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Denoising medical image using level-2 Discrete Wavelet Transform and Bilinear filter

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ABSTRACT

Biomedical imaging focuses on the capture of images for both diagnostic purpose and therapeutic purposes. These technologies utilize radioactive pharmaceuticals (SPECT, PET), x-rays (CT scans), ultrasound, magnetism (MRI), or endoscopy, OCT to assess the current condition of an organ or tissue and can monitor a patient over time over time for diagnostic and treatment assessment. Imaging has become a very important part in diverse fields of medical and laboratory research. Analysis of these different image types requires knowledgeable computerized quantification and visualization tools. Until recently, 3D visualization of images and quantitative observation could only be executed with help of expensive workstations and customized software. Today, much of conceptualizing and inspection can be executed on an inexpensive desktop computer equipped with the appropriate graphics hardware and software. In this review paper, we studied the concept of the Wiener filter and bilinear filter which help in denoising X-ray and MRI images. Besides this also studied about types of images and various domain of filtering, for example, spatial domain and frequency domain which will help in to carry out research. Image quality will be observed using PSNR and MSE parameters.

Keywords— *PSNR, Wavelet, MSE, MRI, Ultrasound, IEF, Medical, Quantization, Pixel, 3D*

1. INTRODUCTION

Computer-aided analysis of medical images was the fruition of much research and attempts in the streams of medical diagnosis and interpretation. It propelled Radiologists and a myriad of healthcare professionals in the direction of accurate diagnosis and assessment of a disease. To achieve optimal diagnosis and accurate image interpretation, medical images are required to be of high resolution. They are also required to be clear and devoid of noise and different interfering artifacts. Substantially large improvement has been achieved in the technologies involving image acquisition and interpretation [1]. While technologies providing high quality and better resolution image bound towards finesse and greater improvement, noise is still a cause of critical concern. Presence of noise in Medical images gives them a blurred, grainy and textured visage. Noise tends to deteriorate image quality resulting in difficulty in Medical diagnosis [2-3]. In some cases, noise even tends to smooth out edge information and other fine details indispensable for assessing diseases. Noise suppression qualifies as a vital step for post-processing. This includes image segmentation and Feature extraction in its ambit.

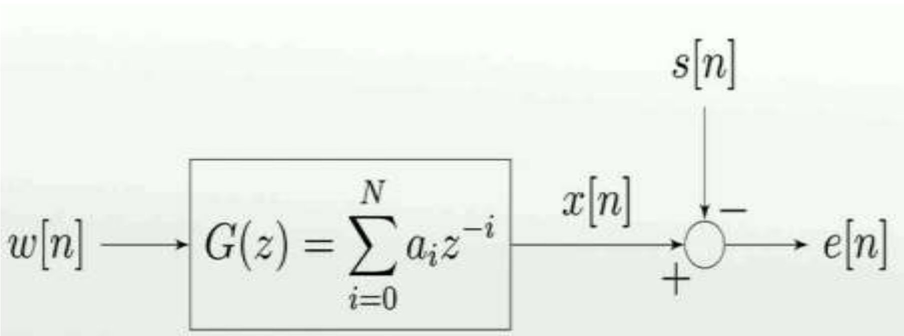

Fig. 1: Weiner filter representation

Due to different factors, noise is inevitably introduced in Medical Images. The noise in medical images tends to deteriorate the quality of the image, suppress the structural details and blur the edges of the image, thus complicating Medical diagnosis [4]. This article focuses on different shrinkage techniques used to de-noise different kinds of medical images. The denoising problem involves the acquisition of an image corrupted by noise and application of an appropriate shrinkage function with an appropriate threshold.

