ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 3, March 2016

A Survey on Applications of Digital Image Processing in Biomedical Field

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ABSTRACT: This paper gives the details about the methods of biomedical image processing and after that it also describe about medical imaging modalities. Some of the medical imaging modalities are described in this paper like X-ray imaging, CT, MRI, and ultrasound. The optical modalities like endoscopy, photography and microscopy are also more important in this field. The following steps of image analysis are explained in this paper, feature extraction, segmentation, classification, quantitative measurements and interpretation. It mainly focuses on segmentation of biomedical images, because of its high relevance. Special segmentation methods and techniques have been developed in the medical field.

KEYWORDS: Medical imaging modalities, optical modalities, image analysis, segmentation

I. INTRODUCTION

The uses of digital imaging systems are nowadays increased in medical diagnostics. So that digital image processing becomes more and more important in health centre. Digital methods Computed Tomography (CT) or Magnetic Resonance Imaging (MRI), the analogue imaging modalities such as endoscopy or microscopy are nowadays equipped with digital sensors. Normally, digital image means collection of individual pixels (which stands for the word "picture" and "element"), to which discrete brightness or colour values are assigned. The entire spectrum of image processing is now used in medical field, based on the techniques used in digital imaging.

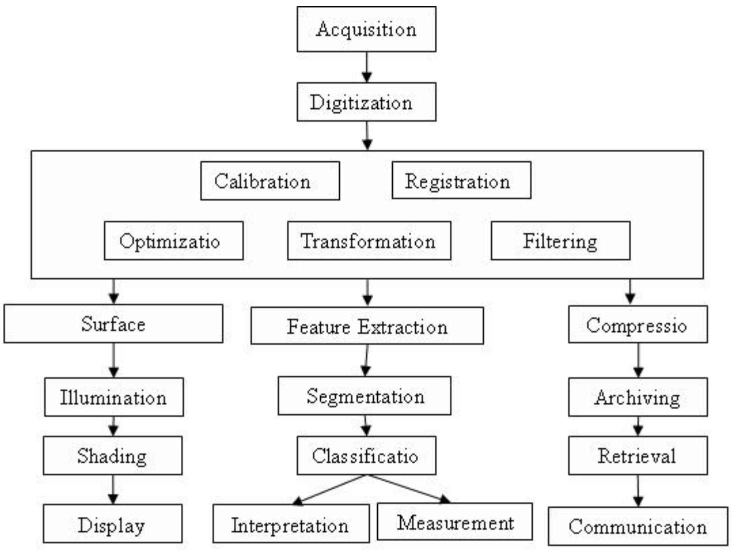

Fig 1. Modules of Image Processing

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II. Steps of Image Processing

The term biomedical image processing means the provision of digital image processing for biomedical sciences. Four major areas of image processing are described below (Fig. 1.1):

A. Image formation

In this the step includes from capturing the image to forming a digital image matrix.

B. Image visualization

It refers to all types of manipulation of this matrix, resulting in an optimized output of the image.

C. Image analysis

This step includes all the steps of processing, which are used for quantitative measurements and abstract interpretations of biomedical images. These steps require a priori knowledge on the nature and content of the images, which must be incorporated into the algorithms on a high level of concept.

D. Image management

It sums up all techniques that provide the communication, efficient storage, transmission, access and archiving of image data. In the image management, the methods of telemedicine also one parts.

III. Imaging Modalities

The medical imaging modalities and optical modalities are described below:

A. X-Ray Imaging

Commonly there are two radiographic images used in medical field imaging, projection radiography and fluoroscopy. Although the 3D tomography is available, these 2D techniques are in wide use because of its high resolution, low cost and depending on application, lower radiation dosages. For imaging acquisition this two imaging modality utilizes a wide beam of x rays. In this large modern medicine field this is the first imaging technique.

