



Medical Image Denoising: A Brief Insight

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Abstract

As the number of pixels increases per unit area, the image acquisition devices are becoming more prone to noise. This elimination of these noisy pixels become more significant especially in the medical imaging as the prevalence of noise can lead to delayed and false diagnosis. In this letter, we briefly highlight the various methods and importance of image denoising in radiology.

Keywords: Medical Imaging; Image Denoising; Radiology; Transform Domain; Spatial Domain

Medical scans have become indispensable for medical practitioners for planning different surgical procedures. The various abnormalities which are revealed by the images of different organs of the body are localized with the help of such imaging modalities. The accurate and precise diagnose of an ailment is underpinning of an effective medical aid. For this the medical society relies majorly upon the different types of radiographic scans which help in the diagnosis, enactment and handling of a particular disease.

The different types of medical scans are, MRI (Magnetic Resonance Imaging), CT (Computed Tomography), PET (Positron Emission Tomography), SPECT (Single Photon Emission Tomography), X-Ray, Ultrasound, and DSA (Digital Subtraction Angiography) [1]. These imaging modalities help in the assessment of various organs of the body like brain, lungs, stomach, soft tissues, bone, teeth, breast and blood vessels. These medical scans are often prone to noise during image acquisition via various medical scanners. For instance MR images are often corrupted with Gaussian and Rician noise and CT and SPECT are corrupted with speckle noise. The prevalence of noise often interferes with the visual perception of these radiographic scans. The noise pixels disguise the visual analysis and leads to false diagnosis.

Hence the removal of the noise in medical imaging is of utmost importance to ensure precise and accurate diagnosis. Pertaining to this image denoising has become a vital dispensation in the case of medical image processing. The interface of the signal analysis theory and technological advancements in the hardware implementation has made it possible to design highly effective and sophisticated image denoising algorithms. Image denoising is a method of constructing a plausible estimate of the original image from the distorted image while preserving as many feature details as possible. The process of removal of noise can be majorly carried out in three domains: spatial domain, transform domain, and dic-

tionary learning methods [2]. In spatial domain methods mathematical operators or imaging masks are directly employed on the image matrix. Some of the most representative spatial domain methods for image denoising are Gaussian Filter, SUSAN Filter, Non-local mean filter, Bilateral Filter, Trained Filters and Bitonic Filtering. These filters strive to maintain a trade off between removal of noise and over smoothing of edge information [3].

In transform domain methods the image pixels are mapped into the corresponding transform before carrying out any operation on them. In image denoising in transform domain first the image is decomposed with help of a transform for instance the Wavelet transform. The imaging coefficients so obtained are thresholded with the help of hard thresholding or soft thresholding. Then these coefficients are inversed transformed to obtain the denoised image. The evolution of Wavelet transform in the image processing was a major breakthrough. However the wavelet transform was not able to work well of 2-D discontinuities on edges and curves. Since then many improvisations in transforms like Ridgelet, Curvelet, Ripplet and Tetrolet have been developed and deployed in the process of image denoising. These days the NSST (non-sub sampled shearlet transform) is readily employed and seems to have given optimum results in case of image denoising due to its property of shift invariance. The transform domain methods are more computationally effective than spatial domain methods as the convolution process is replaced by multiplication process in the transform domain. Some of the readily employed dictionary methods in image denoising are K-SVD and LSSC.

The spatial domain methods are computationally complex as they involve the convolution process and dictionary methods require the exhaustive input of source data sets to design trained data sets. However it has been found that the focus of the research-

ers is rapidly shifting towards hybrid methods which harness the attributes of both spatial and transform domain methods. For instance in DDID [4] (Dual Domain Image denoising), bilateral filtering and wavelet shrinkage are used in combination to obtain efficient image denoising and preservation of image features and edges. The future of medical image denoising lies with more efficient edge preserving image denoising techniques.

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