Medical Image Processing: A Review

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***Abstract- T*he advent of computer aided technologies image processing techniques have become increasingly important in a wide variety of medical applications. Intervention between the protection of useful diagnostic information and noise suppression must be treasured in medical images. Image denoising is an applicable issue found in diverse image processing and computer vision problems. There are various existing methods to denoise images. The important property of a good image denoising model is that it should completely remove noise as far as possible as well as preserve edges. This paper presents a review of some major work in area of image denoising.**

The objective in all discipline is to extract information about the scene being imaged. The rapid progress in computerized medical image reconstruction and the associated developments in analysis methods and computer-aided diagnosis has boosted medical imaging into one of the most important sub-fields in scientific imaging Ultrasound, MRI, CT-Scan, PET Scan are the medical techniques mainly used by the radiologist for visualization of internal structure of the human body without any surgery. These provide ample information about the human soft tissue, which helps in the diagnosis of human diseases.

Keywords- Medical Images; Image Denoising; speckle noise; Wavelet Transformation.

I. INTRODUCTION

Vision is a complicated process it requires numerous components of the human eye and brain to work together. The sense of vision has been one of the most vital senses for human survival and evolution. Humans use visual system to see or acquire visual information, perceive i.e. process and understand it and deduce inferences from the perceived information. The field of image processing focuses on automating the process of gathering & processing visual information. The process of receiving and analyzing visual information by digital computer is called digital image processing. Over the last three spans, we have perceived an expansive growth in both the range of techniques and variety of applications of image processing. We encounter images everywhere in our life. Basically, an image is a projection of a 3D scene into 2D projection plane.

A. Medical Image Processing

Modern 3-D medical imaging offers the potential and promise for major advances in science and medicine as higher reliability images are produced. It has developed into one of the most important fields within scientific imaging due to rapid and continuing progress in computerized medical image visualization. 2-D image signal might be a photographic image, text image, graphic image (including synthetic image), biomedical image (X-ray, ultrasound, MRI, CT-scan etc.), satellite image etc. [1, 2, 3]. In the first stage, input is an image scene and output is a corresponding digital image. In the second stage of processing, both input and output are digital images where the output is an improved version of the input. In the final stage, input is still a digital image but the output is description of the contents. A block diagram of typical image processing is shown in Figure 1.

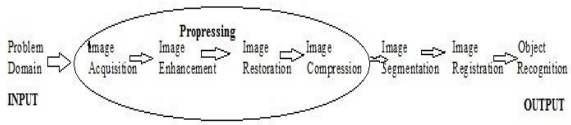

Figure 1: Steps in image processing preprocessing

Medical images encounter a various number of noises such as Gaussian, Poission, Rician & Impulse noise such as salt and pepper noise [52]. Impulse noise is frequently encountered in acquisition transaction, storage and processing of images. The presence of impulse noise is an image could degrade the image quality and cause some loss of image information details so it is a serious problem in medical image analysis because loss of image details which may prove fatal to the life of a person. During the image acquisition and transmission process the quality of the digital images is affected by the introduction of noise, blurring or deformations due to deficiencies in the acquisition or the transmission process, camera motion or misfocus. For telemedicine applications, medical images must be stored prior to transmission. An efficient compression algorithm is required to diagnose from these compress images [37]. Image denoising [54] is an important of pre-processing task before further processing of image like segmentation [63], feature extraction [62], texture analysis etc. The purpose of denoising is to remove the noise while retaining the edges and other detailed features as much as possible.

a) Types of Medical Images

Digital medical images involving many types of images which are different from one to another in

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terms of how is produced and how it is look. Common type of imaging includes are:

Plain X-Ray- X-rays is a type of radiation called electromagnetic waves. This is similar to light and microwaves. X-rays penetrate the body to create a 2-D. It creates pictures of the inside of your body. The images show the parts of your body in different shades of black and white. This happened because different tissues absorb different amounts of radiation. Calcium in bones absorbs x-rays the most, so bones look white. Fat and other soft tissues absorb less so color on hard film, look gray. Air absorbs the least, so lungs look black.

