Medical Image Processing-An Overview

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Abstract: Medical imaging is the method of forming visual representations of the internal parts of a body for scientific analysis and medical involvement. Medical imaging seeks to expose internal structures hidden by the skin and bones, as well as to identify and treat any disease. It also forms a database of normal composition and physiology to make it possible to identify various abnormalities.

Keywords: Image Processing, Magnetic Resonance Imaging (MRI), Detection

I. INTRODUCTION

Medical imaging is a vast field with diverse nature, involving nuclear physics, quantum mechanics, fluid dynamics, advanced mathematics, biology, computer science and computer engineering. While medical imaging is concerned with evolving the technology to produce images of the internal body parts better or expose novel properties of the tissue and inner arrangement, medical image processing is about the developing methods for the analysis, reconstruction and enhancement of the resultant images[1]. It centers on aiding the extraction of the clinically appropriate information about the morphology, physiology and function from the pictures. One significant role for medical image processing is generating objective measurements and quantities that substitute the typical subjective readings of the images by the experts. There are many types of medical strategies, some of them are: Digital X-ray, Fluoroscopy, Ultrasound 2D and 2.5D, Computed Tomography (CT), Nuclear Medicine (NM), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), Single Photon Emission Tomography (SPECT). Some of the image processing systems for medical applications are discussed next.

II. IMAGE PROCESSING SYSTEMS FOR MEDICAL APPLICATIONS

A. Tactile Imaging -

It is a medical imaging approach to translate the sense of touch into a digital image**.** The tactile image is a pressure map on which the direction of soft tissue surface under applied deformation must be specified by its function P(x,y,z).Tactile imaging medical applications include the detection of cancer nodules in the breast or prostate.

B. Photo Acoustic (PA)Imaging -

It is also known as optoacoustic or thermoacoustic imaging has the potential to image animal or human organs, such as the breast and the brain, with concurrent high contrast and high spatial resolution. The photo acoustic (PA) effect is the physical foundation for PA imaging; it refers to the generation of acoustic waves by the absorption of electromagnetic (EM) energy, such as opticalor radio-frequency waves.

C. Thermography -

It means measuring of heat coming from body. This abnormal release of heat causes changes in functions of body. It uses a high definition infrared camera that measures body’s temperature that presents the information as a digitized image. These thermal images (thermograms) are analysed for abnormalities such as tumors that may be signs of disease in body.

D. Computed Tomography (CT) -

Computerized (or computed) tomography was often formerly referred to as computerized axial tomography (CAT) scan. It is an X-ray technique in which several X-ray images are combined with the aid of a computer to generate cross-sectional views and, if needed, 3D images of the internal organs and structures of the body[5]. A CT scan is used to describe normal and abnormal structures in the body. It also assists in procedures by helping to place the instruments or treatments precisely. CT scanning is fast, painless, noninvasive and accurate.

E. Electrocardiography (ECG or EKG) -

It is a medical examination that checks for problems with the electrical activity of your heart. During a heartbeat the heart contracts due to tiny electrical impulses produced by it that spread through the heart muscle. These impulses can be detected by the ECG machine and it provides information on the condition and performance of the heart. Line tracings are displayed on paper by ECG to show your heart's electrical activity. The spikes and dips in the tracings are called waves.

F. Echocardiography (Echo) -

It is a test that takes pictures of heart movement with sound waves. Ultrasound waves are high frequency sound waves that are directed across a device known as a transducer, during an echo test. The device picks up echoes of the sound waves as they spring back from different parts of heart. These echoes are turned into moving pictures of your heart which can be seen on a video screen. Echocardiography uses standard 2-dimensional, 3-dimensional and Doppler ultrasound to create images of the heart.

G. Positron emission tomography (PET) -

This scan is an imaging test that tells how your tissues and organs are functioning. A PET can use minor amounts of radioactive materials called radiotracers, a special camera and a computer to help assess your organ and tissue functions.

