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# An Efficient Image De-Noising Gaussian Noise Using Improved Anisodiffusion Filter with DWT in Medical Images

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**ABSTRACT:** Image de-noising continues to be an active research topic. Although state-of-the-art de-noising methods are numerically impressive and approach theoretical limits, they suffer from visible artifacts. However, the images obtained from medical imaging techniques (MRI, Ultrasound, CT etc.,) often include imaging noises. Therefore de-noising is an essential and used as a preprocessing process to remove their noises before extracting some meaningful information from these images. In this paper presents an efficient de-noising technique based on Anisodiffusion filter with Discrete Wavelet Transform (DWT) is developed. This proposed method enhances the edges in the de-noised image. The proposed method is tested with MRI, Ultrasound, and CT scan medical images. The performance of this method is compared with the existing standard filters and it has produced good result

**KEYWORDS**: Image de-noise; DWT; Anisodiffusion filter; Gradient;

## I. Introduction

Medical imaging is one of the technique and process of creating visual representations of the interior of a body for clinical analysis and visual representation of internal structures of human organs [1].There are many imaging techniques available today, among them Magnetic Resonance Imaging (MRI), Ultrasound, Elastography and Computer Tomography (CT) are most widely used imaging techniques. Magnetic Resonance Imaging (MRI) uses most powerful magnets to polarize and excite hydrogen nuclei of water molecules in human tissue, producing a detectable signal which is spatially encoded, resulting in images of the body. Medical ultrasonography is useful for high frequency broadband sound waves in the megahertz range that are reflected by tissue to varying degrees to produce 2D and 3D images. Ultrasound is used for imaging the abdominal organs, heart, breast, muscles, tendons, arteries and veins.

Elastography is one of the relatively new imaging modality that maps the elastic properties of soft tissue. Elastography is useful in medical diagnoses, as elasticity can discern healthy from unhealthy tissue for specific organs and growth. Computed Tomography (CT) scan, produces 2D image of the structures in a thin section of the body. In CT, a beam of X-rays spins around an object being examined and is picked up by sensitive radiation detectors after having penetrated the object from multiple angles. A computer then analyses the information received from the scanner’s detectors and constructs a detailed image of the object. However the images produced by these image sources are sensitive to image noise and thus degrade the quality of the image.

Noise is any degradation of the image signal caused by external disturbance [2]. Usually the medical images, are affected by noises due to the disturbance in the imaging process and inclusion of imaging artifacts. These image noises are classified as Amplifier noise (Gaussian noise), Salt-and-pepper noise (Impulse noise), Shot noise, Quantization noise (uniform noise), Film grain noise, Speckle noise (Multiplicative noise) and Periodic noise. Gaussian is an idealized form of white noise, which is caused by random fluctuations in the signal [3]. In Gaussian noise, each pixel of the image will be changed from its original value by a small amount. There are many standard filters are available in the literature to remove the noises form the medical images. The standard Median Filter (MF) is effective filter but works better only at low noise densities [4], that is, if the noise level is above 50%, edge details of original image cannot be preserved by the standard median filter. Similarly, Adaptive Median Filter (AMF) works well at low noise densities [5], but in high level noise the window size has to be increased which leads to produce blurring effect in the image. Also these filters will not take into account the local features, as an outcome of which the edges may not recovered satisfactorily.

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The rest of the paper is organized as follows: Related is detailed in Sect. 2. In Sect. 3, Proposed Methodology and the conclusion are in Sect. 5.