Computed Tomography is commonly known as CT or CAT scan. CT uses X-rays to create detailed cross-sectional images of the inside of our body. These multiple images can be used to generate 3-D images. At the time CT scanning, you lie still on a table. The table slowly passes through the center of a large X-ray machine. CT can produce images of every type of body structure, including organs, bones and blood vessels and is used by health professionals to help diagnose and manage many health conditions.

Magnetic Resonance Imaging is increasingly important in clinical routine. MRI is a radiology test that uses magnetic fields and radio waves to produce 3-D images [56]. MRI scanners and a computer produce images of the internal body structures, including the brain and spinal cord, bones and joints, the heart and blood vessels, breast tissue and other internal organs.

TABLE 1: COMPARISONS OF MEDICAL IMAGING

	X-Ray	Ultrasound	MRI	CT-Scan
Resolution	Normal	Spatial resolution Dependent on Transducer selectection	Best	Moderate
Speed	Short	Depends on Operator	Long	Moderate
Cost	Low	Moderate	Relatively High	High
Data Acquisition	Low	Low	High	High
Effects	Ionizing radiation	Non-Ionizing	No	Ionizing radiation
Availability	Maximum	Maximum	Less than CT	Without Much Difficulty

Ultrasound also known as sonography is a type of imaging. Ultrasonic devices are frequently used by healthcare professionals. The use of ultrasound imaging in medical diagnosis is well established because of its noninvasive nature, low cost, capability of forming real time imaging and continuing improvement in image quality [55]. It uses high-frequency sound waves to look at organs and structures inside the body. Unlike x-rays, ultrasound does not expose radiation. During an ultrasound test, you lie on a table. A special technician or doctor moves a device called a transducer over part of your body. The transducer sends out sound waves, which bounce off the tissues inside your body. The transducer also captures the waves that bounce back. The ultrasound machine creates images from the sound waves.

Positron Emission Tomography is a nuclear imaging technique that provides physicians with information about how tissues and organs are functioning. PET, often used in combination with CT imaging, uses a scanner and a small amount of radiopharmaceuticals which is injected into a patient's vein to assist in making detailed, computerized pictures of areas inside the body.

II. APPLICATIONS OF MEDICAL IMAGE ANALYSIS

Imaging technology in Medicine made the doctors to see the interior portions of the body for easy diagnosis. It also helped doctors to make keyhole surgeries for reaching the interior parts without really opening too much of the body. The arrival of digital medical imaging technologies has reformed modern medicine [20]. Extensive use of digital imaging in medicine today, the quality of digital medical images has becomes an important issue. To achieve the best possible diagnosis it is most important that medical images should be sharp, clear, noise free and artifacts [49]. With the advancement in the technologies continuing for gaining digital medical images with higher resolution and quality, removing noise in these digital images remains one of the major challenges in the study of medical imaging. Image de-noising still remains a challenge for researchers because noise removal introduces artifacts and causes blurring of the images. Image processing has a wide spectrum of applications and can be measured into different domains where images are used [15].

a) Brain Tumor Detection

Brain is the most important and vital organ of the human body. The control and coordination of all the other vital structures is carried out by the brain. A brain tumor is a very serious-type among all life threatening diseases which is increasing drastically among the humans. A brain tumor is a mass of tissue formed by an unregulated growth of the abnormal cells in the brain. CT and MRI are the best technologies currently being used for diagnosing brain tumor. It helps the doctors to classify the tumor from either least aggressive (benign) or most aggressive (malignant).

b) Craniofacial Fractures

Imaging is one of the most important tools for orthodontists to evaluate and record size and form of craniofacial structures [21]. Craniofacial fractures are

faced frequently. Major causes are vehicle accidents & sports related injuries. During the treatment of craniofacial fractures, 3-D imaging is an imaging technology ultrasound, CT-scan which provides high quality of image to the orthopedics to diagnoses.

