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RESEARCH ARTICLE

Removal of Various Noise Signals from Medical Images Using Wavelet Based Filter & Unsymmetrical Trimmed Median Filter

NARAYAN DEV GUPTA[1], DEVANAND BHONSLE[2]

[1]M. E. Student, Department of Electronics & Telecom, SSCET, CSVTU, Bhilai, India

[1] narayangupta8@gmail.com

[2]Senior Assistant Professor, Department of Electrical & Electronics, SSCET, CSVTU, Bhilai, India

[2] dev786bhonsle@rediffmail.com

Abstract— In science and technology image processing is now a critical component. Development in computerized medical image reconstruction has make medical imaging into one of the most important sub-fields in scientific imaging. The quality of digital medical images becomes an important issue with the use of digital imaging to diagnose a disease. It is necessary that medical image must be clean. Sharp and noise free to obtain a best possible diagnosis. As the technology became advance the quality of digital images continue to improve, the result is an improvement in the resolution and quality of images, removing noise from these images is one of the challenging task because they could blur and mask important parameter of the images. So for researcher's image de-noising still remains a challenge. There are different image de-noising methods each having their own advantages and disadvantages. In most of images additive random noise is assumed which is modelled as a white Gaussian noise. In this paper we are considering the situation when magnetic resonance medical images are affected by mixed noise (that is both the Gaussian and salt and pepper noise).In this paper a new hybrid method is used to remove the mixed noise from the magnetic resonance medical images by combining both the wavelet based filter and unsymmetrical trimmed median filter. The Performance of proposed hybrid method is evaluated in terms of PSNR and MSE.

Keywords— Magnetic Resonance Image De-noising, Dual Tree CWT, Bayesian MMSE Estimator, Unsymmetrical Trimmed Median Filter

I. INTRODUCTION

The digital images impact on modern society is tremendous. The most common medical images that is used for diagnosis is obtained from Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). There are other types of medical images such as ultrasound, angiography, and Positron Emission Tomography (PET). Medical images are often affected by noise because of both image acquisition from the medical modalities and image transmission from modalities to workspace in the main computer system. This noise usually affects the visual quality of the original images so image de-noising always has been issued in the medical image processing. The task of image de-noising is very important in the field of medical image pre-processing. This step take place before image data is to be analyzed. The image obtained is contaminated by different noise. An algorithm that is used for de-noising the image is purely based on the noise model that we consider.

In the field of image processing, linear filters tend to blur the edges which results in loss of information and do not remove Gaussian and salt and pepper noise effectively. These noises affect the medical images which result in incorrect diagnosis. Gaussian noise is an additive noise, which degenerates image quality that arises from many microscopic diffused reflections leads to discriminate fine detail of the images in diagnostic examinations [9]. Thus, de-noising these noises from a noisy image has become the most important step in medical image processing.

II. Dual Tree CWT Based Image De-noising

The wavelet which provides time and frequency localization simultaneously is the major advantage over other transforms [13]. Moreover, wavelet methods characterize such signals much more efficiently than either the original domain or transforms with global basis elements such as the Fourier transform. To model speech, music, video and non-stationary stochastic signals wavelet can be used. It can also be used for image compression, turbulence, human vision, radar, earthquake prediction; etc. It involves basically three steps

- A linear forward wavelet transforms.
- Nonlinear thresholding step.
- A linear inverse wavelet transforms.

