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Satellite Image Enhancement using Curvelet Transform

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Abstract: ***Satellite Images are used in many fields of research and enhancement of these images is a very important process. Satellite image enhancement is done using various transform techniques, filters and interpolation methods. This paper discusses a method of satellite image enhancement using Curvelet transform and interpolation technique. The quality of the enhanced image is measured using parameters like PSNR and MSE. The visual results show the superiority of the proposed method of enhancement.***

Keywords: Curvelet, Radon, Ridgelet PSNR, MSE

1. Introduction

Satellite images are used in many fields like meteorology, agriculture, geology etc. Enhancement of these images is an important process .Satellite image enhancement is done using various transform techniques like DWT, CWT, and SWT with the combination of interpolation methods. Wavelet transform is used for decomposition of images into different subbands. Interpolation is a technique of increasing the number of pixels in a digital image. Bicubic interpolation is most commonly used other than nearest neighbor and bilinear interpolation. This paper discusses the method of image enhancement using combination of curvelet transform and cubic interpolation. Wavelet based approach of image enhancement is used effectively, but wavelet based approach contains too many coefficients that account for edges (i.e) Singularities along lines or curves. Curvelet based approach is used in many applications like Image Denoising, Enhancement, compressed sensing.

Curvelet based approach uses less coefficients to account for edges. Curvelets are designed to handle curves only using a small number of coefficients and they handle the curve discontinuities very well. Curvelet transform possess very high directional sensitivity and anisotrophy and these elements are very efficient in representing line like edges. The proposed method of image enhancement using curvelet removes the noise present in the image and it also improves the resolution by using the cubic interpolation. The output image obtained is enhanced in terms of edge, resolution and also noise is removed in the image. The paper is organized is follows : section-2 gives a brief description about curvelet transform its decomposition ,partitioning, renormalization, Ridgelet analysis, inverse curvelet transform and its applications.Section-3 discusses the brief review of the proposed method of enhancement , section-4 describes the simulation results and section-5 concludes the topic.

2. Curvelet Transform

The curvelet transform is a multiscale directional transform that allows an almost optimal non-adaptive sparse representation of objects with edges [1].

Various steps performed in curvelet transform [8] are;

- Subband Decomposition
- Smooth Partitioning and Renormalization
- Ridgelet Analysis

In the subband decomposition the image or the object is divided into several subband layers of different frequencies (low pass and high pass). In Smooth Partitioning a window function is defined and the function is multiplied by the window function. The image becomes smooth after multiplying by the window function. The partitioning of the image makes much easier to analyze local lines or curve singularities. In Renormalization procedure each square resulting from the previous stage of smoothening is renormalized to unit square (i.e.) centering each dyadic square to the unit square. Ridgelet Analysis: Each normalized square is analyzed in the ridgelet system. Windowing procedure defined earlier creates ridges of certain width and length. These edges are encoded efficiently by ridgelet transform.

In Inverse curvelet transform procedures like Ridgelet synthesis, Renormalization, Smooth Integration and Subband recomposition is performed. Curvelet transform is used in many applications like Image denoising, Image Enhancement, Compressed Sensing.

