Medical Imaging Advancement

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Abstract-The field of medical imaging, stimulated by advances in digital and communication technologies, has grown tremendously. Medical imaging refers to a number of techniques that can be used as non-invasive methods of looking inside the body. Medical imaging is a central importance in diagnosis, treatment monitoring and patient management. Imaging should only be performed if it is likely to help with diagnosis and improve the management of your health condition or injury. Here, we discuss ultrasound imaging, high resolution computed tomography, magnetic resonance imaging application.

Keywords:Medical Imaging; computed tomography scan; Medical Image processing; Ultrasound; MRI

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I. INTRODUCTION

The use of medical imaging in patient care is increasing dramatically, growing by an estimated 20% each year. No other contributor to healthcare costs - including prescription drugs - is growing as rapidly.
The increase may be due to advances in imaging technology which provide doctors with clearer pictures of what is going on the patient's body. Newer imaging devices offer physicians a 360 degree view of organs, which can help them decide on an appropriate course of treatment. In some cases, the images allow doctors to avoid performing unnecessary surgery on the patient.

However, medical costs associated with diagnostic imaging are growing so fast that insurers have started to restrict coverage. They are concerned that doctors are inappropriately ordering tests, perhaps to avoid malpractice suits, or because they own the machine and thus have a financial interest in performing them. In most cases, patients are not prevented from getting diagnostic imaging tests under the new restrictions, but instead are required to obtain prior authorization from the insurer - a process which often involves filling out multiple forms and waiting for approval.

II. IMAGE PROCESSING

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image. Usually Image Processing system includes treating images as two dimensional signals while applying already set signal processing methods to them.
It is among rapidly growing technologies today, with its applications in various aspects of a business. Image Processing forms core research area within engineering and computer science disciplines too.

Image processing basically includes the following three steps.
1. Importing the image with optical scanner or by digital photography.
2. Analyzing and manipulating the image which includes data compression and image enhancement and spotting patterns that are not to human eyes like satellite photographs.
3. Output is the last stage in which result can be altered image or report that is based on image analysis.

Purpose of Image processing

The purpose of image processing is divided into 5 groups. They are visualization, image retrieval, measurement of pattern and image recognition. Visualization is to observe the objects that are not visible. Image sharpening and restoration is to create a better image. Image retrieval is to seek for the image of interest. Measurement of pattern measures various objects in an image, and image Recognition is to distinguish the objects in an image.

III. EXISTING METHODS OF MEDICAL IMAGES

The following figure shows the clinical procedure which is generally used by leading Hospitals. Scan Centers have highly sophisticated medical Imaging Systems for clinical diagnosis. The Radiology department and scan center takes on the references of other experts and physicians for diagnosis. The arrow diagram shown in Figure 1 will give a clear indication of the process followed in radiology department and scan center.

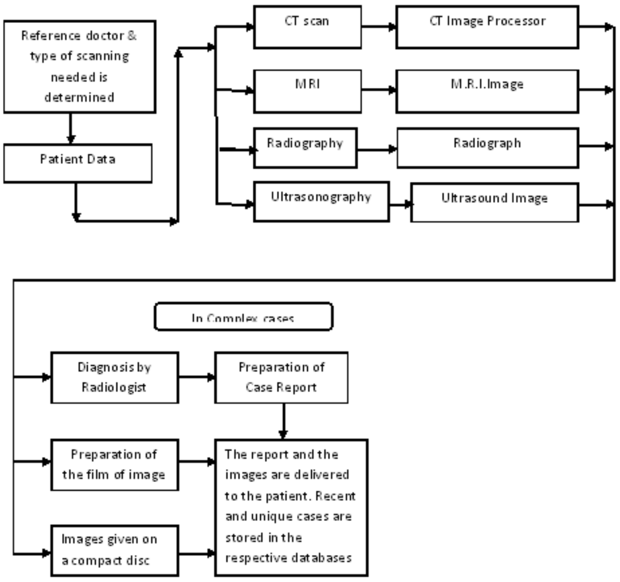

Figure 1: Clinical Procedure

- Radiology

Radiology is the specialty of directing medical imaging technologies to diagnose and sometimes treat diseases. Radiography involves the use of x-rays to produce radiographs. Today, following extensive training, radiologists also direct other imaging technologies such as ultrasound, computed tomography (CT), magnetic resonance imaging (MRI) and Nuclear Medicine to diagnose or treat disease.

- Ultrasound

Medical ultrasonography uses ultrasound (high-frequency sound waves) to visualize soft tissue structures in the body in real time. No ionizing radiation is involved, but the quality of the images obtained using ultrasound is highly dependent on the skill of the person (ultrasonographer) performing the exam. Ultrasound is also limited by its inability to image through air (lungs, bowel loops) or bone.

- CT Scanning

Computed Tomography (CT) imaging uses X-rays in conjunction with computing algorithms to image the body. In CT, an X-ray generating tube opposite an X-ray detector (or detectors) in a ring shaped apparatus rotate around a patient producing a computer generated cross-sectional image (tomogram). Radiocontrast agents are often used with CT for enhanced delineation of anatomy and angiography. With computer manipulation, CT images can be reconstructed into 3D images. Faster scanning times in modern equipment has been associated with increased utilization.