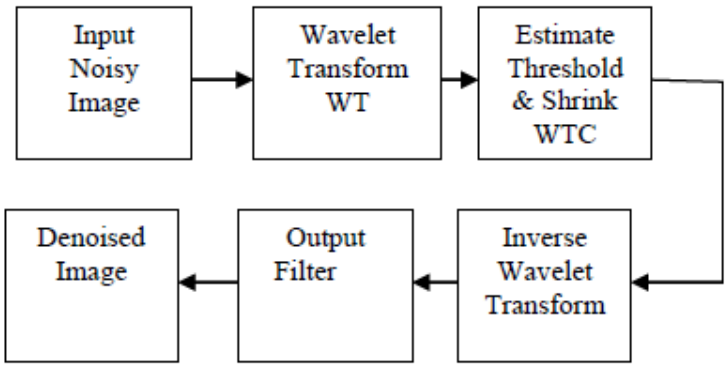


Fig. 1 Block diagram of Image de-noising using Wavelet Transform

The shift-invariance property does not exist in the wavelet transform and it also does a poor job in distinguishing orientation in multiple directions which is the most essential in the case of image processing. For above mentioned reasons, to get some application refinement, the separable discrete wavelet transform is substituted by Dual Tree complex wavelet transform. As it is difficult to implement complex filters which possess ultimate reconstruction property, Complex wavelets have not been used widely in image processing. To overcome this, Kingsbury implemented a Dual Tree implementation of the complex wavelet transform. These redundant transforms included two conventional discrete wavelet transform filter bank trees working in parallel with respective filters of both the trees in approximate quadrature. The basic principle of implementation of filter bank structure of Dual tree complex wavelet transform is to design the filter coefficients differently. DT CWTs gives us phase information; they are shift-invariant with improved directionality. The complex wavelet transform decomposes an image into a pyramid of complex sub images with each level containing six oriented sub images resulting from evenly spaced

directional filtering and sub-sampling, we cannot design such directional filters by using a separable discrete wavelet transform using a real filter pair but complex coefficients makes this selectivity possible[4].

III. Bayesian MMSE error estimator

Bayesian approximation is a method for the designing of statistical inference problems. In the prediction or approximation of a random process from a related observation signal, the Bayesian approach is depend on combining the evidence contained in the signal with prior information of the probability distribution of the process. Bayesian technique comprises of the classical estimators such as maximum a posteriori (MAP), maximum-likelihood (ML), minimum mean square error (MMSE) and minimum mean absolute value of error (MAVE) as special cases. The hidden Markov model, frequently used in statistical signal processing, is an example of a Bayesian model. Bayesian inference is based on reduction of the so-called Bayes' risk function, which incorporates a posterior model of the unknown parameters given the observation and a cost-of-error function. Place classifier error estimation into the framework of optimal mean-square error (MSE) signal estimation in the presence of uncertainty, which results in a Bayesian approach to error estimation based on a parameterized family of feature-label distributions with the prior distribution of the parameters governing the choice of feature-label distribution[15].

IV. Unsymmetrical Trimmed Median Filter

The designing of trimmed filter can be considered as a filter which will reject the noisy pixel from the selected 3 3window.In the case of Alpha Trimmed Mean Filtering (ATMF) it can be considered as a symmetrical filter where the trimming is symmetric at either end. In this procedure, even the uncorrupted pixels are also trimmed. This results in loss of different parameter of image and blurring of the image. To solve the above problem, an Unsymmetrical Trimmed Median Filter (UTMF) is implemented. In unsymmetrical trimmed median filter, the adopted 3 3 window elements are ordered in either increasing or decreasing order. Then the pixel values 0's and 255's in the image (i.e., the pixel values responsible for the salt and pepper noise) are eliminated from the image [1]. Then the median value of the remaining pixels is taken. This median value is used to replace the altered pixel. This filter is called trimmed median filter because the pixel values 0's and 255's are eliminated from the selected window. This technique eliminates noise in much better way than the ATMF.

V. Proposed Methodology

In the proposed work, two methods namely, dual tree discrete wavelet transforms and unsymmetrical trimmed median filters are combined to form a hybrid de-noising model. These techniques are used to remove the mixed noise (Gaussian and salt and pepper noise). The medical images taken are corrupted with two different types of noises. We will take a magnetic resonance medical image. Gray scale conversion of the image is performed. Gray scale conversion is done in order to make a single page matrix for processing of data through digital filter structure and then the intensity values in a gray scale image are equalized through Histogram Equalization. Now noise is added to the image. Here two different types of noise are added to the image that is Gaussian noise and salt and pepper noise. When addition of noise is completed then we will apply dual tree discrete wavelet transform and then unsymmetrical trimmed median filtering and try to get de-noised medical image. The figure 2 shows the proposed method for de-noising mixed noise in medical domain. Bayesian error estimator is used to find the optimal threshold which reduces noise from the medical image. These Bayesian error estimators are optimal when averaged over a given family of distributions, unbiased when averaged over a given family and all samples, and analytically address a trade-off between robustness and accuracy.

