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A COMPARATIVE ANALYSIS OF EXISTING MEDICAL IMAGE DENOISING TECHIQUES.

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Weiner Filter, Median Filter, Gaussian Filter, Gaussian Noise, Speckle Noise, Poisson Noise, Blurred Noise, Salt and Pepper Noise, Digital Images, Medical Images, Ultrasound, Radiography, Medical Resonance Image (MRI), Computed Tomography Image (CT).

ABSTRACT

Image denoising is very essential preprocessing step in analysis of medical images. Image denoising is the process of reconstructing the image by removing the noise present in the medical images. The challenges associated with removing the noise is increasing day by day as increasing large number of patients. This paper exhibits the current challenges and the existing techniques related to medical image denoising. Denoising is very crucial task as small loss of information can deviate doctors from predicting various diseases accurately. The paper surrounds multiple ways and techniques that had been discussed previously by various designated researchers, authors, and journalists related to Radiography, Medical Resonance Image (MRI) Computed Tomography Images (CT). Paper also shows advantages and limitation of the existing techniques.

I. INTRODUCTION

"The branch of medical science that studies the ability of organisms to withstand environmental stress." Drastic changes have come in the field of medical science after the medical revolution in the modern era. The digital method of medical treatment has now been used in curing diseases which areconsidered to be the most widely used techniques in medical imaging. It is used to create images of various parts of the human body so that the detection of diseases and treatment is quick. Various problems related to medical imaging and the alternatives had covered efficiently further.

A. What Medical De noising is?

"Medical Image de-noising means the removal of unwanted noises from the medical images" so that disease prediction can become more precise and treatment can do efficiently. An image often corrupt during acquisition and transmission. Representation de-noising primary purpose is to remove the noises as well as the model should also not get distorted.

Generally, datasets collected by sensors contain noise. Due to the presence of sound, the image may not look like what it should because of which detection of disease cannot happen. And hence it affects the treatment too. A wrong assumption by doctor or wrong prescription can seriously affect the patient or cause death.


SirIsidor IssacRabiwas born on July29,1898,in Rymanow Austria.He developeda methodofmeasuring atomic properties onnuclei.

Just before he diedin Januaryof1988,Rabiimaged himself inan MRImachine.He said, "Itwas eerie, I sawmyself in thatmachine",healsoquoted,"I neverthoughtmyworkwouldcometothis."

B. History

Before the incoming of medical imaging, the tasks performed were manual. (Vaidya) The doctor checks the health of the person by seeing the outer expression or the nerves of the human. Hence, the detection and cure of minor diseases become easy. But the minute primary condition was in-detectable and hence,uncurable too. The span of an average human life is up to 40. As science and technology become accessible, organic treatmentshifts to drugtreatment. Natural fracture bone-breaking can be treated quickly as well as drug curing diseases also cured. But as nuclear physics enhanced much more severe disease came into existence. So, the urge of some technology or processes that could be used to detect the internal organs become inevitable.

On the 3rd of July 1977, the first magnetic resonance imaging (MRI) was carried out on a live human patient. MRI, which identifies atom by how they behave in a magnetic field, has become a beneficial non-invasive method for imagining internal body structures and diagnosing disease.

II. FILTERS AND NOISE

A. What is Noise?

Noises are the unwanted sound that exists in the surrounding. It happens due to various resources which include many external causes in the transmission system and environmental factor. Due to these noises, images get distorted, and sometimes it even Detroit the whole picture. Transmissions produce these noises, due to dark spots or bright spots or due to the imperfections is machinery.

B. Types of Noises in Medical Images.

Different types of noises exist. But, some of the sounds which are found mostly in the Medical Images are

- Gaussian Noise

- Salt and Pepper Noise
- Blurred Noise
- Speckle Noise
- Poisson Noise

1) Gaussian Noise :-

a) The music whose probability density function is equal to statistical noise.
b) Cause due to acquisition.
c) Result in a blurring of the highquality images.
d) The formula for adding Gaussian Noise to an image is g = imnoise(I, 'gaussian', m, var) Where I is input image, m is mean and var is variance.

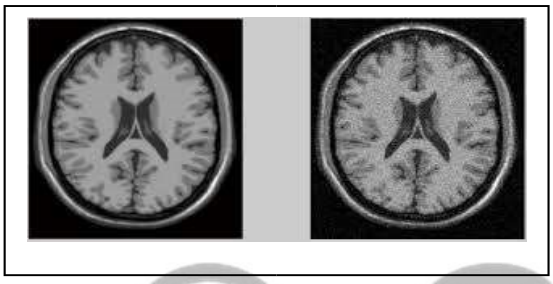

Fig 1.2: (a) Normal Image (b) Gaussian Noise.

