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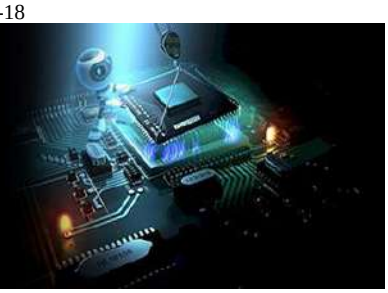

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Medical image denoising: A brief analysis

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Abstract
An image is nothing but a pictorial representation of an object. Image without any disturbance or noise is generally best suitable for use. But if the image is corrupted with noise then that is of no value. So denoise is a kind of concept which is taken into consideration to remove noise. In this paper, I have reviewed some of the papers in the field of denoising particularly in the field of medical technologies. There are abundant number of papers released in this area. Some are having some advantages and some disadvantages. Ultimate approach of image denoising is that, we need to denoise the image in such a way so that features of images like edges, corners and other valuable features would not be removed. The ultimate aim of researchers is to get the true image from the denoised image with the probability of success as 1.Hence,this paper is not only meant for reviewing the papers based on denosing techniques but also provides a future direction to extend for further research in this area of medical image denosing.

Keywords: MRI, CT, X-ray, PET, image denoising etc.

1. Introduction
Medical imaging is a wonderful area in the recent times. Needless to say, medical imaging is an emerging field for diagnosis of many diseases along with proper treatment. Medical imaging is not the only field which can be captured by Doctors or Specialist for treatment of diseases. If this medical imaging is amalgamated with proper denoising of images, then it becomes a cherished moment for researchers, academicians and pathologists as it save more time for treatment of diseases. One of the lucrative and interesting approach in in medical imaging as it demands for more study. This chapter describes how different techniques of machine learning helped medical imaging to make it more flavourable. This chapter described some of the techniques of medical imaging including their risks, benefits and applications. Not only machine learning is restricted to medical imaging. Currently medical image denoising with the help of machine learning, deep learning is a great challenge for researchers. Ultimately PSNR values decide the smoothness of images. Noising has been achieved. For developing the quality of the CT images, a variety of methods have been established. While many algorithms have been proposed for the purpose of image denoising, the problem of image noise suppression remains an open challenge, especially in situations where the images are acquired under poor conditions where the noise level is very high. In this paper, we present a broad review of medical image denoising is presented in spatial domain and transform domain and each has their own assumptions, limitations and advantages. The rest of the paper is structured as follows. Section II briefly describes the modalities of medical imaging techniques. Section III presents the brief review of different denoising techniques. Section IV reveals the guidance for further work followed by conclusion which is at section V.

2. Overview of medical imaging modalities
Computed Tomography (CT)
Computed Tomography gives us images revealing cross section of the body. Computed Tomography takes the help of x-ray to display the image of body parts. If more details is required as far as anatomy is concerned had CT is more preferable to x-rays. CT makes thin slices of anatomy to look into the body. CT t takes the help of a unit called Hounsfield unit, coined by Sir Godfrey Hounsfield.

Benefits of CT
- Spatial resolution is very nice

- Painless and non-invasive
- Vain view is clearer
- Disadvantages
- Exposing to ionizing radiation leads to cancer
- Unable to reveal intral-luminal abnormalities
- Unable to distinguish structure of soft tissue

Risks of CT
- Radiation oozing out of CT may lead to cancer.
- Radiation may damage DNA if exposure is excessive.

CT applications
- Able to examine almost all parts of human body
- Able to diagnose disease, trauma and abnormality

Ultrasound
Ultrasound is a sound which human being is unable to hear. It comes up with frequency which is higher than the audible frequency. The region of the body which are best diagnosed with ultrasound are appendicitis, female peltries, gall bladder, heart, kidney etc. Ultrasound is the best modality for providing real time information.

Benefits of Ultrasound
- Ultrasound is safe as compared to X-ray and CT scan.
- Ultrasound can capture the image of soft tissues.

Risks of Ultrasound
- Prolonged exposure is harmful for health.
- Pressure from ultrasound transducer may give discomfort to pregnant women.
- It is very time consuming.

Ultrasound applications
- Useful examining a baby inside womb of a woman.
- Useful for diagnosing the causes of pain, swelling inside the body.

Magnetic Resonance Imaging (MRI)
Magnetic resonance imaging is one of the more superior modality in medical imaging. The befitting term for MRI is signal unlike density for X-ray and attenuation for CT.MRI eradicates overlapping shadows which are a disadvantage for X-ray. The region of the body which are best diagnosed with MRI are abdomen, bile duct, fossa of brain, vascular structures etc.

