# An Overview on Resolution Enhancement Techniques of Satellite Images

**[1]Arya A R, [2]Sreeletha S H**
[1]M.Tech Scholar, [2]Associate Professor
[1]Computer Science and Engineering,
[1]LBS Institute of Technology for Women, Thiruvananthapuram, India

***Abstract— Satellite images are being used in various research areas of medical, remote sensing, defense, meteorology, Geographic studies and various other industries. The need for image enhancement is one of the major challenges in image processing. In this paper a study of various image resolution enhancement methods in wavelet domain is done. Visual appearance of an image and image quality can be improved by the various enhancement techniques. Some spectral and spatial problems still prevail in satellite images such as motion blur and poor perception. The super resolution images are obtained by applying enhancement techniques on noisy and blurred images. In this paper, some of the resolution enhancement techniques such as Discrete Wavelet Transform, Wavelet Zero Padding, Cycle Spinning, and Dual Tree-Complex WT which improves the visual appearance of the images are highlighted.***

***Index Terms— Cycle Spinning, Discrete Wavelet Transform, Dual Tree-Complex Wavelet Transforms, High Resolution, Low Resolution, Undecimated Wavelet Transform, Wavelet Zero Padding.***

## I. INTRODUCTION

Digital images have varied uses such as research, monitoring the processes on the Earth's surface, defense surveillance, detection of changes in atmosphere, measuring and estimating geographical, biological and physical parameters. So enhancement of images has become a major challenge in image processing area of research. Resolution enhancement of satellite images has become an area of concern. In digital image processing image enhancement is one of the main preprocessing stages. Image enhancement technique is described as a process so as that the resultant image is much more accurate than the original image for a certain application. Poor contrast and noise is the major problem faced in medical and geographical research areas. It is therefore a need to remove the noise and thereby increase image quality. Image Enhancement techniques improve the image quality for human viewing by blurs removal and noise, contrast enhancement, and presenting more details. An important aspect of an image is its resolution. The processing of an image is done in order to obtain more enhanced resolution. The details contained in an image is defined by the resolution of an image. The higher the resolution, the more image details... Spatial techniques are used for changing the gray level values of the individual pixels and hence enhance the overall quality of the image. Frequency domain techniques [1] are adapted for image processing in terms of frequency contents.

## II. INTERPOLATION METHODS

Interpolation [2] is a technique of enhancement which is used to estimate the continuous function values from discrete samples. Interpolation defines many image processing applications such as image decompression, sub-pixel image registration, image resolution enhancement, image fusion etc.

Nearest neighbor interpolation

The nearest neighbor[3] algorithm selects the value of the adjacent points and does not consider the values of neighboring points at all instead it yields a constant interpolant. The algorithm is very simple to implement and has applications in real-time 3D rendering to choose color values for a textured surface.

Bilinear Interpolation

The closest four pixel coordinate is taken into account and assigns that value to the output coordinates. Initially, two interpolations are performed linearly in one direction (horizontally) and then another linear interpolation is performed in the perpendicular direction. The number of grid points needed to evaluate the interpolation function for one- dimensional Linear Interpolation [2], is two and for Bilinear Interpolation [3] it is four. Bilinear Interpolation produces an image of smoother appearance than nearest neighbor interpolation, but the grey levels are altered in the process, results in blurred images [2].

Bicubic interpolation

Bicubic interpolation [3] is sophisticated and produces smoother edges than bilinear interpolation. The computational time of bicubic interpolation is more than other two methods. A new pixel is a bicubic function of 16 pixels in the nearest 4 x 4 neighborhood of the pixel in the original image .The image is slightly sharper than that produced by Bilinear Interpolation, and it does not have the disordered appearance produced in Nearest Neighbor Interpolation. First, four one-dimension cubic convolutions are performed in one direction and then one more one-dimension cubic convolution is performed in the perpendicular direction. Thus to implement a two dimension cubic convolution, a one-dimension cubic convolution is needed.