c) Breast Cancer Detection

Breast cancer is most commonly diagnosed cancer worldwide. Pal et al. [22] state that, annually more than a million women have breast cancer and 400 thousand of those cases lead to death. This fatal disease affects not only developing countries but also developed countries. In order to find the cure it is necessary to quickly diagnose the disease accurately and treat it based on the kind of symptoms appeared. Cheng et al. [17] state that early diagnosis should not only include breast cancer detection but also specify whether the breast cancer is benign or malignant.

d) Congenital Heart Defects

Congenital heart defects are problems with the heart's structure that are present at birth. Doctors usually diagnose holes in heart based on a physical exam and result from test and procedures. Noise suppression of echocardiography images still is a challenging issue for accurate interpretation. One of the major problems associated with echocardiographic image enhancement is the speckle noise [23].

e) Diagnosis Heart Valve Diseases

Heart valve disorders are of importance among the heart diseases. For this reason, early detection of heart valve disorders is one of the most important medical research areas [29]. Cardiologists have access to diverse techniques such as electrocardiograms, chest X-rays, ultrasound imaging, Doppler techniques and angiography etc. for examine the functionality of heart more accurately for the diagnosis. Echocardiography is a clinical procedure for diagnosing heart diseases, especially valve ones.

f) Tuberculosis (TB)

Tuberculosis continues to represent a major public health problem worldwide. Accurate diagnosis and effective treatment are fundamental to reducing illness, mortality and restricting spread of infection.

g) Pathological Brain Detection (PBD)

Labeling brain images as healthy or pathological cases is an important procedure for medical diagnosis. Pathological brain detection can help physicians to detect subjects with brain diseases by an automatic method [65]. Zhang et al. [66] proposed an automatic PBD to distinguish pathological brains from healthy brains in magnetic resonance imaging scanning. This technique provides clearer soft mass dataset of tissue details without causing damages to the patient's tissues.

h) Birth Defects

A birth defect is a health problem or physical change, which is present in a baby at the time he or she is born. Birth defects have been present in babies from all over the world, in families of all nationalities and backgrounds. Anytime a couple becomes pregnant, there is a chance that their baby will have a birth defect. Most babies are born healthy. In fact, 97 out of 100 babies are born healthy [51].

III. A REVIEW ON

Each of the medical imaging devices is affected by different types of noise. For example, the x-ray images are often corrupted by poisson noise, while the ultrasound images are affected by speckle noise [52 and 69]. Speckle is a complex phenomenon, which degrades image quality with a back scattered wave appearance which originates from many microscopic diffused reflections that passing through internal organs and makes it more difficult for the observer to discriminate fine detail of the images in diagnostic examinations [27]. A brief review of some of the recent research work is presented here on different medical problems.

Jafari et al. [5] show a hybrid approach for the detection of brain tumor tissue in magnetic resonance image based on genetic algorithm and SVM.

Deb et al. [6] remove noise based on region filling and explain the drawback using different noise filter like Gaussian Filter or Gaussian smoothing, mean filter, median filter etc. They also have shown the phenomena of region of interest.

Afshan et al. [7] choose different algorithms with segmentation concept over the detection of brain tumor. Authors also explain the advantages and disadvantages of the different methods on the basis of areas, shape and location. They determined that in addition of K- Means Clustering algorithm and Fuzzy C- Means Segmentation gives the best results with respect to shape of abnormal growth.

Murthy et al. [9] describe with thresholding and morphological operations for detecting brain tumor with the help of segmentation.

Kharrat et al. [10] adopted concept of morphology, wavelet transform in the segmentation process to decompose MRI images. Author also use the k-means algorithm is used to extract the suspicious regions or tumors.

Nanthagopal et al. [11] present a method on brain tumor tomography images using the segmentation using by a SVM and probabilistic neural network (PNN) classifiers.

Gupta et al. [13] explain algorithms for multiple stone detection in B-mode ultrasound images of kidney and gall bladder. The proposed term is based on the marker controlled watershed segmentation.

Rathi et al. [14] represented a noval approach for feature extraction and selection on MRI images for brain tumor classification. The method used is PCA & LDA.