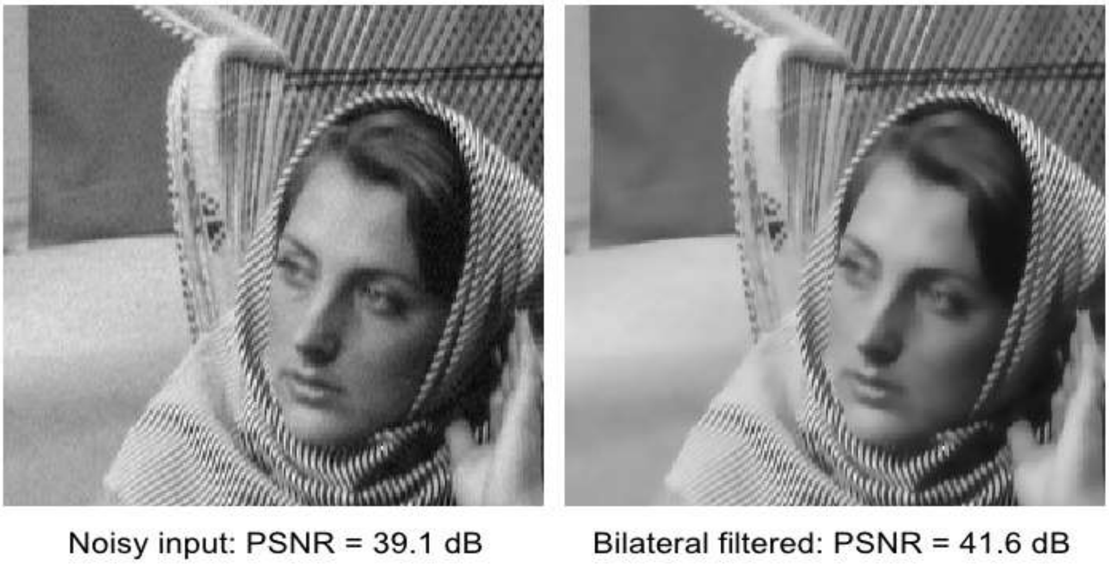

Fig. 2: Bilateral filter impact on image

In our research work, we will use the wiener and bilateral filter to remove noise from the medical image. As we know that there are various types of filter available but each filter is specific to particular types of noise.

2. TYPES OF IMAGE

2.1 Binary Image: A binary image is a digital image that has only two possible values for each pixel. Generally, the two colors used for a binary image are black and white. Binary images are also called two-level because binary means 0 or 1. This means that each pixel is stored as a single bit (0 or 1). A 640×480 image requires 37.5 KB of storage. .Binary images are typically obtained by threshold a gray level image. Pixels with a gray level above the threshold are set to 1, while the rest are set to 0.

2.2 Color Image: Color image is a digital image that includes color information for each pixel. A color image is usually stored in memory as a raster, a two-dimensional array of small integer triplets. There are three channel types which are used in color images and that are:-

- RGB (Red, Green, Blue),
- CMYK (Cyan, Magenta, Yellow, Black)
- HSV (Hue, Saturation, and Value) HSV stores color information in three channels, just like RGB, but, value channel is devoted to brightness and the other two convey color information**.**

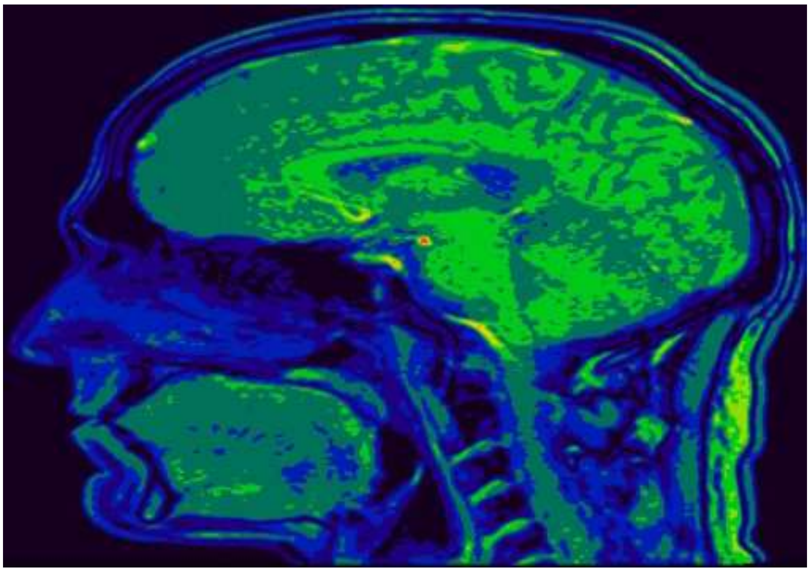

Fig. 3: Color MRI of brain

2.3 Grayscale Image: Grayscale image is formed by converting a color image or RGB image into gray by using a specific command. The lightest shade is white, Intermediate shades of gray are represented by equal brightness levels of the 3 primary colors (RGB) for transmitted light, or equal amounts of the three primary pigments for reflected light. The maximum color depth of the converted grayscale image is 8 bits. Since all three components must be equal for any shade of gray there are only 256 possible combinations [5]. Thus, grayscale images have a maximum color depth of 8bits. A grayscale or grayscale digital image is an image in which the value of each pixel carries only intensity information. Images of this type, also known as black & white are composed exclusively of shades of gray, whose intensity lies in the range of o to 255 or varying from black (0) to white (1). Grayscale images have many shades of gray in between. These images are also known as monochromatic images.