2) Salt and Pepper Noise:-

a) It is known as Salt and Pepper Noise due to the presence of Bright and Dark pixels.
b) Due to sharp and unexpected changes of images arise, abrupt changes, or dead pixels.
c) It can be removed using DFS (Dark Frame Subtraction).
d) Morphological or Median Filter helps the most.

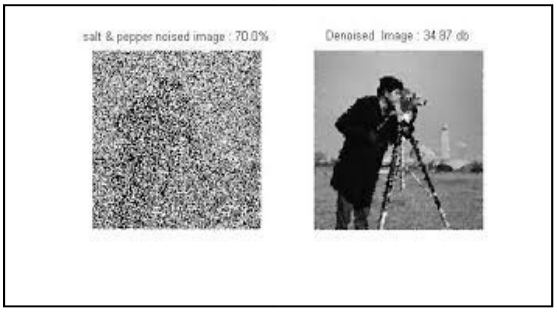

Fig 1.3: (a) Noised Image (b) Cleared Image.

3)Blurred Noise:-

a) As the word says, this type of noise causes dizziness or blurriness in the image.
b) Cause-Light intensity and external factors.
c) Reason capturing reasonable photos under low light visions under a handheld camera can be an annoying experience.

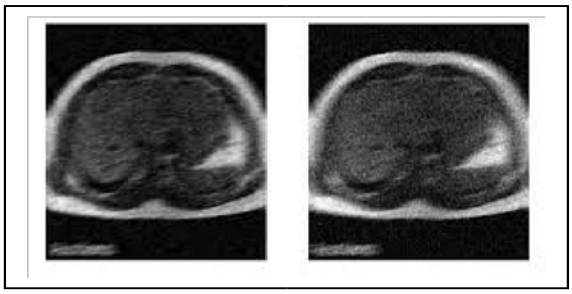

Fig 1.4:- (a) Blurred Image (b) De-noised Image.

4*)Speckle Noise:-*

a) Cause due to error in data transmission.
b) These are the granular noises present in the images. It reduces the quality of the aperture radar, and Synthetic Aperture Radar (SAR) or Magnetic Resonance Imaging (MRI).
c) Result in the random variations of the return signal, which increases the grey level in an image.
d) Speckle noise is the coherent imaging of objects in the image.

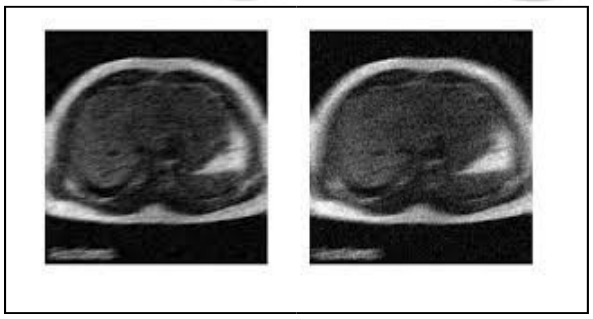

Fig 1.5:- (a) Speckle Noise (b) De-noised Image

5)Poisson Noise:-

a) It is an electronic noise which is a form of ambiguity related to the quantity of the light.
b) The formula for adding the passion noise is j = imnoise (I, 'Poisson').
c) Where I am the double-precision, then input values pixels are interpreted as means of Poisson distributions.

Fig 1.6:- (a) Poisson Noise (b) De-noised Image.

C. Filters to De-noise images.

Noise removing method has become an essential method in medical imaging applications, and the most commonly used filters are

- Median Filter.
- Weiner Filter.
- Gaussian Filter.

The need for smoothening of images becomes essential, which is required to remove the noise and for that best filters have used in most of the imaging processing applications.

1) Median Filter

a) It is known as order-static filtering in image processing.
b) Median Filter is a prevalent technique because it takes the particular area and calculates the intensity of all the pixels in the median filter.
c) The disadvantage of using this filter is the dark pixels raise to the median level, but the bright pixels come down to low pixels. Thus, the intensity of the pixel becomes moderate, and the image loses its edges.

2) Weiner Filter

a) It deals with the corrupted noise signal
b) It filters the image pixel by pixel.
c) If anyone wants to use the Weiner filter, then he/she/ others may know about the properties of the image. It removes the blurred and other types of noise present in it.
d) There is a property called a mean square error calculated for every image. It reduces the mean squared error value to a more excellent range.