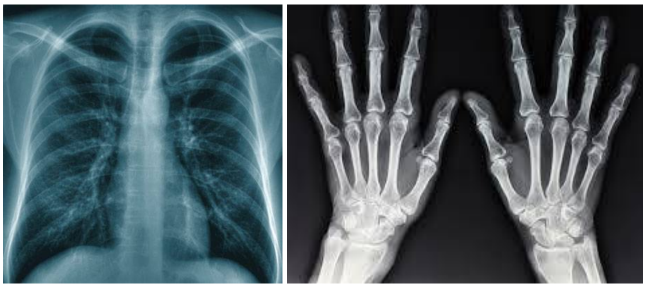

Fig 2. X – Ray Images

B. Fluoroscopy

Fluoroscopy always produces real-time images of all internal structures of the body. To visualize internal organs of the body, Contrast media such as barium, iodine and air are used as they work. Always it produces radiation results. To convert the radiation into an image an image receptor is required. Early on this was a fluorescing screen. It gave way to an IA (Image Amplifier) which was a large vacuum tube that had the receiving end coated with cesium iodide which contains a mirror at the opposite end which was replaced with a TV camera.

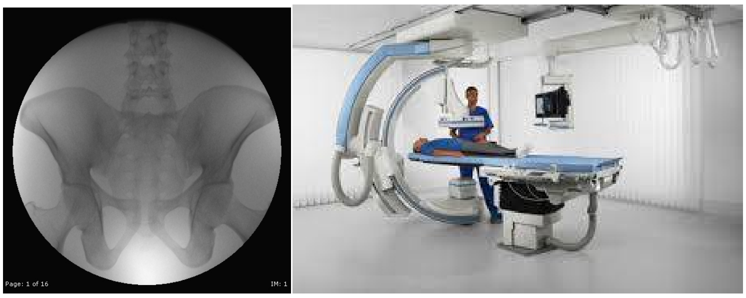

Fig 3. Fluoroscopy Images

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C. Projection Radiography

It is another most commonly used x-rays. This type of x-rays used to find the type and extent of a fracture and also used for detecting pathological changes in the lungs. With the help of barium which is the radio-opaque contrast media can visualize the structure of the stomach and intestines.

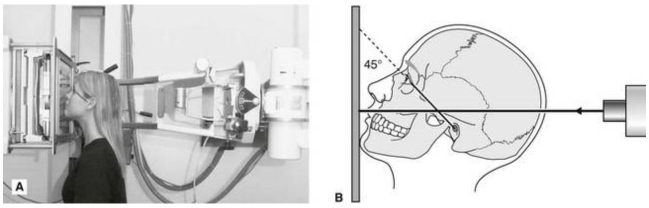

Fig 4. Projection Radiography Images

D. Tomography

It is a method of imaging a single plane, or slice of an object resulting in a tomogram. Generally there are two methods of such images, namely conventional tomography and computer-assisted tomography.

a. Conventional Tomography

It always uses mechanical movement to record an image which goes directly onto X-ray film. This type of tomography contains various techniques as follows:

1. Linear Tomography
2. Poly Tomography
3. Zonography
4. Panoramic radiography

b. Computer Assisted Tomography

In This type of tomography, a computer processes data which received form radiation detectors and computationally constructs the scanned image of the structures. This type of imaging technique is better than conventional tomography as they can easily image both hard and soft tissues. But in this case it is complex to conventional tomography at imaging soft issues. The following techniques are exist:

E. X-ray computed tomography (CT)

This is a helical tomography technique. First it gives a 2D image of the structures of the body. By using CT, a beam of X-rays spins around an object being examined. After that the examined image is chosen by sensitive radiation detectors after having penetrated the object from multiple angles. Then finally a computer analyses the data received form the radiation detectors and then creates a detailed image of the object and its contents using the mathematical principles laid out in the Radon transform.