## II. RELATED WORK

In [3] authors discussed most of the rules relating simple nonlinear threshold values for wavelet-based de-noising have assumptions that the wavelet coefficients are independent values. However, when we talk of natural images, we observe that wavelet coefficients have significant dependency. The phrase Peak Signal to Noise Ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupted noise that affects the fidelity of its representation. In this paper, experimentation is performed to study the effect of Increasing Gaussian noise on PSNR and the corresponding measure. In [5] authors illustrated on two types of image models corrupted by impulse noise, we propose two new algorithms for adaptive median filters. They have variable window size for removal of impulses while preserving sharpness. The first one, called the ranked-order based adaptive median filter (RAMF), is based on a test for the presence of impulses in the center pixel itself followed by a test for the presence of residual impulses in the median filter output. The second one, called the impulse size based adaptive median filter (SAMF), is based on the detection of the size of the impulse. In [6] authors proposed a new definition of scale-space is suggested, and a class of algorithms used to realize a diffusion process is introduced. The diffusion coefficient is chosen to vary spatially in such a way as to encourage intraregional smoothing rather than inter region smoothing. It is shown that the 'no new maxima should be generated at coarse scales' property of conventional scale space is preserved. As the region boundaries in the approach remain sharp, a high-quality edge detector which successfully exploits global information is obtained. In [7] authors discussed a image restoration based on the “mean curvature motion” equation. Existence and uniqueness of the “viscosity” solution of the equation are proved, a stable algorithm is given, experimental results are shown, and the subjacent vision model is compared with those introduced recently by several vision researchers. The algorithm presented appears to be the sharpest possible among the multi-scale image smoothing methods preserving uniqueness and stability.

## III. PROPOSED ALGORITHM

The proposed method accepts the image De-noising for Gaussian Noise in Medical Images parameters as input which contains the MATLAB simulation where the improved Anis diffusion Filter with DWT coding based image de-noising algorithm is applied to the noisy image databases. This overall proposed architecture in figure 1 follows a de-noising process flow from the beginning to end state.

### A. *Image preprocessing*

MATLAB plays a vital role in Image Processing in order to develop the quality of image. MATLAB is a high-level language and interactive environment for computation of numbers, visualization, and programming. Data can be analysed, algorithms can be developed and models and applications can be created using MATLAB.

The main goal of the pre-processing is to improve the image quality to make it ready to further processing by removing or reducing the unrelated and surplus parts in the background of the medical images are CT and MRI images that complicated to interpret. Hence pre-processing is essential to improve the quality. It will prepare the mammogram for the next two- process segmentation and feature extraction. The noise and high frequency components removed by filters.

### B. *Gaussian noise*

Gaussian noise is one of the statistical noise having a probability density function (PDF) equal to that of the normal distribution, which is also known as the Gaussian distribution.

The probability density function p of a Gaussian random variable z is given by

$$PG^{(z)} = \frac{1}{\partial\sqrt{2\pi}} e^{-\frac{(z-\mu^2}{2\partial^2}} \quad \text{eqn. (1)}$$

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where, z represents the grey level, $\mu$ the mean value and $\sigma$ the standard deviation.

