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An Analysis of Image Processing Techniques and Tools in Medical Images

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Abstract— Due to the great growth in the usage of computer technologies, image-processing techniques have become one among the most significant as well as rapidly used one in a broad variety of applications, particularly in medical imaging. Medical images are mostly used as radiographic techniques in disease recognition, clinical examinations along with treatment planning. The basic idea of medical image analysis is to develop imaging content. A typical medical imaging system is composed of five major processing phases i.e., image acquisition, pre-processing, segmentation, feature extraction/selection, and classification. Medical scan image usage machines are also constantly as fundamental. With these devices, it is possible to quicken and advance the errand of the examination of the diseases. Here, we have done a study on the present advanced techniques that have been used in various stages of medical image processing along with various medical image tools will be analyzed in a few directions. The essential focus of the assessment is to aggregate and examination on the medical apparatus in order to propose clients of different working systems on what sort of medical image devices to be utilized while investigating different kinds of imaging.

Keywords— Medical Imaging Tools, Pre-Processing, Segmentation, Feature Extraction, Classification.

I. INTRODUCTION

Representation is a difficult procedure it needs various segments of the human eye as well as mind to cooperate. The sense of visualization has been a standout amongst the most basic faculties for human survivalas well as evolution. People utilize the visual framework to get visual information, see for example process, reorganization and conclude inductions from the apparent data [1]. The field of image processing bases on robotizing theway toward assemble and preparing visual data.The method of receiving as well as analyzing visual data by a computer is known as image processing.

Medical diagnosis assisted by computer frameworks that utilization an assortment of machine learning algorithms and artificial intelligence has been accessible sincethe early 1990s.These medicinal diagnostic devices utilize a patient's manifestations, indicative estimations and lab results as data sources, and the framework restores a positioned rundown of findings alongside proposed medications [2]. Even though such apparatuses exist to analyze a general disease, radiology does not yet have a summed up instrument which can aid determination.

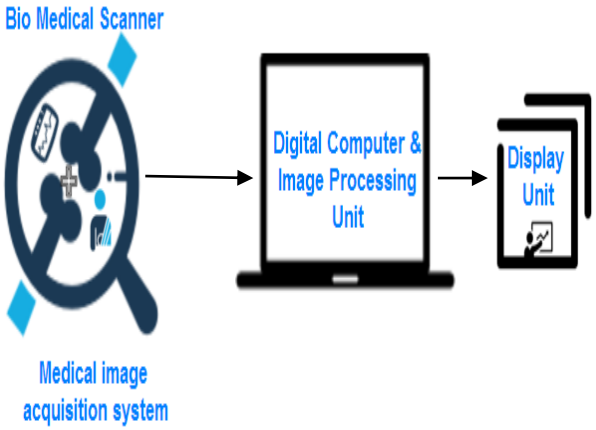

Fig1.Medical image investigation system

This paper will concentrate on medical image processing systems and tools. Numerous applications happen everywhere throughout the medical way of occasions, inside diagnostic settings, yet vitally in the region of training, doing just as evaluation before operations [3], hence, the advantages and disadvantages of the medical image will directly impact the outcome of the diagnosis from a specialist to the patient.

II. MEDICAL IMAGE PROCESSING TOOLS (MIP)

Imaging is an essential aspect of medical sciences for visualization of anatomical structures, functional or metabolic information of the human body [4]. Structural and functional imaging of human body is important for understanding in following states,

- Human body anatomy
- Physiological processes
- Functions of organs
- Conduct of entire or a piece of organ affected by unusual physiological conditions or an infection