3) Gaussian Filter

a) This filter is used to specially remove speckle noise present in ultrasound images or MRI brain images.
b) Gaussian Distribution works in it. The noise pixel, which is present in the image, is replaced by the average of the surrounding pixel. Such that the noise pixel takes the average intensity values.

III. REVIEW OF MEDICAL IMAGE DENOISING TECHNIQUES

A large scale researches had been done on finding denoising techniques. The study classifies the de-noising process of different types of images such as Radiography, Ultrasonography, Computed Tomography, Medical Resonance Imaging.

A. Radiography

1) *Martin Stahl et al.* [7] proposed an unsharp enhancement algorithm for small size data; the standard version of this algorithm results in a multi-scale architecture. By the pyramid structure, their algorithm had been decomposed into eight, or more channels resulting structure of dissimilar sizes, known as scales. By non-linear processing, the weak structures intensify at each scale, which results in superior performance.
2) *Sabine Dippel et al.* [8] proposed two multiscale methods that are supposed to be far more efficient than the usual unsharing way. These methods are Laplacian Pyramid and Fast Wavelet Transform.
3) *HakanOctem et al.* [9] proposed a local adaptive image enhancement and simultaneous de-noising algorithm. This method is the modified version of the wavelet transform coefficients.
4) *Triet le et al.* [10] produces a model to denoise an image having Poisson noise was employed by their model. It preserves the edges of the picture. The result was that it protects the low intensity of the photographs as well as the sides too.
5) *Frosio et al.* [11] produce a median filter which detects pulses corrupted by impulsive noise. The screen was applicable to both synthetic and real images.
6) *Krishnamoorthy et al.* [12] produce an algorithm for image denoising and enhancements in orthogonal polynomial transformation (OPT) for radiologists.

B. Ultrasonography

1) *Su Cheol Kang et al.* [13] design an active filter based on a simple wavelet de-noising method. The wavelet threshold algorithm has been replaced by the wavelet coefficients. This procedure became a local procedure as the local regularity of the functions has been characterized by the wavelet coefficients.
2) *Shujun Fu et al.* [14] produces a nonlinear edge enhanced anisotropic diffusion model tp preserve the corners and ultrasonic echoic bright strips.
3) *Oleg Michailovich et al.* [15] produces a simple preprocessing procedure that customizes the acquired radio frequency images so that the noise in the background image turned out to be the image similarto white Gaussian noise. Non-Linear Filter Wavelet De-noising, Total Variation, and Anisotropic Diffusion are the three different wavelet de-noising techniques that are used when assumed that the image is White and Gaussian.
4) *Fan Zhang et al.* [16] proposes a Laplacian Pyramid-based Nonlinear Diffusion (LPND) - A speckle reduction method. In this method, the laplacian gets detached by the nonlinear filtering of the bandpass ultrasound images. When these techniques are in use, it gave better image resolution and thus, more significant results.

C. Computed Tomography (CT Images).

1) *Jou-Wei Lin et al.* [17] proposed a piece of vital information for clinical application, for the utilization of multiscale wavelet transforms on image-based psychological quantifications.

2) *Joao Sanches et al.* [18] produces a Bayesian denoising algorithm that contains white Gaussian and multiplicative noise described by Poisson and Rayleigh distributions. The Sylvester–Lyapunov equation, developed.
3) *Arivazhagan et al.* [19] proposed or analyzed that the performance of an image de-noising system for four-level of DWT

   Decomposition, i.e., speckle noise added two facial and two CT Images. The following conclusions were derived:

   i. For most of the images added with Speckle noise, the maximum PSNR (dB) was attained for the first level of DWT decomposition (SNR1).
   ii. The NSR obtained for a superior level of DWT decomposition was lesser than SNR1 or SNR2.

   Images corrupted with single noise intensities; a unique level of DWT is applicable while images with high noise intensities, the second level of DWT is required.

D. Medical Resonance Imaging (MRI Images).

1) *Aleksandra Pizurica et al.* [20] proposed a wavelet domain method for noise filtering in medical images. For noise suppression in therapeutic ultrasound and magnetic resonance imaging, their results have demonstrated its efficacy.
2) *Paul Bao et al.* [21] proposed an MRI image denoising scheme by using an adaptive wavelet thresholding technique. Their project multiplies the adjacent wavelet sub bands and then differentiate edge structure from noise in a better manner. The results show that not only it conserve edges but also achieve high MSR and CR measurements.
3) *Lei Jiang et al.* [22] have proposed an adaptive wavelet-based Magnetic Resonance images de noising algorithm. For background-noise modeling, a Rician distribution was introduced, and Maximum Likelihood method has been employed for parameter estimation procedure.
4) *Yang Wang et al.* [23] proposed the way to deal with the data corrupted by Rician Noise adapts the NL Mean Filter. MR Images or DT Images contains in real data or synthetic data.

