

# CURVELET Based IMAGE DENOISING

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**Abstract**— In the proposed method second generation curvelet transform is used for image denoising. Curvelet coefficients are thresholded for noise removal. The threshold is determined by noise image standard deviation. The existing denoising methods are frequency filtering and frequency smoothing. These methods are having same drawback that the denoising process will cause loss of image information. The new frequency domain denoising method was wavelet based denoising. Wavelet transform require many coefficient for representing edges and thus take more memory. But the curvelet transform overcome this disadvantage that it takes few nonzero coefficients to describe the edge. The loss of data in denoising using curvelet transform will be less compare to other methods and requires minimum number of curvelet coefficients.

**Keywords**— Standard deviation, Threshold value, curvelet coefficient, noise ratio, SNR, SSIM, variance.

## Introduction

In remote sensing images noise are introduced during image acquisition, sensor saturation, quantization error and transition error. Noise can generally be grouped into two classes:

- Independent noise.
- Noise which is dependent on the image data.

Independent noise: Image independent noise can often be described by an additive noise model, where the recorded image  $f(i,j)$  is the sum of the true image  $S(i,j)$  and the noise  $n(i,j)$ .

$$f(i,j)=S(i,j)+n(i,j)$$

The noise  $n(i,j)$  is often zero-mean and described by its variance  $\sigma_n^2$ . The impact of the noise on the image is often described by the signal to noise ratio (SNR), which is given by:

$$SNR=\frac{\sigma_s^2}{\sigma_n^2}$$

Where,  $\sigma_s^2$  and  $\sigma_f^2$  are the variances of the true image and the recorded image.

Data dependent noise: In the data-dependent noise, is possible to model noise with a multiplicative, or non-linear, model. These models are mathematically more complicated; hence, if possible, the noise is assumed to be data independent.

The noise present in the image the quality of the image is degraded. Image denoising is required to remove the noise content in the image and enhance the image. The noise present in the image should be removed in such a way that there is minimum loss in information content of the image.

## PROPOSED METHOD

Denoising is the process of reducing the noise in the digital images that consists of three steps:

- transform the noisy image to a new space.
- In the new space, keep the coefficient where the signal to noise ratio is high, reduce the coefficient where the signal to noise ratio is low.
- Transform the manipulated coefficients back to the original space.

The noise threshold is being calculated by statistical properties of noise and after thresholding the curvelet coefficients the image is reconstructed.

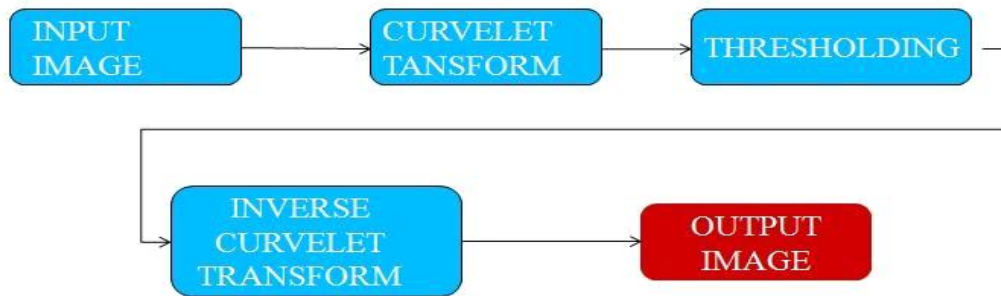


Figure 7: System Design

The noisy image is transformed to the curvelet domain by applying forward curvelet transform to the image. The threshold is performed on basis of statistical properties of coefficients. A thresholding is calculated based on which depends on standard deviation of curvelet coefficients. The thresholding is based on combination of three parameters to compute the threshold value for denoising the given image, the contrast ratio which is the ratio of standard deviation and mean of curvelet coefficients, the absolute median of curvelet coefficients and a level dependent parameter.

The threshold also depends on the absolute median of curvelet coefficients. In the multiresolution analysis, the noise propagates at a higher level also, but in a smoothed manner. For better noise removal, thresholding at higher levels are also required. Hence, the threshold value should decrease, going from lower to higher levels. The thresholding is applied to these noisy levels in order to reduce the noise and reconstruct the images. The thresholding is done based on the equation

$$\text{Threshold} = 12j - 1 (\sigma\mu)M$$

Where  $j$  is the number of level at which thresholding is applied,  $M$  is absolute median of curvelet coefficients,  $\sigma$  and  $\mu$  are standard deviation and absolute mean of curvelet coefficients at  $j^{\text{th}}$  level. Now apply inverse curvelet transform to reconstruct the image.