The figure 2 below illustrates major types of medical image processing tools,

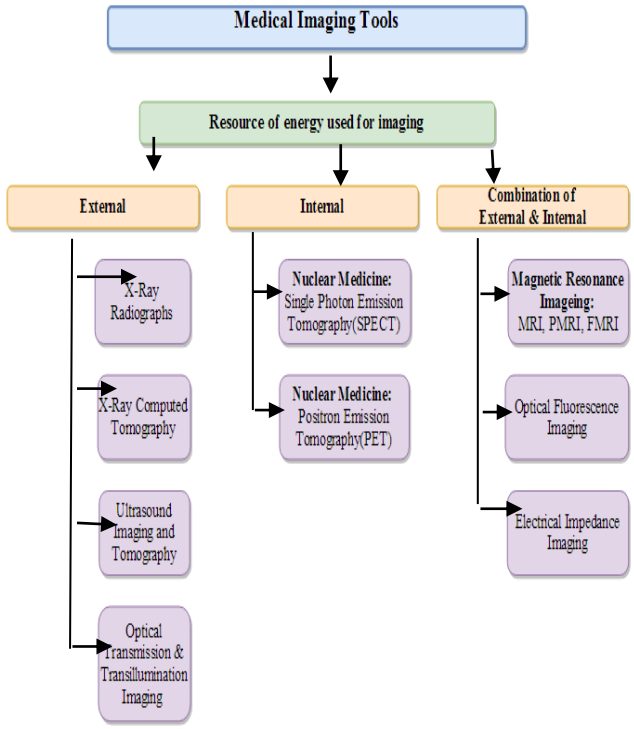

Fig2.Medical imaging tools

A significant reason behind image processing is to improve the presence of an image, in this way; there is a lot of imaging instruments [5]. Advanced medicalimages including numerous sorts of images which are not quite the same as to each other as far as how is created and what it looks like. The regular kind of imaging incorporates are:

a. External Medical Imaging Tools

Plain X-rays: It is a type of radiation known as electromagnetic waves. This is related to light and microwaves. X-rays infiltrate the body to generate a 2-D. It generates pictures of the internal body. The scans demonstrate the parts of patient body in differentdimness of black as well as white. This happened because different tissues absorb particular amounts of radiation. Fat as well as other soft tissues absorb less so color on hard film, look gray [6].

Computed Tomography is generallycalled CT. CT uses X-rays to generate detailed cross-sectional images of the internal body. These numerous images can be utilized to create 3-D images [7].

b. Internal Medical Imaging Tools

A **SPECT** scanutilizes radioactive tracers which are injected into the blood to produce pictures of heart. A radioactive tracer is injected into bloodstream. Inside the body, the tracer creates a kind of energy known as gamma rays. A gamma camera picks up signals from the tracer, and a computer changes them into images of blood flow through heart.

Positron Emission Tomography is a nuclear imaging method which provides physicians with data on how tissues as well as organs are running [8].

c. Combination of External & Internal

Magnetic Resonance Imaging (MRI) is progressively critical in medical everyday practice. MRI is a radiology test that utilizes magnetic fields and radio waves to deliver 3-D pictures [9]. This scanners and a digital computer produce images of the interior body structures, including the brain and spinal cord, bones as well as joints, the heart and veins, bosom tissue and other inner organs. Some normal MR imaging examinations are listed below:

i.Functional MRI (FMRI)
ii.Parallel MRI (PMRI)
iii.Diffusion MRI (DMRI)

The imaging tools provide assistance to scientists with an extensive set of plug-in, toolkit, functions, and apps for image processing, analysis. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard image processing techniques to it [10]. The below table illustrates the most common used medical image processing tools,

The imaging instruments give help to researchers a broad arrangement of the module, toolbox, capacities, and applications for imageprocessing, investigation. Most image-processing strategies include regarding the image as a two-dimensional flag and applying typical image processing techniques to it [10]. The underneath table shows the general utilized therapeutic medical image processing tools,

Table1. Comparisons of Medical Imaging

S.No	Tools	Field of Use	Advantage	Disadvantage
1	Radiography	Bones imaging and dental domain	Excellent for Imaging bones, Noninvasive, Good availability, Low cost	Harmful rays, Bad results for soft tissues
2	Computed Tomography (CT)	Cardiac, Bones, Cerebral, Pulmonary Imaging	Excellent for bones Imaging, Provides 3D anatomical information, Good availability, Noninvasive	Harmful rays, Bad result for soft tissue, Claustrophobia
3	Magnetic resonance imaging (MRI)	Cardiac, Cerebral, Chest, Abdomen, Pelvis etc.,	Main modality for image guided surgery, High ability to discriminate between fine differences in tissue characteristics, Very safe	Problem with metal corps, Problem of availability, High cost
4	Positron Emission Tomography (PET)	Oncology, Neurology, Cardiology, Psychiatry	Functional Imaging, Used in a lot of domains, less radiation	Invasive method
5	Ultrasound Imaging and Tomography	Cardiology, Endocrinology, Gynecology, Obstetrics, Ophthalmology	Noninvasive, Clean & safe, In-expensive	Noisy, Gas filled & bony structures cannot be imaged

i. In recent years, among the different tools of medical images, MRI has gained popularity in diagnosis and treatment planning [13]. Over the years MRI technology has advanced significantly to be more valuable, providing improved spatio-temporal resolution as well as reducing the acquisition time.

