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NOISE FILTERING OF REMOTELY SENSED IMAGES USING ITERATIVE THRESHOLDING OF WAVELET AND CURVELET TRANSFORMS

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ABSTRACT:

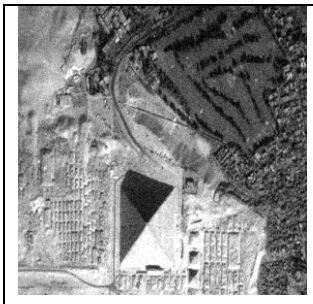
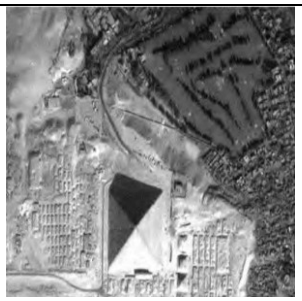
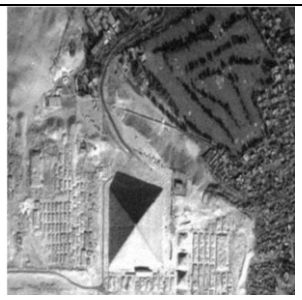
In recent past, advancements in observing the Earth from space have led to a new class of images with very high spatial resolution. These high resolution images give good quality of detailed information about the properties of the various objects. For different purposes, remote sensing images are used to extract some features, detect the presence various phenomena, or for interpretation. These applications require high signal-to-noise ratio (SNR) to get correct results and better performance. The data that are contaminated with noise can cause a failure to extract valuable information and degrade the interpretation.

This article presents some techniques for noise filtering of remotely sensed images based on multiresolution analysis (MRA). Multiresolution techniques provide a coarse-to-fine and scale-invariant decomposition of images for image interpretation. The multiresolution image analysis methods have the ability to analyze the image in an adaptive manner, capturing local information as well as global information. Further, noise being one of the biggest problems in image analysis and interpretation for further processing, is effectively handled by multiresolution methods. The paper aims at the analysis of denoising of image using wavelets and curvelets on high resolution multispectral images acquired by the Quickbird and medium resolution Landsat Thematic Mapper satellite systems.

Wavelet transform showed great effect when dealing with one and two-dimensional signal with point singularity features. However, for the two-dimensional image, the main characteristics were characterized by the edges. Wavelets can only capture limited directional information due to its poor orientation selectivity. By decomposing the image into a series of high-pass and low-pass filter bands, the wavelet transform extracts directional details that capture horizontal, vertical, and diagonal details. However, these three linear directions are limiting and might not capture enough directional information in remotely sensed images. Wavelet transform coefficients are not the best and the most sparse to describe the image edge singular features. In order to avoid this shortcoming of wavelet transform and process images of high dimension more effectively, curvelet transforms present in the literature is used. It combines the directional filtering and multiscale ridgelet transform, which makes curvelets useful for denoising of images. Its anisotropic characteristic is advantageous to the edge expression, especially to the curve singularities of signal.

To improve the performance of noise filtering an iterative thresholding scheme for wavelets and curvelets is proposed to the problem of restoring an image from noisy image and analyzing the effects of denoising. For each region of the MRA the algorithm is tested to obtain optimum results. The problem is to decide the threshold value to be chosen for noise removal. Each coefficient of the image is considered as a threshold value and the final PSNR of the reconstructed image is calculated. On comparing of the PSNR values obtained, the threshold value giving the highest PSNR is chosen.

Two comparative measures are used for evaluation of the performance of the methods for denoising. One of them is the peak signal to noise ratio and the second is the ability of the noise filtering scheme to preserve the sharpness of the edges. By both of these comparative measures, the curvelet has proved to be better than the others. Results are illustrated using Quickbird and Landsat images for fixed and iterative thresholding.

			
Nosiy Image (SNR= 9.54dB)	Wavelet with fixed thresholding (PSNR =25.92dB)	Wavelet with proposed thresholding (PSNR =27.7dB)	Curvelet denoising (PSNR=28.69)