#### INPUT DATASETS Used

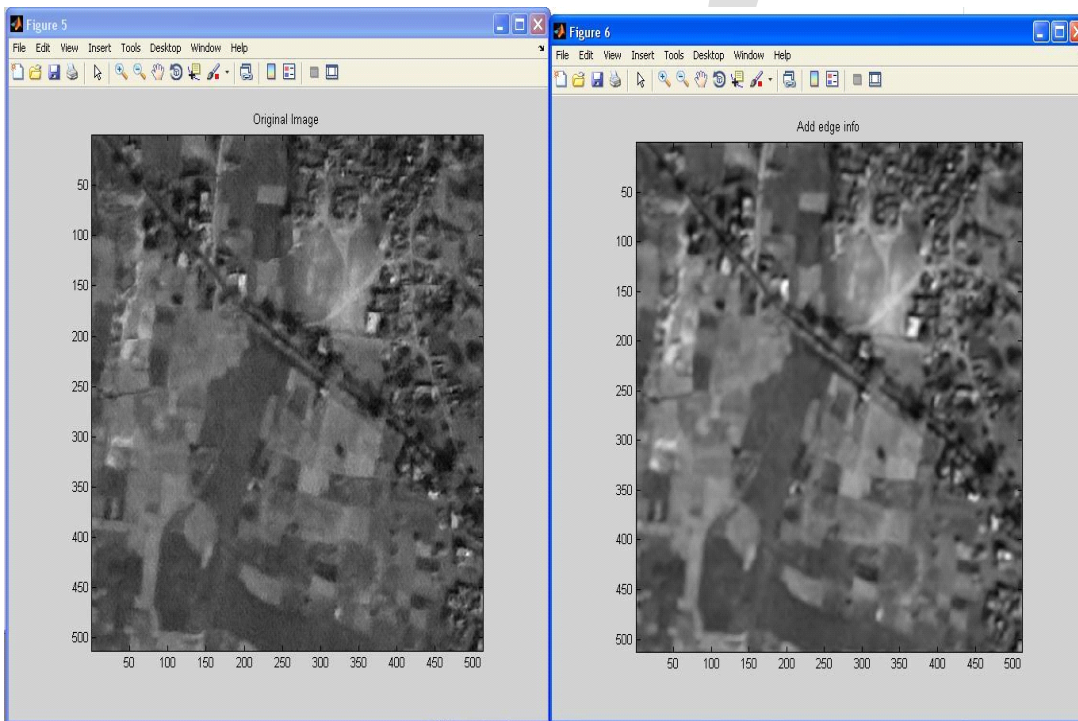
**CARTOSAT1 images:** Cartosat-1 or IRS-P5 is a stereoscopic Earth observation satellite in a sun-synchronous orbit, and the first one of the Cartosat series of satellites. Satellite DOP, Path/Row, Resolution, Radiometric Resolution, min and max values.





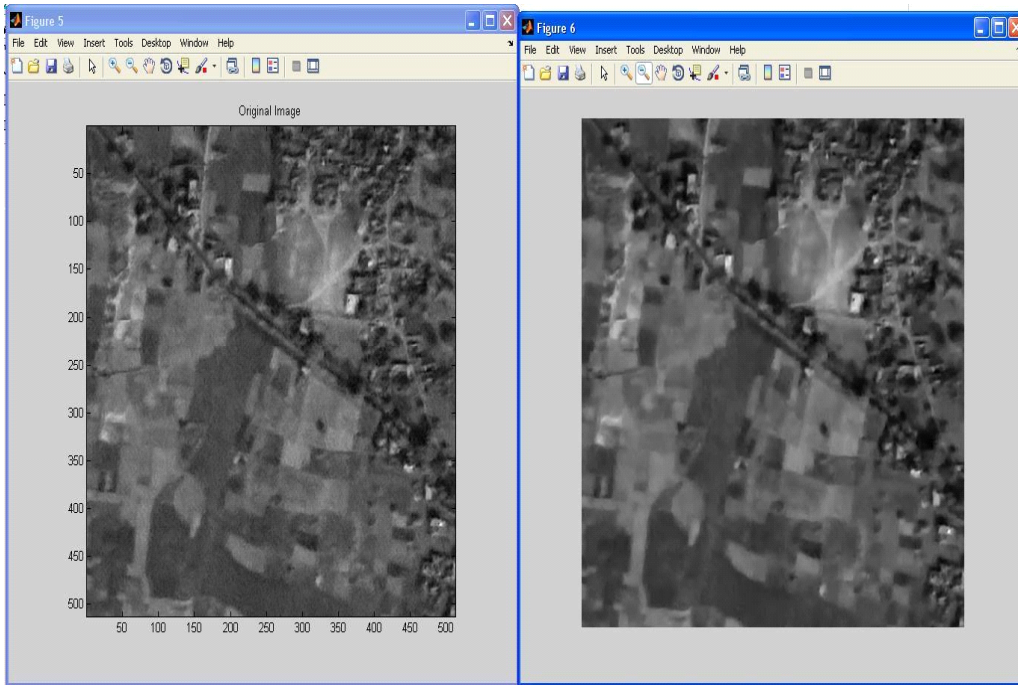
[multilevel threshold based image denoising in curvelet domain]