Miller et al. [16] explain that medical images have poor contrast along with serious types of noises. The suppression of noise in medical images corrupted by noise is major issue in image processing and computer vision.

Elalfi et al. [32] represented the extracting texture features from medical echocardiography images, combining intensity histogram features and Gray Level Co-occurrence Matrix (GLCM) features. Gaussian filter and Gabor filter are used for the preprocessing technique. Back propagation artificial neural network (B-P ANN) is used to identify the heart value diseases.

Somnath et al. [33] proposed the denoising method of medical images using thresholding & optimization using a stochastic and randomized technique of Genetic Algorithm. Image is divided into fixed size blocks for wavelet transformation process.

Kaur et al. [36] prescribed initially pre-processing of the image, after pre-processing segmentation is divided the given image in the two uniform parts, i.e. ROI and non-ROI.

Hassanpour et al. [38] presented method based on morphological transform to enhance the quality of the medical image. In this method disk shaped mask with morphological operations are performed and at last enhanced image are determined based on the Contrast Improvement Ratio (CIR) measure.

Viswanath et al. [40] presented the paper on kidney abnormalities using ultrasound images. Image restoration is used for removing the speckle from ultrasound noise using Gabor filter and artificial neural network (ANN) for classification.

S. Senthilraja et al. [43] implemented a filter named WB-Filter for Medical Image denoising. WB – Filter is a combination of median filtering and bilateral filtering to determine the better performance compare to median, wiener and bilateral filters. In this filter each pixel in an image is replaced by a weighted average of intensity values from nearby pixels and second filter used to minimize the mean square error between estimated and the desired.

Abrahim et al. [44] propose with speckle reduction method and coherence enhancement of ultrasound images based on method that combines total variation (TV) method, wavelet shrinkage.

Vanithamani et al. [45] proposed an algorithm for despeckling of medical ultrasound images, which is based on wavelet thresholding, bilateral filtering in transform domain.

Yousefi Rizi et al. [46] highlighted on the study of performance of wavelet based ultrasound image denoising method using curvelet technique with dual tree complex, real & double density wavelet transform denoising methods were applied to real ultrasound images.

Lazrag et al. [47] highlighted on intravascular ultrasound using curvelet transform. The performance of the CT has also been compared with the wavelet transform method.

Yousefi Rizi et al. [48] highlighted on IVUS image analysis. A comparison with performance is done on the curvelet transform, adaptive diffusion filter method used for ultrasound despeckling. The anisotropic diffusion filter is used to despeckle medical ultrasound images.

Linguraru et al. [57] presents the automated computation of hepatic tumor burden from abdominal infected computed tomography images. Authors also used SVM and feature selections are employed to reduce the number of false tumor detections.

Gabralla et al. [59] propose image denoising scheme by modifying the wavelet coefficients using soft-thresholding method. The denoising process rejects noise by thresholding in the wavelet domain.

Chong et al. [60] proposed a novel blind image deconvolution approach based on noise variance estimation. This method first performs the noise variance estimation from the noisy blurred image. Images are restored by the least-square filter method using the estimated parameters at each step.

Deng et al. [61] proposed an iterative scheme to solve single image super-resolution problems. Authors proposed the smooth components of an image using a thin-plate reproducing kernel Hilbert space (RKHS) and edges using approximated Heaviside functions.

Conclusion-

In this paper a systematic study on medical image processing over various automated brain tumor cancer detection is done with partial survey of various classification techniques for MRI brain image. A relative study is made on various techniques. This paper deals with the different methods in image classification as i) Image Preprocessing and Segmentation ii) Feature Reduction and iii) Classification. Many algorithms have been proposed in the literature for each image processing stage. After evaluation, it is clearly shown the various methods which can detect the medical disease efficiently and provide accurate result. This work will be continue for new algorithm for brain tumor detection and other diseases which will provide more efficient result than the existing methods in near future. Accuracy and reliability are always assigned much importance. Hence this approach will highlight new panoramas for developing more robust image segmentation technique.

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