## III. METHODS FOR RESOLUTION ENHANCEMENT

The various techniques discussed are [4]:

### A. Wavelet Zero Padding (WZP)

Wavelet zero padding is one of the simplest methods for image resolution enhancement. In this method, wavelet transform of a LR image is taken and zero matrices are embedded into the transformed image, by discarding high frequency sub bands through the inverse wavelet transform and thus HR image is obtained [2].

### B. Cycle Spinning

A highly resolved image is obtained by following these steps. In this method, first an intermediate HR image is obtained by using the WZP method. After that obtain N number of images by using spatial shifting wavelet transforming and discarding the high frequency component. Wavelet Zero Padding process is again applied to all LR images to obtain number of HR images. Once obtain HR images, then realigned and averaged them to give a final HR image.

### C. WZP-CS Method

It is combination of WZP and CS technique [3]. Final high resolution image is obtained using two steps. Those steps are as follows:

**1)** An initial approximate, unknown high resolution image is generated using wavelet domain zero padding (WZP).
**2)** The cycle-spinning technique is applied to accomplish the following tasks.
**a)** Estimated high resolution images obtained in step 1 are used to generate number of low resolution images.
**b)** Wavelet zero padding method is again applied to all those low resolution images yielding N high resolution images.
**c)** These intermediated high resolution images are realigned and averaged to give the final high resolution reconstructed Image.

### D. Discrete Wavelet Transform (DWT)

Discrete Wavelet Transform (DWT) [5] based technique is most widely used technique for performing image interpolation [3]. DWT use filter banks and special wavelet filters for the analysis for the reconstruction of the multi- resolution time frequency plane [8]. Here DWT is used to decompose a low resolution image into 4 subband images LL, LH, HL and HH. All low and high-frequency components of image are then interpolated. Then a difference image is obtained by subtracting LL image from the original LR image. Resulting image is then added to the interpolated high frequency components to obtain estimated form of HF subband images. Finally IDWT used to combine these estimated images along with the input image to obtain high resolution images [3].

### E. Dual tree-Complex WT (DT-CWT)

In this technique, dual-tree CWT (DT-CWT) [9] is used to decompose an input image into different subband images. In this technique direction selective filters are used to generate high frequency sub-band images where filter show peak magnitude responses in the presence of image features oriented at angle +75, +45, +15, -15, -45 and -75 degrees, respectively [12]. Then six complex valued images are interpolated. Once interpolated, combine all images to generate a new high-resolution image by using inverse DT-CWT. Resolution is achieved by using directional selectivity provided by the CWT, where the high-frequency subbands contribute to the sharpness of the high-frequency details. Finally IDT-CWT used to combine all these images to produce resolution enhanced image.

### F. DWT-SWT

DWT-SWT stands for Discrete wavelet transform- Stationary wavelet transform. In this technique DWT is used in order to preserve the high frequency components of the image (stationary wavelet transform uses high and low pass filters [8]). The DWT and SWT [7] are used to decompose the input image into different subbands. In this technique DWT is used in order to preserve the high frequency components of the image [8]. But because of DWT, information loss occurs due to the down sampling in each sub-band. Hence to minimize this loss SWT is employed. The SWT high frequency subbands and interpolated high frequency subbands have the same size hence that can be added with each other. After correlation new high frequency sub-bands are obtained. After interpolation inverse discrete wavelet transform (IDWT) is applied to all the interpolated subbands to obtain final High resolution image.

## IV. CONCLUSION

Resolution enhancement scheme offers novel idea and do the analysis of the performance and limitations of various techniques. The techniques based on wavelets have the drawback of losing the high frequency contents and results in blurring. DT-CWT and DWT-SWT can enhance performance of satellite images in terms of MSE and PSNR. For achieving visually acceptable images, image enhancement algorithms provide wide range of approaches. Here we have studied recent development methods of image enhancement and pointed out the area of research for image enhancement in spatial domain. The future scope will be the development of adaptive algorithms for effective image enhancement using Fuzzy Logic and Neural Network.