Applications of Medical Image Analysis

Image processing has a wide range of utilization and can be estimated into various areas where images are utilized [14]. They are recorded as pursues,

- Brain Tumor Detection
- Bone Cancer Detection
- Craniofacial Fractures
- Breast Cancer Detection
- Congenital Heart Defects
- Diagnosis Heart Valve Diseases
- Tuberculosis (TB)
- Pathological Brain Detection (PBD)
- Birth Defects

III. MEDICAL IMAGE PROCESSING

The increasing use of computers to aid the diagnosis (CAD)produced a fastdevelopment of computing algorithms applied to medicine inthe last decades. The objective of CAD is to improve the accuracy of the diagnosis, and the consistency of the interpretation of the radiological image. However, some CAD tools that show great results are not used in the clinicalroutine because they have high computational cost. The difficulties inapplying these CAD algorithms in the clinical routine and thelimitations thatstill exist related to the storing, processing, searching and retrieving ofimagesin large databases has been motivating the researchers tofindnew solutions to solve these problems.The use of image processing and neural networks techniques applied to medical images obtained considerablesuccess in the medicalimages analysis community. The modules of medical image processing system is described below,

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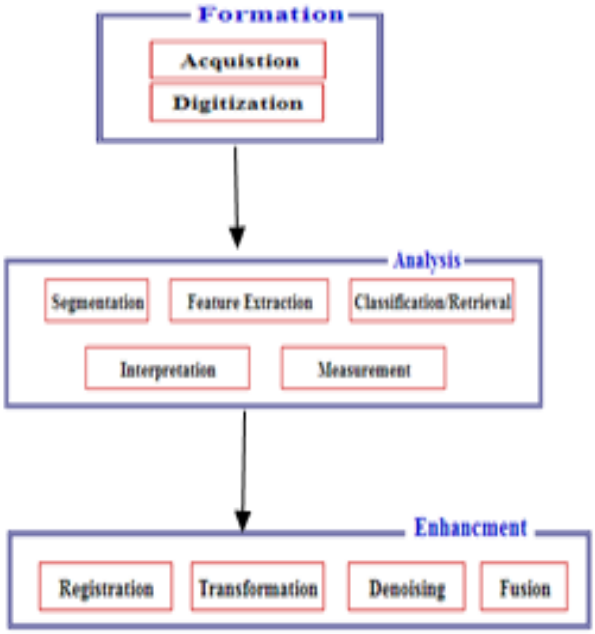

Fig3. Modules of medical image processing system

The commonly used term ‘medical image processing system’ means the utilization of digital image processing and analysis techniques for medical images used in diagnosis and treatment. In general, medical image computing paradigm covers the following five major domains as shown in Fig.3. The first major domain namely image formation, includes all the steps from capturing the image to forming a digital image matrix. Generally, the output images obtained by different image formation schemes are of sub-optimal quality and not readily suitable for further use. In most cases, these images are undergone through some form of image enhancement. This refers to all types of manipulation of the obtained images, resulting in optimized and improved output images. The domain of image visualization indicates realistic visualization of the image data specifically in 2D, 3D and 4D format. The image analysis domain encompasses diverse sorts of techniques which are used for quantitative measurements and abstract

interpretations of biomedical images [15]. Digital Image analysis is largely concerned with four basic operations [16].

i. Medical Image Preprocessing

Generally, due to various sources of interference and other physical phenomena that affect the underlying measurement processes in imaging and data acquisition systems, medical images get deteriorated by different types of noises. Some of the main troubles in medical images areimpulse in MRI, Speckle in US and Poisson in SPECT etc. limited contrast, motion artifacts and bias field etc. These objects affect the visual quality of the medical images, limit the accuracy of computer-aided diagnosis (CAD), clinical visual inspection and performance of subsequent high level image processing and analysis tasks.

The preprocessing technique itself does not build the natural data content in the image. It basically stresses certain predetermined image attributes. Preprocessing methods are commonly perceptive and application reliant. A portion of the preprocessing methods are:

a. Contrast stretching/normalization
b. Noise Filtering
c. Histogram Modification

ii. Image Segmentation

After applying the preprocessing algorithms, many image segmentation methods namely, Sobel, Prewitt, Roberts, LoG, Canny edge detection, basic global thresholding and Otsu's global thresholding are applied on the images. Usually segmentation process stops when the object of interest isolated from rest of the background.Image segmentation broadly classified into two types:

a. ***Local segmentation:*** It deals with sub-images which is a small part of whole image
b. ***Global segmentation:*** It is concerned with segmenting a whole image.