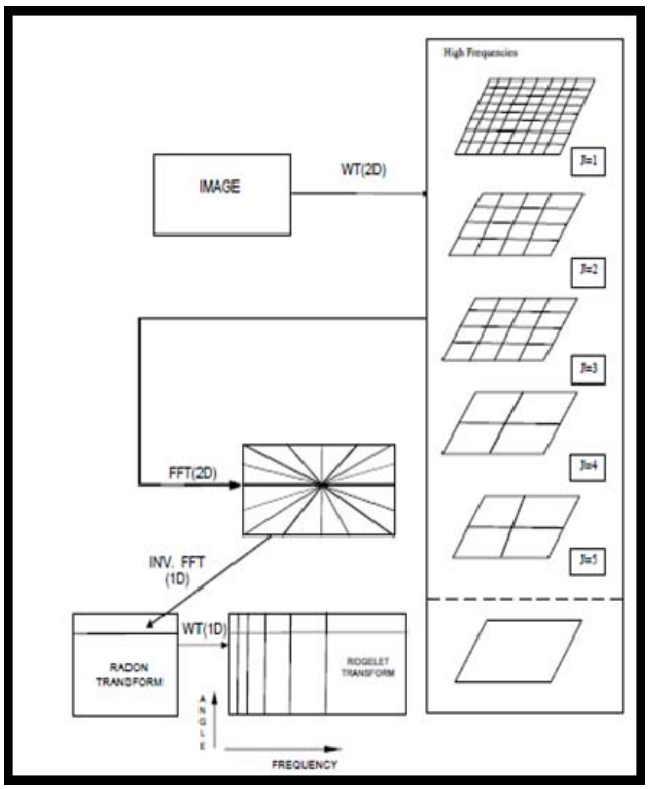

Figure 1: Curvelet Transform Process [2]

3. Proposed Method of Image Enhancement

In the proposed method of Image enhancement the satellite image is taken as the input image and is applied to the process of curvelet transform. The process like Decomposition, Partitioning and Ridgelet analysis is done. Then the image is interpolated [7] using cubic interpolation and finally the inverse curvelet transform is applied to the image, in which the process like Inverse ridgelet transform, inverse fft, inverse dwt is performed to get enhanced image in terms of edges, noise and resolution. The quantitative parameters like PSNR, MSE is measured to estimate the quality of the enhanced image.

4. Simulation Results

Test Image: 1

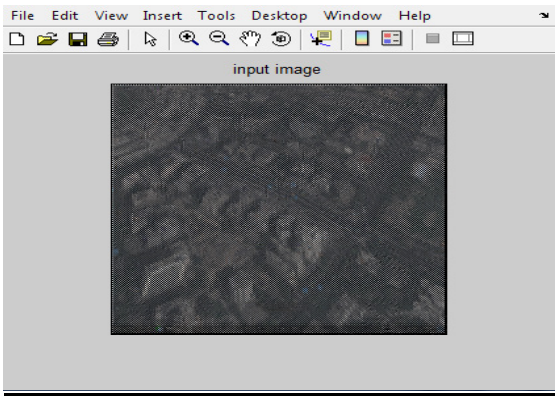

Figure 2(a): Input Satellite Test Image 1

Figure 2 (b): Output Satellite Image

Test Image: 2

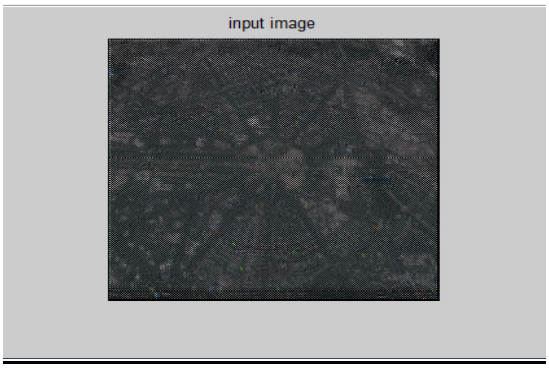

Figure 3(a): Input Satellite Test Image 2

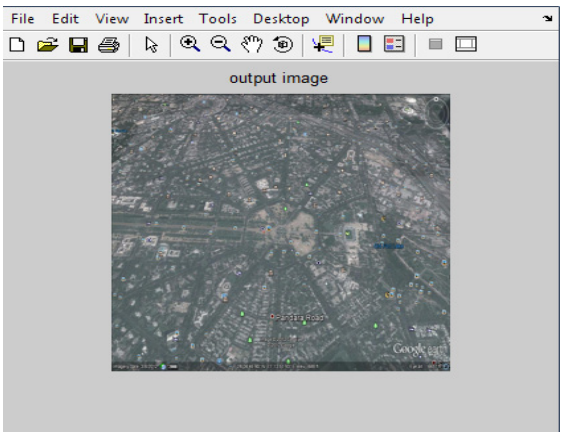

Figure 3(b): Output Satellite Image

Table 1: Values of MSE and PSNR

Measurement Parameters	*Test Image 1*	*Test Image 2*
PSNR	77.1614	76.9669
MSE	0.0013	0.0014

5. Conclusion

In this paper we discussed the method of satellite image enhancement using curvelet transform and interpolation method. The image is enhanced interms of edge, resolution and noise. The image quality is measured in terms of PSNR and MSE.

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