## RESULTS



Original noisy image

Curvelet based denoised image



**Wavelet based denoised image**

**Curvelet based denoised image**

## CONCLUSION

The image usually has noise which is not easily eliminated in image processing. The main purpose of the noise reduction technique is to remove noise by retaining the important feature of the images. The curvelet transform based denoising is superior to other denoising methods such as Fourier and wavelet denoising because it can handle one-dimensional discontinuity, i.e., straight edges. Remote sensing images having more curved edges hence the curvelet transform can handle linear discontinuities in images.

## SSIM INDEX

- The structural similarity (SSIM) index is a method for measuring the similarity between two images.
- SSIM considers image degradation as perceived change in structural information
- The SSIM metric is:

$$SSIM(x,y)=\frac{2\mu_x\mu_y+C1}{\sigma_x+\sigma_y+C2}\frac{(\mu_x^2+\mu_y^2+C1)}{(\sigma_x^2+\sigma_y^2+C2)}$$

Where, X and Y are the noisy input and denoised output image,  $\mu_x$  and  $\mu_y$  are the mean of the noisy input and denoised output image,  $\sigma_x$  and  $\sigma_y$  are the standard deviation of noisy input and denoised output images

## Standard Deviation (SD)

The large value of Standard Deviation means that image is poor quality

	<b>Curvelet transform</b>	<b>Wavelet transform</b>
SD	5.0022	17.7162
SSIM	0.7789	0.6241

Table 2: Image denoising quality assessment

**REFERENCES:**

- [1] Fundamentals of remote sensing –A Canada centre for remote sensing tutorial.
- [2] Mohamed Elhabiby, Ahmed Elsharkawy & Naser El-Sheimy. “Second Generation Curvelet Transforms Vs Wavelet transforms and Canny Edge Detector for Edge Detection from WorldView-2 data”. *International Journal of Computer Science & Engineering Survey (IJCSES)*, Vol.3, No.4, August 2012 DOI :
- [3] B. R. Corner, R. M. Narayanan and S. E. Reichenbach. ” *Noise estimation in remote sensing imagery using data masking* ”. INT. J. REMOTE SENSING,2003, vol 24,NO.4,689-709
- [4] D. Mary sugantharathnam Dr. D. Manimegalai.” *The Curvelet Approach for Denoising in various Imaging Modalities using Different Shrinkage Rules* ”. International Journal of Computer Applications (0975 – 8887) Volume 29– No.7, September 2011
- [5] Binh NT, Khare.” *A. Multilevel threshold based image denoising in curvelet domain*”. journal of Computer science and Technology 25(3): 632640 May 2010
- [6] Lakhwinder Kaur Savita Gupta R.C. Chauhan .” *Image Denoising using Wavelet Thresholding* “
- [7] Naga Sravanthi Kota, G. Umamaheswara Reddy. “*Fusion Based Gaussian noise Removal in the Images Using Curvelets and Wavelets With Gaussian Filter* “. International Journal of Image Processing (IJIP), Volume (5) : Issue (4) : 2011
- [8] D.Gnanadurai, and V.Sadasivam.” *An Efficient Adaptive Thresholding Technique for Wavelet Based Image Denoising* ” International Journal of Information and Communication Engineering 2:2 2006
- [9] C. Patvardhan, A. K. Verma, C. V. Lakshmi.” *Denoising of Document Images using Discrete Curvelet Transform for OCR Applications* “. International Journal of Computer Applications (0975 – 8887) Volume 55– No.10, October 2012
- [10] Dr Jyoti Singhai, Preety D Swami.” *Modified Cubic Threshold Denoising Technique using Curvelet Transform* “.
- [11] JIANG Tao, ZHAO Xin. “ *Research and application of image denoising method based on curvelet transform*”.
- [12] M. M. Mokji, S.A.R. Abu Bakar.” *Adaptive Thresholding Based On Co-Occurrence Matrix Edge Information* “.journal of Computers, VOL. 2, NO. 8, October 2007