## V. ACKNOWLEDGMENT

We are greatly indebted to our principal Dr. K. C. RAVEENDRANATHAN, Dr. SHREELEKSHMI R, Professor, Head of the Department of Computer Science and Engineering, Mr. MANOJ KUMAR G., Associate Professor, Department of Computer Science and Engineering, LBS Institute of Technology for Women who has been instrumental in keeping my confidence level high and for being supportive in the successful completion of this paper. We would also extend our gratefulness to all the staff members in the Department; also thank all my friends and well-wishers who greatly helped me in my endeavor. Above all,we thank the Almighty God for the support, guidance and blessings bestowed on us, which made it a success.

## REFERENCES

**[1]** Giri Nandan and Navdeep Kanwal, "Image Resolution Enhancement Methods for Different Applications", International Journal of Information and Computation Technology, Vol 4, 2014, Number 17 , pp. 1733-1738.
**[2]** W. K. Carey, D. B. Chuang, and S. S. Hemami, "Regularity-preserving image interpolation," IEEE Trans. Image Process., vol. 8, no. 9, pp.1295–1297, Sep. 1999.
**[3]** H. Demirel and G. Anbarjafari, "Satellite image resolution enhancement using complex wavelet transform," IEEE Geoscience and Remote Sensing Letter, vol. 7, no. 1, pp. 123–126, Jan. 2010.
**[4]** S.S. Bedi and Rati Khandelwal , "Various Image Enhancement Techniques- A Critical Review", International Journal of Advanced Research in Computer and Communication Engineering , Vol. 2, Issue 3, March 2013.
**[5]** K. Narasimhan, V. Elamaran, Saurav Kumar, Kundan Sharma, and Pogaku Raghavendra Abhishek, "Comparison of Satellite Image Enhancement Techniques in Wavelet Domain", Research Journal of Applied Sciences, Engineering and Technology, 2012.
**[6]** Hasan Demirel and Gholamreza Anbarjafari, "Discrete Wavelet Transform-Based Satellite Image Resolution Enhancement", IEEE

Trans. on Geoscience and Remote Sensing, vol. 49, no. 6,2011.
**[7]** E. Mohan, K.B. Jayarraman, U. Maheswaran, D. Sathiyaraj and G.Dhakshanamoorthi, "A Novel Approach For Satellite Image Resolution Enhancement", International Journal of Engineering and Advanced Technology (IJEAT), Vol-2, Issue-4, April 2013.
**[8]** A. K. Bhandari, A. Kumar and P. K. Padhy," Enhancement of Low Contrast Satellite Images using Discrete Cosine Transform and Singular Value Decomposition", World Academy of Science, Engineering and Technology, Vol:5, 2011.
**[9]** R. Reeves, and K. Kubik, "Benefits of Hybrid DCT Domain Image Matching", International Archives of Photogrammetric and Remote Sensing, Vol. 33, Part B3. Amsterdam 2000, pp. 771-778.
**[10]** C. J. Christopher, M. Prabukumar, and A. Baskar, "Color Image Enhance- ment in Compressed DCT Domain", ICGST - GVIP Journal , Vol-10, 2010, pp. 31-38.
**[11]** C. Sanderson, and K. K. Paliwal, "Fast feature extraction method for robust face verification", Proceeding of IEEE Conference on Electronics Letter, Vol-38, No. 25, December 2002, pp. 1648-1650.
**[12]** G. Sorwar, A. Abraham, and L. S. Dooley , "DCT Based Texture Classification Using Soft Computing Approach", Proceeding of 10th IEEE Conference on Fuzzy Systems , Vol-2, 2001, pp.445-448.
**[13]** AthiraK. Vijay and M. Mathurakani, "Image Denoising Using Dual Tree Complex Wavelet Transform", International Journal of Research in Engineering and Technology, issue- 01 vol 03, 2014.
**[14]** R. C. Gonzalez and R. E. Woods, " Digital Image Processing", Prentice Hall, New Jersey, 2008