



A Review on Image Denoising Using Modified Bayes Thresholding

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Abstract: In this Paper we are going to have review on the recent work done on image de-noising. Image de-noising is one of the most essential tasks in image processing for better analysis and vision. Datasets collected by image sensors are generally contaminated by noise. Furthermore, noise can be introduced by transmission errors and compression. Thus, de-noising is the first steps to be taken to compensate such data corruption. Image de-noising still remains a challenge for researchers because noise removal introduces artifacts and causes blurring of the images. In this Paper we take a review on de-noising of speckle noise introduced in ultrasound image and hence assessing the quality of de-noising by evaluating SNR value of de-noised image.

Keywords: Digital image processing, Multi focus image fusion, DCT, DWT.

Introduction

Digital images play an important role both in daily life applications such as satellite television, magnetic resonance imaging, and computed tomography as well as in areas of research and technology such as geographical information systems and astronomy. Datasets collected by image sensors are generally contaminated by noise. Furthermore, noise can be introduced by transmission errors and compression [1]. Thus, de-noising is often a necessary and the first steps to be taken apply an efficient de-noising technique to compensate or such data corruption. Image de-noising still remains a challenge for researchers because noise removal introduces artifacts and causes blurring of the images. Image De-noising is used to produce good estimates of the original image from noise observations. The restored image should contain less noise than the observations while still keep sharp transitions (i.e. edges). Suppose an image $f(m, n)$ is corrupted by the additive noise [2]. Then,

$$g(m, n) = f(m, n) + \eta(m, n) \quad (1)$$

Where $\eta(m, n)$ are independent identically distributed Gaussian random variable with zero mean and variance σ^2 . Image de-noising is one of the most essential tasks in image processing for better analysis and vision. There are many types of noise which can decrease the quality of images. The Speckle noise which can be modelled as multiplicative noise, mainly occurs in various imaging system due to random variation of the pixel values. It can be defined as the multiplication of random values with the pixel values. Mathematically this noise is modelled as [3]:

$$\text{Speckle noise} = I * (1 + N) \quad (2)$$

Where 'I' is the original image matrix and 'N' is the noise, which is mainly a normal distribution with mean equal to zero.

Speckle noise is a multiplicative noise. This type of noise occurs in almost all coherent imaging systems such as laser, acoustics and SAR (Synthetic Aperture Radar) imagery. The source of this noise is attributed to random interference between the coherent returns.

Fully developed speckle noise has the characteristic of multiplicative noise. Speckle noise follows a gamma distribution and is given as

$$F(g) = \frac{g^{\alpha-1}}{(\alpha-1)! \alpha^\alpha} e^{-\frac{g}{\alpha}}$$

(3)

Where variance is α^α and g is the grey level.

In 2012, Afandi Ahmad et.al presented an efficient analysis of DWT thresholding algorithm for medical image de-noising [4]. This research work proposes an effective exploration centered on subjective and objective experiment for filtering techniques of the non-linear adaptive thresholding domain within discrete wavelet transform. The objective experiment shows thresholding design's performance on de-noising course with respect to signal to noise ratio i.e. SNR. Then visual outcomes been measured with a review of image specialists for a de-noised image then produces the data for subjective experiment with respect to mean opinion score i.e. MOS. This research work succeeded to give a new thresholding technique which reveals better performance with respect to SNR and visual outcome entitled as hybrid estimated threshold (HET). It exposes that HET is the finest filtering technique to eliminate the Salt & Pepper, Gaussians, and Speckle noise.

In 2014, HaryaliDhillon, Kaur et.al. Presented a research paper introducing a new threshold technique for de-speckling ultrasound images [5]. Ultrasound images are despoiled as they hold speckle noise. Lately image de-noising using the wavelet transform has been enticing much consideration. The research work in this paper comprises different filtering methods likewise Wiener and Median and a proposed novel method that outspreads the conventional methods with respect to signal to mean square error by refining the threshold parameter function K which yields outcomes that are centred on diverse noise levels.

Bayes Thresholding

BayesShrink was proposed by Chang, Yu and Vetterli [6]. The objective of this technique is to minimize the Bayesian risk, and therefore named as BayesShrink. It uses soft thresholding and is subband-dependent, which meant that thresholding in the wavelet decomposition is done at each subband of resolution. The Bayes threshold, t_B is demarcated as

$$t_B = \sigma^2 / \sigma_s^2 \quad (4)$$

Where noise variance is denoted by σ^2 and the signal variance without noise by σ_s^2 . The noise variance σ^2 is assessed from the subband HH1 by the median estimator as shown in Equation (4). Additive noise we have

$$w(x, y) = s(x, y) + n(x, y) \quad (5)$$

Since the noise and the signal are sovereign of each other, it can be specified as

$$\sigma_w^2 = \sigma_s^2 + \sigma^2 \quad (6)$$

σ_w^2 can be computed as

$$\sigma_w^2 = \frac{1}{n^2} \sum_{x,y=1}^n w^2(x, y) \quad (7)$$

The signal variance σ_s^2 is computed as

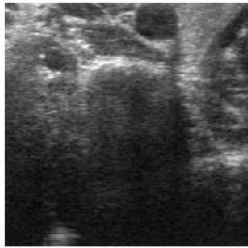
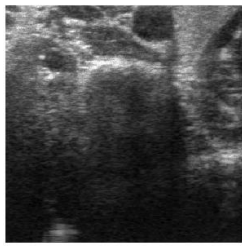
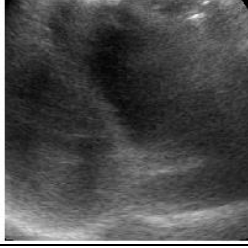
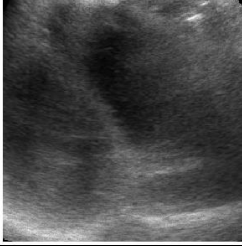
$$\sigma_s = \sqrt{\max(\sigma_w^2 - \sigma^2, 0)} \quad (8)$$

With σ^2 and σ_s^2 , the Bayes threshold is computed from Equation (8). Using this threshold, the wavelet coefficients are thresholded at each band. Matlab 8.1 [7] is used for the implementation of BayesShrink.

Simulation Results

Below table shows the reviewed results taken for denoising done on speckle noise for an ultra-sound image of stomach, neck and chest at different standard deviations ($\sigma = 0.0983, 0.0815, 0.0875$) respectively. The quality assessment of denoised image for bayes thresholding is been evaluated by SNR in dB as shown in below Table 1.

Table 1: SNR of denoised image with Bayes Thresholding [4].

Original Image	Speckle Denoised Image(SNR dB)
	
Stomach ($\sigma = 0.0983$)	16.18
	
Neck ($\sigma = 0.0875$)	18.04
	
Chest($\sigma = 0.0815$)	19.49

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