For the monochrome image, image segmentation algorithms based on two properties: discontinuity and homogeneity.Methods based on discontinuities are called as boundary based methods and methods based on homogeneity are called region based methods [18].

iii. Feature Extraction

Feature extraction is necessary to complete feature extraction before classification. It is the process by which assured features of concern within an image are detected as well as represented for further processing. It is a challenge to choose a fine feature set for image classification. It is a vital step in most computer vision and image processing solutions because it marks the evolution from pictorial to non-pictorial facts representation. The resulting representation can be subsequently used as an input to classification techniques, which will then label,classify or recognize the semantic contents of the image or its objects [19]. Image features properties can be referred as,

a. ***Global features:*** average gray level, shape of intensity, histogram.
b. ***Local features:*** circles, lines, texels (elements composing a textured region)
c. ***Other local features:*** shape of contours etc.

Features are attributes of the data elements based on which the elements are assigned to various classes. Important Features are,

- Shape Features
- Spectral Features
- Texture Features
- Transform Features

iv. Image Classification

Image classification is the process of assigning pixels in the image to categories or classes of interest i.e.,It is a process of mapping numbers to symbols (Features).So as to characterize a lot of data into various classes or classifications, the connection between the information and the classes into which they are grouped must be surely known.To achieve this by computer, the computer must betrained [20]. Training is key to the success of classification. Important aspects of accurate classification are,

- Learning techniques
- Feature sets

Types of Learning can be categorized as follows.,

a. ***Supervised Learning:*** Learning process designed to form a mapping from one setof variables (data) to another set of variables (informationclasses).
b. ***Unsupervised learning:***Exploration of the data space to discover the scientific lawsunderlying the data distribution.

Table2. Collection of medical image processing techniques

Author Name	Year	Methodology	Imaging Modalities	Function
Gupta et al. [21]	2010	Marker controlled watershed	B-mode ultrasound mages - multiple stone detection	Segmentation
R. Vanithamani et al. [22]	2011	Wavelet based Bilateral filter	Ultrasound Images	Preprocessing
Rathi et al. [23]	2012	PCA & LDA	MRI images -	Feature Extraction

			brain tumor	& selection
R. Tomari et al [24]	2014	ANN Light	Microscope	Classification
Afshan [25]	2014	Fuzzy C-Means	MRI – Brain tumor	Segmentation
Murthy et al. [26]	2014	Thresholding and morphological operations	MRI – Detecting brain tumor	Segmentation
Vijaya G et al. [27]	2014	Adaptive noise filter	Lung CT Images	Preprocessing
Y. Song et al [28]	2015	Locality-constrained Sub-cluster Representation Ensemble (LSRE)	High Resolution Computed Tomography (HRCT) -	Classification
Y. Iwahori [29]	2015	K-means clustering	Endoscope - Polyp detection	Segmentation
F. YousefiRizi [30]	2012	Curvelet Transform & Adaptive Complex Diffusion Filter	Intravascular Ultrasound Images	Noise Reduction
Yu‐Dong Zhang [31]	2015	Wavelet packet Tsallis entropy and fuzzy support vector machine	MRI-brain tumor	Classification
Viswanath et al. [32]	2015	Artificial Neural Network (ANN)	Ultrasound images-kidney abnormalities	Classification
A. A. A. Setio et al [33]	2016	Multi-View Convolution Networks (ConvNets)	Pulmonary nodule detection – CT	Classification

IV. CHALLENGES IN MEDICAL IMAGE PROCESSING

There are several challenges for the computer to understand an image. ***First:*** diversity and number of image data increase continuously, ***Second:*** mathematical and statistical formulation and techniques, and how they could be adjusted in the medical domain, ***Third:*** computing power [2]. Some specific challenges in medical image processingare,

- Image enhancement and restoration
- Automated as well asexact segmentation of features of interest
- Automated alsoperfect registration with fusion of multimodality images
- Classification of image features, namely characterization and typing of structures Quantitative measurement of image features and an interpretation of the measurements
- Improvement of integrated systems for the medical sector

V. CONCLUSION

Medical image classification is an interesting research area,it combines the diagnosis problem and analysis purposes in themedical field. In this paper a systematic study on existing tools of medical imagesand various techniques on medical image processingare conducted. Each medical image processing tool has its own limitations.This paper reviews on the existing tools of medical image processing also recommends some medical imaging tools to be applied on medical image analysis as well as deals with the various techniques in image processing such as Image Preprocessing, Segmentation, Feature extraction and Classification.

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