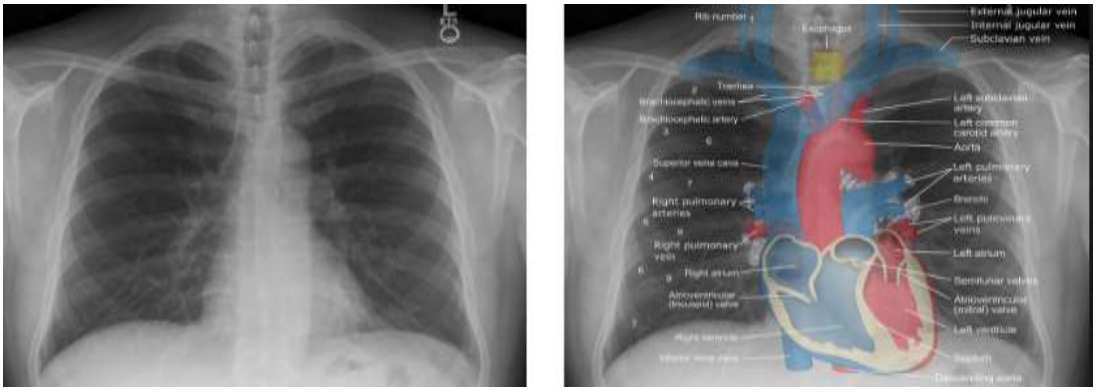

Fig. 4: Gray X-Ray of chest

3. RELATED WORK

Tanay Mondal, Dr. Mausumi Maitra: Proposed Adaptive Two-Pass Median filter. As the name suggests it employs a median filter on the noisy image twice. This adaptive system tries to correct for false replacements generated by the first round of median filtering operation. Based on the estimated distribution of the noise, some pixels changed by the first median filter are replaced by their original values and kept unchanged in the second median filtering. And in the second round, it filters out the remaining impulses. Even though the filter gives some good results in terms of noise suppression but spoiling of good pixels is more and it results in overall poor performance [6]. Sezal Khera and Sheenam Malhotra: Proposed Accurate Noise Detector filter. This filter justifies its name by detecting noise to the perfection. Based on Progressive Switching Median Filter, it generates an edge flag image to classify the pixels of the noisy image into ones in the flat regions and edge regions. The two types of pixels are processed by different noise detector. When noise is the very high prevention of false-detection and non-detection becomes difficult. Therefore, iteration is dedicated for verification of the noise flag image. This scheme exhibits good performance on images not only with low noise density but also with a high percentage of corruption. But all these come at the cost of computational complexity which is very high and not at all suitable for real-time applications [7]. Manyu and Sheng Zheng: Proposed Switching Median filter. This is also a two-stage process, wherein the first stage noise detection is carried out and in the second stage, filtering is done. The noisy image is convolved with a set of convolution kernels. Each of the kernels is sensitive to edges in a different orientation. The minimum absolute value of these four convolutions is used for impulse detection by comparing with a threshold. By varying the size of kernel different variations of SM may be obtained. Three such variations of SM are reviewed here in this paper. Because of its four kernels, it detects noise effectively even in those images where the edge density is more. But when the kernel size increases to 7×7 and 9×9 it fails in doing so. Also, it fails in preserving finer details [8]. Arin H. Hamad et al: Proposed Differential Ranked Impulse Detector. This is another nonlinear technique which also works in two stages. It aims at filtering only corrupted pixels. Identification of such pixels is done by comparing signal samples within a narrow rank window by both rank and absolute value. The first estimate is based on the comparison between the rank of the pixel of interest and rank of the median. The second estimate is based on the brightness value which is analyzed using the median. It is a good filter in low noise conditions but the performance slightly degrades in beyond 20% of noise. It also leaves noise blotch without correcting [9]. J.Mohan, V. Krishnaveni, Yanhui Guo: Proposed Advanced Impulse Detection Based on Pixel-Wise MAD filter. This scheme is based on the modified median of absolute deviation from the median (MAD). MAD is used to estimate the presence of image details. An iterative pixel-wise modification of MAD is used here that provides a reliable removal of impulses. Its performance is more than average and fails when the edge density is more [10].