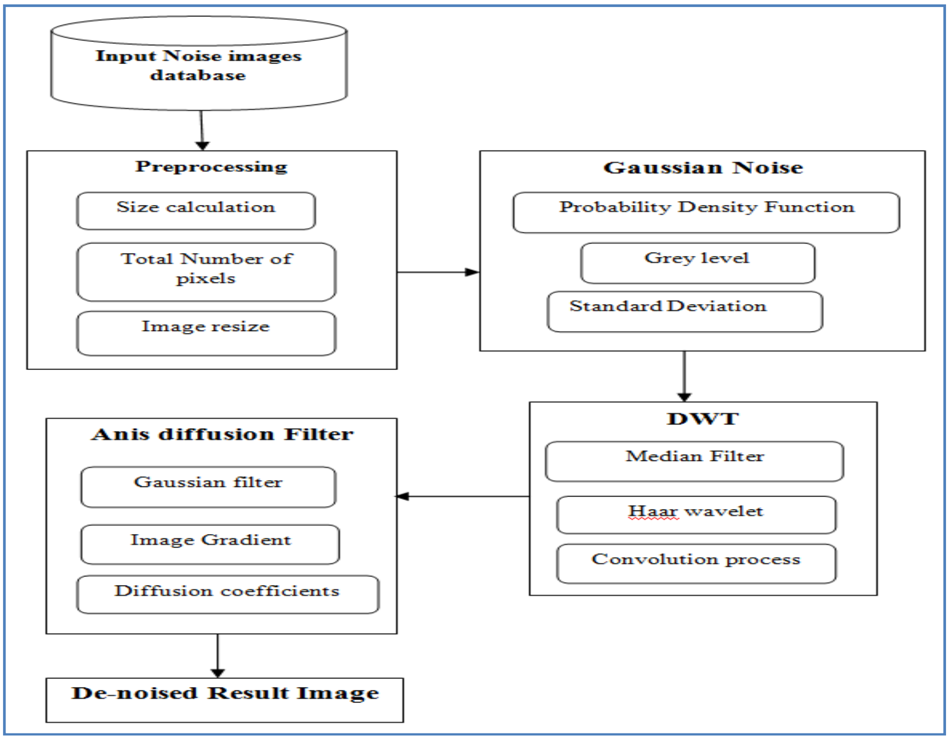


Fig.1. Proposed Framework flow diagram

C. *Discrete Wavelet Transform (DWT)*

The Discrete Wavelet Transform (DWT) of image signals produces a non-redundant image representation, which provides better spatial and spectral localization of image formation, compared with other multi scale representations such as Gaussian and Laplacian pyramid. The DWT can be interpreted as signal decomposition in a set of independent, spatially oriented frequency channels. The signal S is passed through two complementary filters and emerges as two signals, approximation and Details. This is called decomposition or analysis. The components can be assembled back into the original signal without loss of information. This process is called reconstruction or synthesis.

The mathematical manipulation, which implies analysis and synthesis, is called discrete wavelet transform and inverse discrete wavelet transform. An image can be decomposed into a sequence of different spatial resolution images using DWT. In case of a 2D image, an N level decomposition can be performed resulting in 3N+1 different frequency bands namely, LL, LH, HL and HH.

D. *Anisotropic Diffusion Filter*

Anisotropic diffusion, also called Perona-Malik diffusion is a technique to reduce image noise without removing significant parts of the image content, such as edges, lines or other details, which are important to the interpretation of the image. Anisotropic diffusion resembles the process that creates a scale space, where an image generates a parameterized family of successively more and more blurred images based on a diffusion process. Each of the images

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resulting in this family is given as a convolution between the image and a 2D isotropic Gaussian filter, where the width of the filter increases with the parameter. This diffusion process is a linear and space-invariant transformation of the original image. Anisotropic diffusion is normally implemented, by means of an approximation of the generalized diffusion equation.

Formally, let $\Omega \subset R^2$ denote subset of the plane and I(. , $t$): $\Omega \rightarrow$ R be a family of gray scale images, then anisotropic diffusion is given by:

$$\frac{\partial I}{\partial t} = div\ c(x, y, t\ \nabla I = \nabla c.\nabla I + c(x, y, t, \nabla I) \quad \text{eqn. (2)}$$

where, $\nabla$ denotes the Laplacian, $\nabla$ denotes the gradient, div-(...) is the divergence operator and c(x, y, t) is the diffusion coefficient and it controls the rate of diffusion, usually chosen as a function of the image gradient so as to preserve edges in the image.

Though the Anisodiffusion filter with DWT is an edge preserving filter when it is used as a preprocessing procedure for image segmentation and analysis, the preserved edge details are not enough for accurate segmentation of individual objects present in the images, especially for medical images. Therefore, in this proposed method the edge details are added to the noisy image before applying the de-noising procedure based on the Anisodiffusion filter.

## IV. Conclusion and Future Work

In this paper presents a novel image de-noising process using Anis diffusion Filter with DWT coding on medical images to remove the Gaussian noise present in images by preserving the edges. This proposed method is tested with MRI, CT scan and Ultrasound medical images. The performance of this method is also compared with the standard filters, Mean filter, Median filter, Linear filter, Adaptive filter, Gaussian filter, Unsharp filter, Sobel filter. Presently, we have de-noised only the Gaussian noise in the medical images, in future it may be modified to eliminate all types of noises in medical images.

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