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Comparative analysis on Speckle noise reduction techniques on computed tomographic images

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ABSTRACT

Reduction of speckle noise is one of the most important processes to increase the quality of computed topographic images. Image variances or speckle is a granular noise that inherently exists in and degrades the quality of CT images. Before using CT images for diagnosis purpose, the very first step is to reduce the effect of Speckle noise. Most of speckle reduction techniques have been studied by researchers; however, there is no comprehensive method that takes all the constraints into consideration. Filtering is one of the common method which is used to reduce the speckle noises. This paper compares different speckle reduction filters and presents the performance analysis for reducing speckle noise in computed topographic images in terms of the assessment parameters PSNR and MSE.

Key words: Computed Tomography images, Speckle Noise, mean filter, map filter, median filter, PSNR, MSE.

INTRODUCTION

Unlike many other imaging applications, where the quality of the de-noised image is estimated by how pleasant visual interceptions it gives to the human eye, medical applications require some constraints, for example the generation of artifact that could be misinterpreted as clinically interesting features. To achieve the best possible diagnoses it is important that medical images be sharp, clear, and free of noise and artifacts. While the technologies for acquiring digital medical images continue to improve, resulting in images of higher and higher resolution and quality, noise remains an issue for many medical images. Removing noise in these images remains one of the major challenges in the study of medical imaging. This paper stresses the importance of such situations and devises some requirements that should be met in order to be of better assistance in real clinical analysis. Generally speaking there are two techniques of removing/ reducing speckle noise, i.e., multi-look process and spatial filtering. Multi-look process is used at the data acquisition stage while spatial filtering is used after the data is stored. No matter which method is used to reduce/remove the Speckle noise, they should preserve radiometric information, edge information and last but not least, spatial resolution. These are the conditions that any speckle noise reduction technique should meet. Here, spatial filtering techniques are used to de-speckle computed topographic images.

Speckle noise and its reduction

Speckle is not a noise in an image but noise-like variation in contrast. It arises from random variations in the strength of the backscattered waves from objects and is seen mostly in medical imaging. Speckle reduction of medical ultrasound images represents a critical pre-processing step, providing clinicians with enhanced diagnostic ability.

´ Speckle noise is the characteristic seen in computed topographic images that contribute to the visual noise.

´ Some filtering techniques are applied to speckle noised image

Speckle filtering

Speckle filtering consists of moving a kernel over each pixel in the image and applying a mathematical calculation using the pixel values under the kernel and replacing the central pixel with the calculated value. The kernel is moved along the image one pixel at a time until the entire image has been covered. By applying the filter a smoothing effect is achieved and the visual appearance of the speckle is reduced.

Maximum a Posteriori filter

Maximum a Posteriori filter uses a maximum likelihood probability approach to estimate the true signal value for the center cell in the filter window. The MAP filter assumes that speckle noise has a negative exponential distribution, and maximizes a probability function involving the center cell value, the local mean and standard deviation,

Fig. 1: Slice of cerebellum

Fig. 2: Weiner filtered image

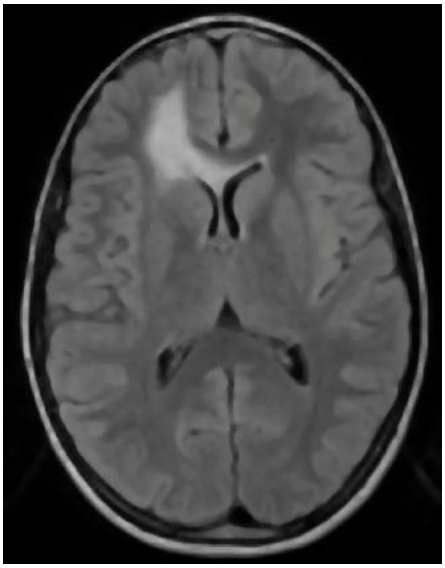

Fig. 3: Median filtered image

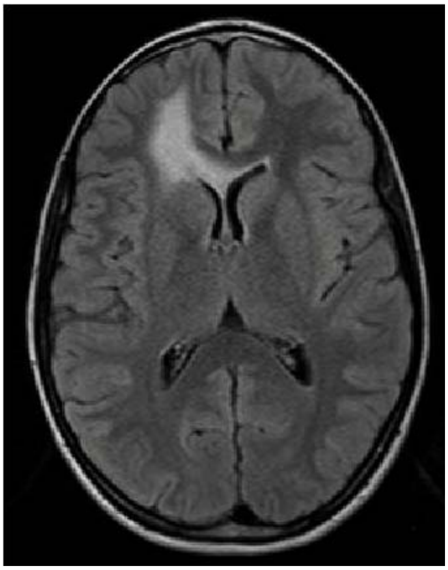

Fig. 4: MAP filtered image

and the noise standard deviation (assumed constant for the entire image).

Median filter

It is defined as the median of all pixels within a local region of an image. It performs much better than arithmetic mean filter in removing salt and pepper noise from an image and in preserving the spatial details contained within the image. This method is particularly effective when the noise pattern consists of strong, spike like components and the characteristic to be preserved is edge sharpness.

Weiner filter

Using deconvwnr function to despeckle an image using the Wiener filter. Wiener deconvolution can be used effectively when the frequency characteristics of the image and additive noise are known, to at least some degree.

Estimation of statistical parameters

The parameters which are used in the filter performance evaluation are Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR).

MSE

Mean square error (MSE) is given by:

$$MSE=\sum_{I=j=1}^{N}[f(i,j)-F(i,j)]^2/N^2$$

Where, f is the original image F is the filtered image and N is the size of image. MSE is an estimator in many ways to quantify the amount by which a filtered/noisy image differs from noiseless image

PSNR

PSNR is the ratio between possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. PSNR in decibels is easily defined from RMSE as given below

PSNR = 20 log10 (255/RMSE)
Higher PSNR value provides higher image quality.

Numerical results

Slice of Cerebellum	Speckle technique reduction	PSNR	MSE
	Median filter	35.88	16.78
	MAP filter	26.81	135.44
	Weiner filter	26.13	158.32

CONCLUSION

From this paper it is reviewed that higher the PSNR value and minimum the MSE; filter is better. From these de-speckling techniques, it is seen that Median filter is better compared to other two filters.

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