1. Gaussian and salt and pepper noise are added.
2. Perform decomposition of image by Applying forward dual tree discrete wavelet transform to noisy medical image.
3. Compute thresholding of corresponding level using Bayesian MMSE Estimator.
4. To reconstruct the image perform inverse dual tree discrete wavelet transform to decomposed image.
5. The de-noised medical image obtained from wavelet method is again processed for removing salt and pepper noise.
6. Image obtained from step 4 is applied to unsymmetrical trimmed median filter.
7. Now we get de-noised medical image.

Figure 2.Proposed methods for de-noising mixed noise in medical images

The advantage of wavelet de-noising is possible to remove the noise with little loss of details. The wavelet mode de-noises only the Gaussian type of noise. So when multiple noise present in the image it will remove only Gaussian the remaining noise are still present in the image. So for removing the remaining noise and to preserve the fine details UTMF filter is applied.

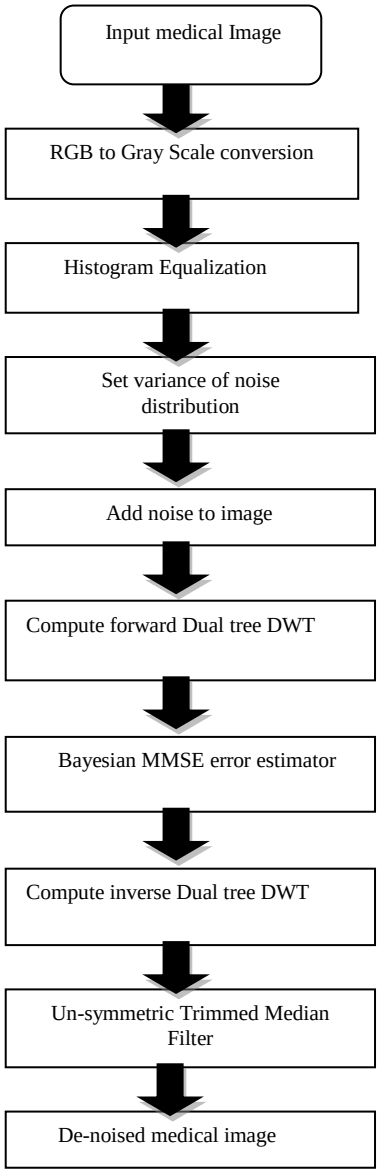


Figure3. Flowchart of proposed hybrid model.

VI. PERFORMANCE PARAMETER

To judge the performance of the de-noising techniques Mean Squared Error and Peak Signal to Noise Ratio are the automatic choice for the researchers. PSNR is a popular way to measure the image quality in image processing field. The MSE represents the cumulative squared error between the de-noised and the original image, whereas PSNR represents a measure of the peak error. MSE may be defined by

$$\text{MSE} = \frac{1}{M} \sum_{i=1}^{M} (g_i - f_i)^2$$

Where $f = \{f_i | i = 1, 2 \ldots M\}$ is original image and $g = \{g_i | i=1, 2, \ldots, M\}$ is de-noised image.

The PSNR has been computed using the following formula

$$PSNR = 10 \log10 (R^2/MSE)$$

R is the maximum fluctuation in the input image data type.

VII. EXPERIMENTAL RESULTS

The proposed image de-noising algorithm has been tested on magnetic resonance medical images (512×512) that are contaminated by additive Gaussian noise and salt and pepper noise. The implementation of this work is performed in MATLAB 7.8 software. Performance measure is shown in the Table 1.The PSNR, MSE value is calculated for different value of noise variance and accordingly de-noised image is shown in fig.4.

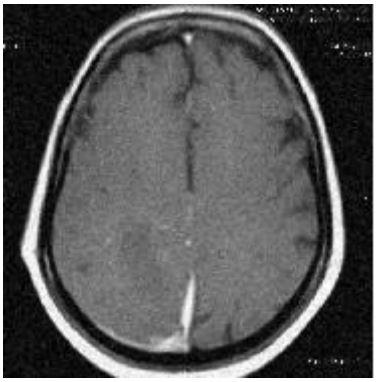
Table1. Performance Measure

Noise variance	PSNR(db)	MSE
0.01	33.0	32.1
0.05	30.11	63.39
0.10	29.58	71.50
0.15	29.69	69.78

Noisy Medical Image
(Gaussian and Salt and Pepper)