Fig 5. X-ray computed tomography Images

F. PET imaging

Positron Emission Tomography is the most recent medical imaging technique: in common with the others, it measures physiological function instead of gross anatomy. A small positron-emitting radioisotope with a short half-life (like carbon-11, nitrogen-13, fluorine-18, and oxygen-15) is included into a metabolically active particle (like water, glucose or ammonia) and injected into the patient. This is called radiotracers. At the time of a positron is produced within a patient, it goes to several millimetres while losing its kinetic energy. When the moving positron finds an electron, they suddenly disappear and their rest loads are converted into two 511keV annihilation photons, which

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spread away from the annihilation site in opposite directions. The patient is enclosed by multiple rings of gamma photon detectors, so that no detector rotation is required.

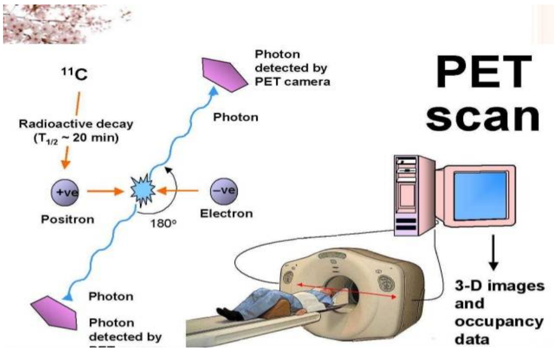

Fig 6. PET Images

G. Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging is a non-ionizing technique that uses radio frequency electromagnetic radiation and large magnetic fields. The large magnetic fields are produced by superconducting magnets, in which current is passed through coils of superconducting wire whose electrical resistance is virtually zero. A magnetic resonance imaging (MRI) scanner or nuclear magnetic resonance (NMR) imaging scanner uses great magnets to polarize and excite hydrogen nuclei of water molecules in human tissue, producing a detectable signal which is spatially encoded, resulting in images of the body. Like CT, MRI also creates a 2D image of a thin slice of the body and is so considered a tomography imaging technique. Nowadays MRI imaging is producing images in the form of 3D blocks.

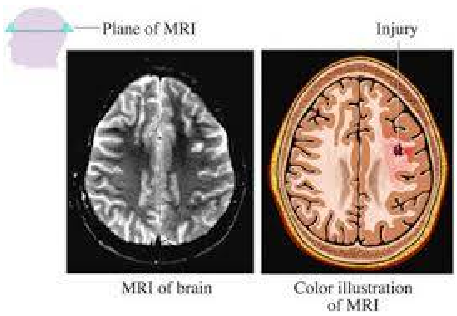

Fig 7. MRI Images

H. Ultrasound

Ultrasound always uses high frequency broadband sound waves in the megahertz range. Those are reflected by tissue cell to varying degrees to produce images. It is mostly related with the fetus image of pregnant women. The uses of ultrasound are much broader. This ultrasound also uses in imaging the heart, abdominal organs, muscles, arteries, tendons, breast and veins. Even though it uses to find many structures of body, it provides less anatomical detail when compare with other techniques such as MRI or CT. The models of ultrasound differ from other medical imaging modalities in the detail that it is controlled by the transmission and receipt of sound waves. Tissue receive high frequency sound waves and depending on the work of the different tissues. The high frequency sound waves are sent into the tissue and depending on the composition of the different tissues; the signal will be reduced and returned at separate intervals. A path of reflected sound waves in a multifaceted structure can be distinct by input ultrasound sound wave and the Reflection and transmission coefficients of the relative structures. It is very secure to use and does not show to cause any adverse effects. It is also relatively not expensive and rapid to perform.

Fig 8. Ultrasound Images

IV. CONCLUSION

The various image modalities are available to imagine internal parts of human organs. Magnetic Resonance Imaging (MRI) is an innovator non-invasive imaging technique. Image processing and analysis tools support quantities medical diagnosis. Digital image analysis can give to enlarged accuracy and impartiality of medical diagnosis. Image processing/analysis is not only consider those issues described in this paper, it also considered such as image registration to find many other issues available in medical field.

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BIOGRAPHY

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