- MR Imaging

Magnetic Resonance Imaging (MRI) uses strong magnetic fields to align spinning atomic nuclei (usually hydrogen protons) within body tissues, then uses a radio signal to disturb the axis of rotation of these nuclei and observes the radio frequency signal generated as the nuclei return to their baseline states. An advantage of MRI is its ability to produce images in axial, coronal, sagittal and multiple oblique planes with equal ease. MRI scans give the best soft tissue contrast of all the imaging modalities. With advances in scanning speed and spatial resolution, and improvements in computer 3D algorithms and hardware, MRI has become an essential tool in musculoskeltal radiology and neuroradiology.

- Nuclear Medicine

Nuclear medicine imaging involves the administration into the patient of radiopharmaceuticals consisting of substances with affinity for certain body tissues labeled with radioactive tracer. The most commonly used tracers are Technetium-99m, Iodine-123, Iodine-131 and Xenon-133. The heart, lungs, thyroid, liver, gallbladder, and bones are commonly evaluated for particular conditions using these techniques. While anatomical detail is limited in these studies, nuclear medicine is useful in displaying physiological function. The excretory function of the kidneys, iodine concentrating ability of the thyroid, blood flow to heart muscle, etc. can be measured.

- Radiation Therapy

Radiation therapy (or radiotherapy) is the medical use of ionizing radiation as part of cancer treatment to control malignant cells. Radiotherapy is commonly used for the treatment of malignant tumors (cancer), and may be used as the primary therapy. It is also common to combine radiotherapy with surgery and/or chemotherapy and/or hormone therapy. The precise treatment intent will depend on the tumor type, location, and stage, as well as the general health of the patient.

IV. MEDICAL IMAGE PROCESSING

Image processing consists of following steps as shown in figure

- Image Acquisition
- Image preprocessing
- Segmentation
- Representation and Description
- Object recognition and Interpretation
- Knowledge Base

Image Acquisition: This is the first step or process of the fundamental steps of digital image processing. Image acquisition could be as simple as being given an image that is already in digital form. Generally, the image acquisition stage involves preprocessing, such as scaling etc.

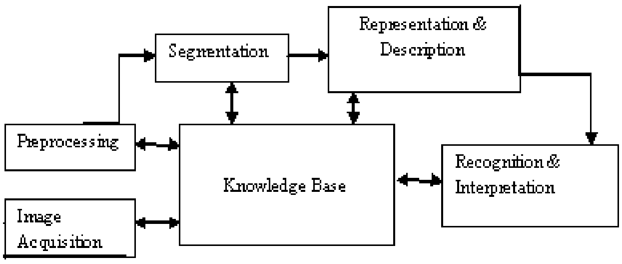

Figure 1: Steps of Image processing

Image preprocessing is composed of two stages i.e. Image Enhancement and Image Restoration.

Image Enhancement: Image enhancement is among the simplest and most appealing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image.

Image Restoration: Image restoration is an area that also deals with improving the appearance of an image. However, unlike enhancement, which is subjective, image restoration is objective, in the sense that restoration techniques tend to be based on mathematical or probabilistic models of image degradation.

Segmentation: Segmentation procedures partition an image into its constituent parts or objects. In general, autonomous segmentation is one of the most difficult tasks in digital image processing. A rugged segmentation procedure brings the process a long way toward successful solution of imaging problems that require objects to be identified individually.

Representation and Description: Representation and description almost always follow the output of a segmentation stage, which usually is raw pixel data, constituting either the boundary of a region or all the points in the region itself. Choosing a representation is only part of the solution for transforming raw data into a form suitable for subsequent computer processing. Description deals with extracting attributes that result in some quantitative information of interest or are basic for differentiating one class of objects from another.

Object recognition: Recognition is the process that assigns a label, such as, “vehicle” to an object based on its descriptors.

Knowledge Base: Knowledge may be as simple as detailing regions of an image where the information of interest is known to be located, thus limiting the search that has to be conducted in seeking that information. The knowledge base also can be quite complex, such as an interrelated list of all major possible defects in a materials inspection problem or an image database containing high-resolution satellite images of a region in connection with change-detection applications.

V. APPLICATIONS

There are many areas where medical imaging is really useful.

- Computer aided diagnosis
- Telemedicine
- Medical Image management
- Picture archives and communication system

VI. SUMMARY

In this study, the overview of various segmentation methodologies applied for digital image processing is explained briefly. The study also reviews the research on various research methodologies applied for image segmentation and various research issues in this field of study. This study aims to provide a simple guide to the researcher for those carried out their research study in the image segmentation. Image segmentation has a promising future as the universal segmentation algorithm and has become the focus of contemporary research. In spite of several decades of research up to now to the knowledge of authors, there is no universally accepted method for image segmentation, as the result of image segmentation is affected by lots of factors, such as: homogeneity of images, spatial characteristics of the image continuity, texture, image content. Thus there is no single method which can be considered good for neither all type of images nor all methods equally good for a particular type of image. Due to all above factors, image segmentation remains a challenging problem in image processing and computer vision and is still a pending problem in the world.

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