IV. LITERATURE SURVEY

S.no	Tittle of Paper	Author	Year of Publication	Results	Limitation
1.	Multi View Image Denoising using convolutional neural network.	Shiwei Hu*, Zoung Hen Hu*, Hongrui-Ziang	7 June 2019	Denoise multiple images with CNN has been successfully achieved.	The author presents no exception.
2.	An overview of deep learning in medical imaging focusing on MRI	Alexander SelvikvågLundervold, ArvidLundervold	21Nov 2018	The selection of filters for removing the noise from medical images relies on the type of noise which is present in the image and filtering technique which will be used.	Difficulty in deciding exactly what it is that makes one model better than another, to societal challenges related to maximization and spread of the technological benefits.

3.	Oriental Journal of computer science and technology.	Nalin Kumar and Mrs. M Nachamai	3 March 2017	The selection of filters for removing the noise from medical images relies on the type of noise which is present in the image and filtering technique which will be used.	It is only present for linear model not for non-linear model.
4.	Medical Image using convolutional denoising encoders.	LovedeepGondara	August 2016	Small datasets can easily be worked through these methods.	1. Cannot work High Resolution images. 2. Performance have to be boosted.
5.	Image De-noising Techniques – An Overview	Alisha P B, Gnana Sheela K	Jan- Feb, 2016	Spatial Filters in Linear Model and Wavelet Transform in Non- Linear Model suited best.	Model based on wavelet coefficients has not been found.
6.	An Extensive Review on Significant Researches on Medical Image Denoising Techniques	Mredhula.L,M.A.Dorairangaswamy	14 Febuary, 2013	CT Images caught great speed in advancement and could also be further improved.	MRI Images requires more concern and still less review and research found in this region.

V. DIRECTIONS FOR FUTURE RESEARCH

In this review paper, different aspects require to de-noise an image as well as various topics had been covered permanently. This paper includes the most occurring noises in medical images as well as the filters requires to de-noise them. Analysis was done on Radiography, Ultrasound, MRI, and CT Images. CT images are one of the most common modalities in medical imaging. But,MRI images also have higher possibilities of enhancement. This paper will act as a cornerstone for the budding researchers in finding appropriate techniques for medical images. In the future, we expect numerous brainwaves will rise through our review work.

Conclusion

Medical Image De-noising is a new research area that attracts the attention of researchers to a great extent in recent years. The paper provides a broad review of the significant researches and techniques that exist for the medical image. Here the studies are first categorized on various noises and filters mostly used in medical de-noising followed by a concise description of the digital or medical images salient features of the critical researches in the literature review. Thus, the paper paves the path for the budding researchers to get familiar with the different techniques present in the medical image de-noising.