De-noised Medical Image using proposed method

Noise Variance=0.01



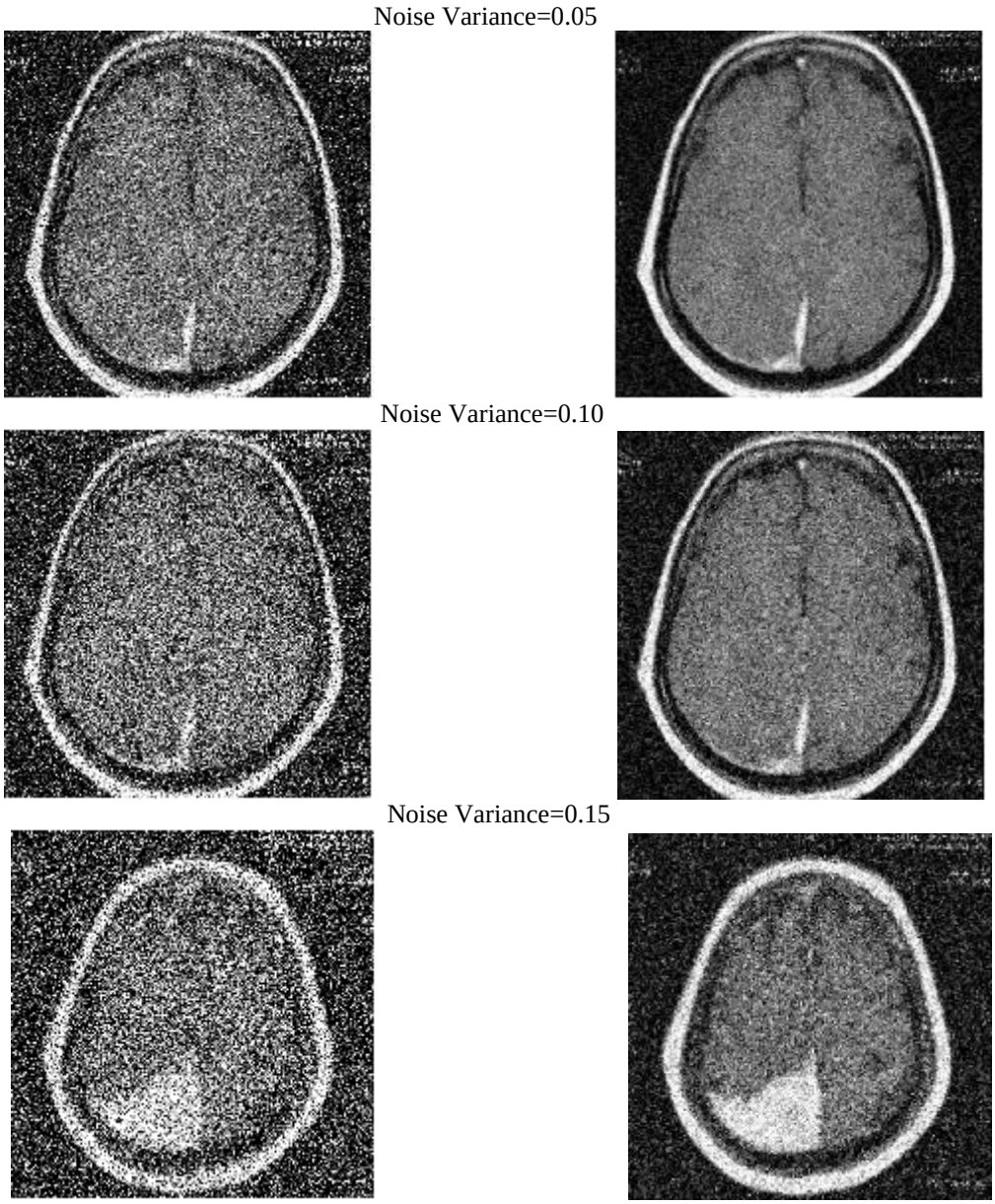


Fig.4. various de-noised MR images using proposed method

VIII. CONCLUSIONS

In this paper a new hybrid method is proposed by combining the wavelet based principle and unsymmetrical trimmed median filter approach for de-noising the magnetic resonance medical image corrupted by mixed noise (Gaussian and salt and pepper noise). The performance of proposed algorithm is tested at different noise level and evaluated in terms of PSNR, MSE. The proposed algorithm gives us better noise removal of mixed noise on the basis of PSNR and MSE.

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