4. DOMAIN FILTERING

There are many different kinds of image denoising algorithms. They can be broadly classified into two classes:

- Spatial domain filtering
- Transform domain filtering

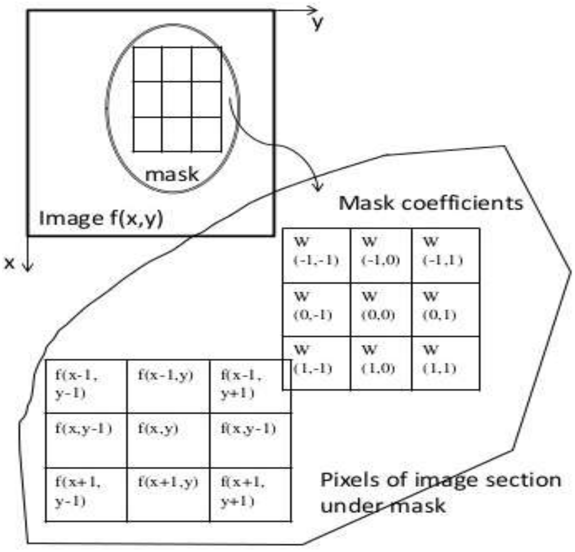

Fig. 5: Spatial domain filtering

As evident from the names, spatial domain filtering refers to filtering in the spatial domain, while transform domain filtering refers to filtering in the transform domain. Image denoising algorithms which use wavelet transforms fall into transform domain filtering.

Spatial domain filtering can be further divided on the basis of the type of filter used:

- Linear filters
- Non-Linear filters

An example of a linear filter is the Wiener filter in the spatial domain. An example of a non-linear filter is the median filter. Median filtering is quite useful in getting rid of Salt and Pepper type noise. Spatial filters tend to cause blurring in the denoised image [11]. Transform domain filters tend to cause Gibbs oscillations in the denoised image. Transform domain filtering can be further divided into broad classes based on the type of transform used:

- Fourier transform filters
- Wavelet transform filters

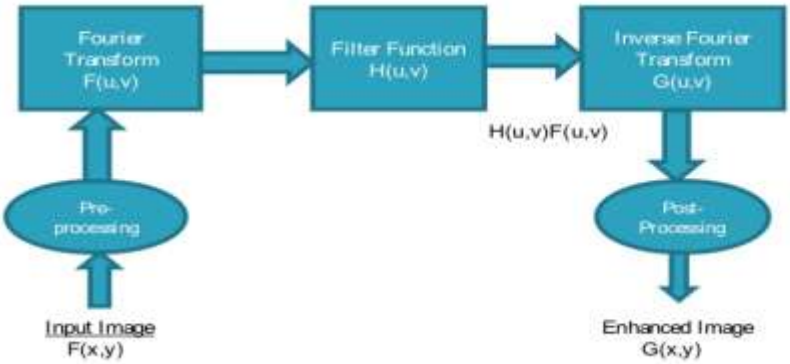

Fig. 6: Frequency domain filtering operation

5. SOFTWARE USED

Software: MATLAB Version R2015a: It is powerful software that provides an environment for numerical computation as well as a graphical display of outputs. In Matlab, the data input is in the ASCII format as well as binary format. It is a high-performance language for technical computing integrates computation, visualization, and programming in a simple way where problems and solutions are expressed in familiar mathematical notation.

- Acquisition, Data Exploration, Analysing &Visualization
- Engineering complex drawing and scientific graphics
- Analysing algorithmic designing
- Mathematical and Computational functions
- Modeling and simulating problems prototyping
- GUI (graphical user interface) building environment.

Using MATLAB, you can solve technical computing problems very easily and time-saving as compared to traditional programming languages, such as C, C++, and FORTRAN.

The name MATLAB stands for matrix laboratory.

Table 1: MATLAB features

MATLAB is a high-level language used for numerical computation, visualization, and application development
It create very friendly environment for iterative exploration, design, and problem solving
Mathematical functions for solving ordinary differential equations, Fourier analysis, linear algebra, statistics, filtering, optimization, numerical integration
Development tools for enhancing code quality and maximizing performance
Tools for building applications with custom graphical interfaces (GUI)
Functions for integrating MATLAB based algorithms with external applications and we can able to generate code in hex file, c, embedded etc.

6. CONCLUSION

In this review paper, our main focus is how to denoise 3D medical image especially X-Ray and MRI image. As we know noise tends to deteriorate image quality resulting in difficulty in Medical diagnosis. In some cases, noise even tends to smooth out edge information and other fine details indispensable for assessing diseases. To analyze the image in an effective way there are many techniques which can be used. We studied various research papers and came to the conclusion that there are many filters available which need to utilize properly to get optimum result. The medical image must be diagnosed properly otherwise it would lead to the worst case. With the momentum of time, huge development occurred in image processing using advanced technology. In our research work, we will use the DWT concept in which image will be transformed from one domain to another domain (frequency domain). Due to this transformation, the image can be processed smoothly and effective result can be obtained. A detailed studied carried out on bilinear filter and Wiener filter which will be used in research work. Image processing is one of the tremendous filed in which research going from past many years. In these days we are more concern toward medical application in which there is huge scope to get many advantageous results.

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