H. Magnetic resonance imaging (MRI):

It is a non-invasive, radiology technique that uses a strong magnetic field, radio waves and a computer to create detailed images of the organs and tissues within the body. An MRI scan can be used to examine almost any part of the body, including the: brain and spinal cord, bones and joints, breasts, heart and blood vessels, Internal organs, such as the liver, womb or prostate gland. The basic flow of process is shown in figure 1. These techniques are used to detect a tumor in brain.

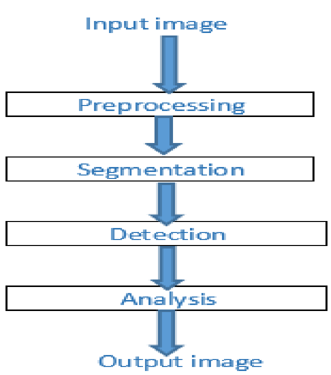


Figure 1 Basic flow of MRI process

Magnetic Resonance Imaging (MRI) is an advanced medical imaging technique used to produce high quality images of the parts contained in the human body .From these high-resolution images, we can derive detailed anatomical information to examine human brain development and discover abnormalities shown in Figure 2. MRI consists of T1 weighted, T2 weighted and Proton Density weighted images and are processed by a system which integrates fuzzy based technique with multispectral analysis.

Multi-spectral Analysis: We have talked about image processing grounded on one single MR image. However, Magnetic Resonance Imaging data are by nature multi-spectral because their distinct characteristics rely on the acquisition sequences and their parameters. Extracting data from multispectral MR exams may deliver us additional valuable evidence in disease diagnosis and treatment valuation [4].

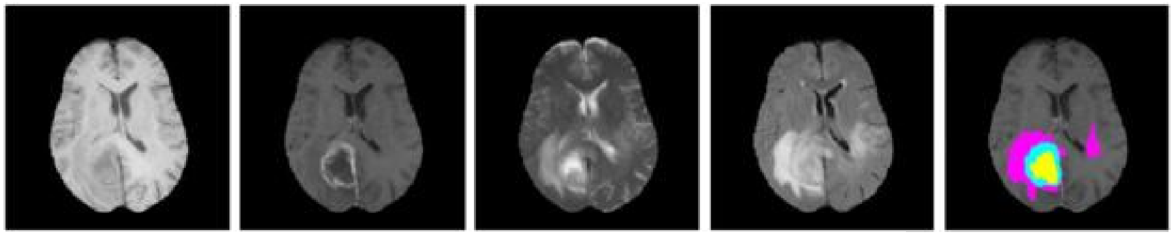


Figure 2: One axial slice of an MR image of a high-grade glioma patient. From left to right: T1-weighted image,

T1-weighted image with contrast enhancement, T2-weighted image, T2FLAIR-weighted image and manual segmentation into necrotic (yellow), active (green), edema (pink) tumor compartments. Necrosis and active tumor regions were segmented based on the T1-weighted image with contrast enhancement, whereas the edema region was segmented based on the registered T2FLAIR-weighted image.

This is a concise note on existing imaging techniques; the subsequent part of discussion is about the processing of images produced as a result of medical imaging. The study of conduct present in images can be done by hand by the experts and doctors. The coordination of technology toward automation, the job of analyzing images for some conclusion is done with computers. For this, images are processed for particular objective of diagnosis. The medical image processing is full with an example case of MRI images. At this point we will comprehend how image processing can be done to detect tumors in brain. Tumors appear on images obtained from MRI in two ways, either darker in color than brain tissue. Although radiologists have all these MRI images, but due to dearth of any typical process for tumor detection, deductions based on these images differ from doctor to doctor. There are different techniques that can be used in image processing to detect tumor in brain.