MRI benefits
- MRI can take image in any direction.
- Provides good soft time contrast.
- It can distinguish between fat, water and muscle.
- MRI disadvantages
- Conducting MRI test bears high cost.
- It takes more time as compared to X-ray and CT.

MRI risks
- Patients with chemotherapy should not opt for MRI.
- Patients with brain MRI may experience nausea, headache.

MRI applications
- It is best suitable for degenerative diseases.
- MRI is able to separate normal tissue from pathologic tissue
- MRI is able to diagnose stroke in the early stage

Optical Imaging
This kind of imaging uses optics to extract images of the cellular and molecular function in the living body. It is suitable for deep tissues as the light propagates in a diffused manner. Optical imaging is practically helpful for mammography.

Optical imaging advantages
- It reduces exposure of patient by using non-ionizing radiation.
- It is very much helpful for examining soft tissues.

Optical imaging disadvantages
- Clinical translation is very limited.
- It is used for low depth penetration.

Optical imaging applications
- It is applicable for cancer diagnosis.
- It is actively implemented in industrial and academic environments.

Positron Emission Tomography (PET)
PET is a kind of imaging modality which uses the help of radioactive material to create an image. It displays the image of metabolic activity of cells within the body.

PET advantages
- Images are captured in as single scan using PET.
- It is able to distinguish easily between cancer cells and normal cells.

PET disadvantages
- It is not able to capture images of small tumour properly.
- As it is a new technology, so this medical technology is

PET applications
- It provides information about metabolism of a disease.
- PET when combined with CT or MRI provides accurate result for diagnosis.

3. Brief overview of some denoising methods implemented on medical imaging

Lei Zhang *et al.* [1] proposed an efficient PCA-based denoising method with local pixel grouping (LPG). By transforming the original dataset into PCA domain and preserving only the several most significant principal components, the noise and other unnecessary details can be eradicated. However, the PCA based scheme applies directly to the noisy image without data selection and many noise residual and visual artifacts will appear in the denoised outputs. The procedure gave satisfying result in preserving edges using principal component analysis.

Lei Jiang *et al.* [14] devised a method which is adaptive wavelet based and implemented on MRI images. The team implemented maximum likelihood for parameter procedure. By updating the shrinkage function along with spatial constraints, difference between edge and noise related coefficients were achieved. The team implemented their

procedure on both real and simulated images of MRI. The result of the algorithm produced great efficiency and outperformed other similar procedures.

Nicolas Wiest Dassle *et al.* [13] had proposed an algorithm for MRI images using the help of NL means filter. This algorithm shown good performance in terms of Peak-Signal-to-Noise Ratio.

Suiren Wan *et al.* [7] proposed a method for deconvolution of high-frequency ultrasound skin images using the mixture of higher-order spectral methods and wavelet analysis. The performance was awesome with the satisfied result of PSNR.

Ali *et al.* [5] revealed an efficient method for the fusion of Magnetic Resonance Imaging (MR) and Computed Tomography (CT) images. Fusion of these images received good performance as compared to traditional wavelet transform. The curvelet transform in the fusion of MR and CT images was superior. The obtained curvelet fusion results have increased PSNR values than the wavelet fusion results.

Frosio *et al.* [6] have devised an algorithm to denoise radiographic images corrupted by impulsive noise. This method used the photon counting process, with some pixels corrupted by impulsive noise. Basically this method was used to denoise images taken using X-ray.

Kumar *et al.* [16] have proposed for the diagnosis of benign and malignant liver tumors from Computed Tomography (CT) images by using curvelet transform based multi-resolution texture feature extraction and neural network. The output of the team expressed that the classification accuracy of curvelet based diagnosis was higher than the wavelet based method. Their algorithm is suitable for diagnosis of liver.

Paul Bao *et al.* [15] proposed an adaptive wavelet thresholding technique for MRI images. Their algorithm was able to reveal features of edges. The team also achieved high MSR values with the implementation of adaptive threshold.

4. Guidance for further work

In this analysis paper, some methods developed for denoising the medical images are revealed. The ultimate goals is to denoise those images of medical imaging techniques which are frequently used by Radigraphers. The the X-ray, CT and MRI images play a very crucial role as these are most common modalities. Therefore, this paper will definitely give great idea for researchers who are to going to start their research in the field of denoising in the field of medical imaging as well as meant for progressing.

5. Conclusion

Medical image denoising is a growing field and has become a cynosure of all eyes among faculties, researchers from image and signal processing in recent times. Here the very frequent modalities of medical image techniques has been discussed. Then the overview of few denosing techniques of medical imaging has been browsed in order to get the basic idea of denoising implemented on medical images.

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