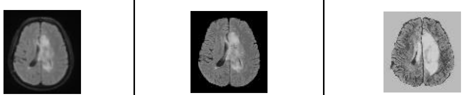
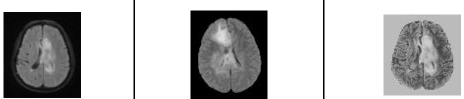
Sl.No	Tumor Images		
	Original Image	Skull Stripped Image	Enhanced Image
1			
2			
3			
4			
5			
6			
7			

Figure 3. Experimental results of skull stripped image, enhanced image of tumor images

Sl.No	Non - Tumor Images		
	Original Image	Skull Stripped Image	Enhanced Image
1			
2			
3			
4			
5			
6			
7			

Figure 4: Experimental results of skull stripped image, enhanced image of non-tumor images

IV. SUMMARY & FUTURE WORK

In this paper, I have presented Skull Stripping & Image Enhancement for brain MRI image preprocessing for tumor detection. The MRI image dataset that I have utilized in our proposed image segmentation technique is taken from the publicly available sources.

In future the work can be extended to segmentation using Modified fuzzy C-means algorithm, Feature extraction of the region like mean, standard deviation, range and pixel orientation and Final classification using the support vector machine.

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