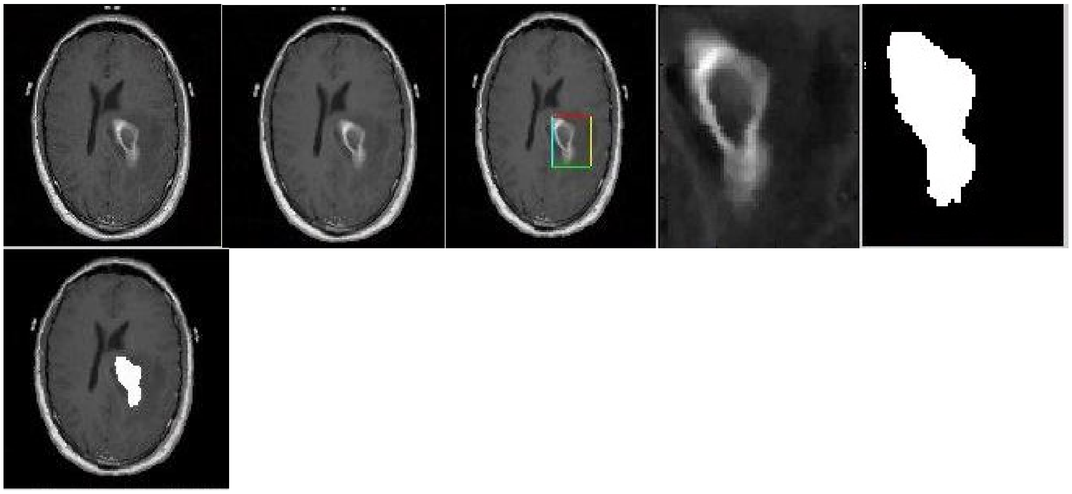
Pre-processing of MRI images is the initial step in image analysis which perform image enhancement and noise lessening techniques which are used to enhance the quality of image, then some morphological operations are applied to detect the tumor in the image. Segmentation is one of the primary steps leading to image analysis and interpretation. The objective is easy to state, but challenging to achieve precisely. Image segmentation methodologies can be classified based on the features and the type of techniques used. Features include pixel intensities, edge information, and texture, etc.

Techniques based on these features can be broadly divided into structural and statistical methods [3]. Gray-level thresholding is the simplest and yet often an effective segmentation method. At this stage, structures in the image are assigned a label by comparing their gray-level values to one or more intensity thresholds.

A single threshold assists to segment the image into only two regions, a foreground and a background [4]. A high pass filter is the root for most sharpening methods. An image is sharpened when its contrast is enhanced between adjoining areas with little unlikeness in brightness or darkness. In signal processing, it is often required to be to perform some kind of noise reduction on an image or on a signal. The median filter is a non-linear digital filtering technique and often used to remove noise. Morphological image processing is a set of non-linear operations related to the shape or morphology of features in an image.

MATLAB based image processing of MRI images for tumor detection is shown below. Following are the steps performed:

1) Give MRI brain image as input.
2) Convert it into gray scale image.
3) Apply high pass filter and median filter for noise removal and to enhance the quality of image.
4)Compute the threshold segmentation.
5) Compute the watershed segmentation.
6) Compute morphological operation.
7) Finally output will be the detected tumor region.



MRI Image Preprocessing Region of interest Segmenting Threshold image Extracted image

Figure 3 extraction of ROI from MRI image using image processing

III. CONCLUSION

Medical image processing has enabled for accurate and fast quantitative analysis and visualization of medical images of numerous modalities. Due to advancement in image processing tools, it has become possible to acquire high quality images of different organs and analyze the images using various software, thereby facilitating the early detection of many diseases such as tumors, cancer, abnormalities in organs, etc. thus enabling accurate diagnosis which has helped in saving human life. Medical image segmentation is a powerful tool that is often used to detect tumors.

The researchers are working to add more features to this tool. In medical sciences, image processing enhances the ability to diagnose and treat various medical disorders. A very correct diagnosis can only assert a correct treatment of disease. We have shown an example of brain image processing in figure3 for tumor detection. We hope that this paper has helped you in learning the fundamentals of medical image processing and most prominently understand the crucial goal in medical image processing-- helping patients.

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