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References

[1] Isidor Issac Rabi, "Rabi," *Copy &Paste,* https://www.aps.org/publications/apsn ews/200607/history.cfm 30 September 2019.
[2] How to add 5% Gaussian Noise to an Image?, Copy & Paste https://www.google.com/search?q=ga us-sian+noise&rlz=1C1CHBD_enIN790IN790&sxsrf=ACYBGNQTFqTbXPr2W5v75LJX_iNEHvHdyA:1569810543724&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjo4Mrv_fkAhXj73MBHZeFCQUQ_AUIEigB&cshid=1569810755167706&biw=1370&bi h=622#imgrc=40yjg3jXWlljQM, 30 September 2019.
[3] De-noised Image by Adaptive Median Filter, Copy&Paste. http://pixelsciences.blogspot.com/201_7/07/adaptive-median-filter-for-imagecorrupted-by-salt-and-peppernoise.html.30 September 2019.
[4] Oriental Journal of Computer Science and Technology (a)Blurred MRI Image (b) De-noised Image.Copy&Paste.http://www.computerscijournal.org/vo_l10no1/noise-removal-and-filteringtechniques-used-in-medical-images/.30 September 2019.
[5] The Curious Case of Poisson Noise and MATLAB imnoise command, Copy&Pastehttps://ruiminpan.wordpress.com/201_6/03/10/the-curious-case-of-poissonnoise-and-matlab-imnoise-command/September 30, 2019
[6] C. JMartin Stahl, TilAach and Sabine Dippel, "Digital Radiography Enhancement by NonLinearMultiScale Processing," Medical Physics, Vol 27, No. 1, pp. 56-65, 2000.
[7] Sabine Dippel, Martin Stahl, RafelWeimker, and Thomas Baffert, "Multiscale Contrast Enhancement for Radiographies: Laplacian Pyramid Versus Fast Wavelet Transform," IEEE Transactions On Medical Imaging Vol.21., pp. 343-353,2002.
[8] HakanOktem, Karen Egiazarian, Jarkko Nittylahti and JuhaLemmetti, "An Approach to Adaptive Enhancement of Diagnostic X-Ray Images," EURASIP Journal on Applied Signal Processing, Vol. 2003, No. 5., pp. 430-436,2003.
[9] Triet Le, Rick Chartrand, and Thomas Asaki, "A Variational Approach to Reconstructing Images Corrupted by Poisson Noise," Journal of Mathematical Imaging and Vision, Vol.27, No.3, pp.257-263,2007.
[10] Frosio and Borghese, "Statistical Based Impulsive Noise Removal in Digital Radiography," IEEE Transactions On Medical Imaging, Vol. 28, No. 1, pp.3-16, 2009.
[11] Krishnamoorthy, Amudhavalli and Sivakkolunthu, "An Adaptive Pyramid Domain for Ultrasonic Speckle Oriental Science Publishing Co. India, Reduction," IEEE Transactions On March 03,2017. Medical Imaging, Vol.26, No.2, pp.200-211,2007.
[12] Su Cheol Kang and Seung Hong Hong ," Experimental and Theoretical Analysis of Wavelet-Based Denoising Filter for Echocardiographic Images,"Studies in Health Technology and Informatics, Vol.84, No. 2,pp.906909, 2001.
[13] Shujun Fu, QiugiRuan,Wenqia Wang and Yu Li , " Feature Preserving NonLinear Diffusion for Ultrasonic Image Denoising and Edge Enhancement ,"World Academy of Science , Engineering and Technology, Vol.37, No.2, pp.148151,2005.
[14] Oleg Michailovich and Allen Tannenbaum, "Despeckling of Medical Ultrasound Images," IEEE transactions on ultrasonics, ferroelectrics and frequency control, Vol.53, No.1, pp.6478,2006.
[15] FanZhang, YangMoYoo, Liang Mong Koh and Yongmin Kim, "Nonlinear Diffusion in Laplacian Pyramid Domain for Ultrasonic Speckle Oriental Science Publishing Co. India, Reduction," IEEE Transactions On March 03, 2017. Medical Imaging, Vol.26, No.2, pp.200-211,2007.
[16] Jou-Wei Lin, Andrew Laine ans Steve Bergmann, " Improving PET- Based Physiological Quantification Through Methods of Wavelet Denoising ," IEEE Transactions On Biomedical Engineering . Vol 48, No.2.pp.202-212,2001.
[17] Joao Sanches , Jacinto Nascimento, and Jorge Marques,"Medical Image Noise Reduction Using the Sylvester -Lyapunov Equation,"IEEE Transactions On Image Processing, Vol 17, No. 9, pp.1522-1539,2008.
[18] Arviyazhgan, Deiyalakshmi and Kannan, "Performance Analysis of Image Denoising System for different levels of wavelet decomposition," International Journal of Imaging Science and Engineering , Vol.3, 2007.
[19] Aleksandra Pizurica, Wilfried Philips Ignace Lemahieu and Marc Acheroy ," A Versatile Wavelet Domain Noise Filtration Techniques for Medical Imaging ," IEEE TRANS. ON MEDICAL IMAGING, Vol.22, No.3,PP.1-1.8,2002.
[20] Paul Bao and Lei Zhang , "Noise Reduction for Magnetic Resonance Images via Adaptive Miultiscale Products Thresholding, "IEEE TRANSACTIONS ON MEDICAL IMAGING, Vol.22, No.9, pp.1089-1099,2003.
[21] Lei Jiang and WenhuiYang,"Adaptive Magnetic Resonance Image Denoising Using Mixture Model and Wavelet Shrinkage,"Proc. VII the Digital Image Computing: Techniques and Applications , pp.831-838,2003.
[22] YangWang and Haomin Zhou,"Total Variation Wavelet Based Medical Image Denoising," International Journal of Biomedical Imaging, pp.1-6,2006.
[23] Nalin Kumar, Mrs. M Nachamai, "Noise Removal and Filtering used in Medical Images"