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Editorial

Medical Image Denoising

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Editorial

Medical image analysis [1-4] is an important area of interest among researchers these days. Digital images have some degree of noise and get corrupted with noise during its acquisition from various sensors and transmission by different media. The most commonly used medical images are received from MRI (Magnetic Resonance Imaging), CT (Computed Tomography), Mask and contrast images (Digital subtraction angiography) and X-ray equipments. Usually, the addition noise into medical image reduces the visual quality that complicates diagnosis and treatment. The perception of the addition of noise as artefacts can lead to false diagnosis. Generally MRI images are corrupted with Rician noise and speckle noise. CT images are contaminated with structural and salt and pepper noise. Although a plethora of techniques are devised to curb the prevalence of noise in medical images but there is still a lot margin left. Image denoising is basically a trade-off between noise removal and preservation of significant image details. As the number of pixels per unit area keeps on increasing, the modern image acquisition devices are becoming increasing sensitive to noise. Therefore there grows a huge dependability on image denoising algorithms to reduce the effect of noise and artefacts in the resultant image. Noise can be perceived as a random fluctuation in the colour information or the intensity value of the image pixels. A large sum of image denoising techniques has been presented so far. Removal of noise is a fundamental operation in image processing and its applications range from the direct i.e. photographic enhancement to the technical i.e. as a sub problem in image reconstruction algorithms. Spatial filters [5-8] are traditional means of removing noise from images and signals. Spatial filters usually smooth the data to reduce the noise, and also blur the data. Several new techniques have been developed in the last few years that improve on spatial filters by removing the noise more effectively while preserving the edges in the data. Some of these techniques used the ideas from partial differential equations and computational fluid dynamics such as level set methods, total variation methods nonlinear isotropic and anisotropic diffusion, Other techniques combine impulse removal filters with local adaptive filtering in the transform domain to remove not only white and mixed noise, but also their mixtures. In order to reduce the noise present in medical images many techniques are available like digital filters (FIR or IIR), adaptive filtering methods etc. However, digital filters and adaptive methods can be applied to signal whose statistical characteristics are stationary in many cases. Recently the wavelet transform has been proven to be useful tool for non-stationary signal analysis. Image transforms consider transforming the images into other domains in which the similarities of the transformed coefficients are employed. These methods are particularly based on the assumption that the true signal can be well approximated by a linear combination of few basis elements. Hence the basic fundamental is to preserve few high magnitude transform coefficients that contain the true signal intensity and thresholding rest of the coefficients that contain noise so as to calculate the total estimated signal. Transform domain has been researched in context of image denoising for decades. A large number of variants have been proposed in this category like DCT, Wavelets, BM3D, Directionlet Curvelet, Coutourlet, Ridgelet, Tetrolet, Shearlet and corresponding thresholding techniques like sure shrink Visu shrink and Bayes shrink Wavelet is a multi resolution analysis tool. As far as the coining of wavelet transform is concerned there are primitively fifteen variants of wavelet namely Haar wavelet, called the mother wavelet, Symlet, Mexican Hat Wavelet, Morlet, Mayerlet, Daubechies, Symlet, Coiefflet, Spline Wavelet, Battle Lemarie Wavelet, DWT, CWT, Gaussian Wavelet. It uses multiscale pyramid representation method. During wavelet thresholding images are decomposed into low frequency and high frequency sub bands. The low frequency sub bands are called the approximation level and high frequency sub bands are called detailed levels. The sub bands are processed by hard and soft thresholding. Visu-shrink, Sure-shrink And Bayes Shrink are the popularly known thresholding formulas. FT and WT are better to represent 1-d signals but when it comes to 2-d signals edges and contours are the main concerns to be addressed in an image processing task. Since wavelet was a tensor product of 1D wavelet transform which is able resolve 1D singularity but not 2D. In the beginning to overcome the problems possessed by wavelet transform Ridgelet transform was proposed. Then in progression came Curvelet and Ripplet transform. Ripplet transform another MGA tool is a higher order generalization of the parabolic scale law. Ridgelet resolves the discontinuities along lines where as Counterlet and Ripplet [9,10] is confined to resolve discontinuities along smooth curves. But these transforms are incapable to resolve discontinuities along edges and contours. There for the rescue Vladan proposed a multidirectional anisotropic transform based on integer lattices named Direction-let. This is the most promising technique of image processing manuover. PURE-let (poison unbiased risk estimate linear expansion of thresholds) is a denoising function for shot noise. It was devised to do two functions one is signal preservation and the noise suppression in the presence of shot noise. PURE denoising function uses un normalized haar wavelet transform. The advantages of PURE-let are lesser computations, less memory and less complexity. The main idea behind dictionary learning methods is sparse representation. They perform denoising by learning a large number of group of pixels blocks from an image database, such that each block can be expressed as a linear combination of the few patches from the dictionary so obtained. K-SVD is the well known dictionary denoising method. In contrast in another method namely K-LLD classification is done on the basis of SKR in order to the disguise of different patches as similar patches. The other state of art dictionary method is WESNR; it targets the mixed noise that is the Gaussian and the impulse noise.

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Many denoising algorithms were developed on wavelet framework effectively but they suffer from four shortcomings such as oscillations, shift variance, aliasing, and lack of directionality. Immense amount of research work is carried in field of denoising and is still going on to contour the margins left for better trade off.

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