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# **A Review On Image Resolution Enhancement Techniques**

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**Abstract:** Image resolution enhancement is one of the first steps in image processing. Image resolution enhancement is the process of manipulating an image so that resultant image is more suitable than the original one for specific application. Image enhancement can be done in various domains. For image resolution enhancement there are many methods, out of which image interpolation scheme is one of the most effective method. However, resolution is vital aspect of any image. Good quality image i.e. high resolution image produces better result in image processing applications. An interpolation is the technique to increase the resolution of the image by selecting new pixel from surrounding one. Image interpolation in complex wavelet transform produces better results for any imaging application. DTCWT technique is used to improve the resolution of any satellite image. The paper focuses on the different techniques that are used to increase resolution of the images and their comparative results.

**Keywords:** Image Resolution, Discrete Wavelet Transform, Multi wavelet Transform, Interpolation

## **I. INTRODUCTION**

The most important in the field of image processing is to enhance the resolution of the an image. A common Resolution Enhancement (RE) technique is to differ the size of dots similar to pixels. Image resolution is the feature an image holds. Higher resolution means that extra image detail. Image enhancement is one of the pre-processing techniques. The pre-processing is used to state the image before going for processing [1]. Enhancement is used for a particular application to get an obvious image that is much more suitable than unique image. Image processing is the processing of an image as well as it takes one image as an input with produces image as an output. This includes Noise Removal Image Segmentation, Image Enhancement, Image Compression etc. The Resolution Enhancement has classified as,

### **A. Pixel Resolution**

For the resolution, when the pixel counts are referred as the convention is to explain the pixel resolution among the set of two positive integers: 1) Number of pixel rows (height) 2) Number of pixel columns (width).

### **B. Spatial Resolution**

It is the determine of how lines are closely determination in an image. In remote sensing, it is usually limited by imperfect focus, diffraction etc.

### **C. Spectral Resolution**

Color images differentiate light of different spectra. Multi spectral images decide even finer differences of spectrum or wavelength than is required to reproduce color.

### **D. Temporal Resolution**

Movie cameras and high speed cameras can decide measures at dissimilar points in time. The time resolution used for movies is typically 24 to 48 frames/sec.

### **E. Radiometric Resolution**

It find out how delicately a system can represent or distinguish differences of intensity and typically expressed as number of levels or number of bits.

The important aspect of an image is frequently referred as Resolution. In order to obtain a more enhanced resolution, the various images are being processed. Interpolation is one of the commonly used techniques for image resolution enhancement. Interpolation

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has been extensively used in various image processing applications such as super resolution [2]-[5], facial reconstruction [6], multiple description coding [7]. There are mainly three well known interpolation techniques, namely neighbour interpolation, bilinear interpolation, and bicubic interpolation. Wavelet domain from the image resolution enhancement is a reasonably recent research topic and recently various new algorithms have been planned [3]-[6]. Discrete wavelet transform (DWT) [8] is one of the newest wavelet transforms used in image processing. DWT decomposes an image into diverse subband images, specifically low-low (LL), low-high (LH), high-low (HL), and high-high (HH). An additional latest wavelet transform which has been used in numerous image processing applications is stationary wavelet transform (SWT) [9]. In tiny, SWT is analogous to DWT but it does not use down-sampling, hence the subbands will have the same size as the input image.

### II. IMAGE RESOLUTION ENHANCEMENT TECHNIQUES

There are various image resolution enhancement techniques as explained as below.

- A. Discrete Wavelet Transform (DWT)
- B. Stationary Wavelet Transform (SWT)
- C. Vector-Valued Image Regularization with Partial Differential Equations (VVIR-PDE)
- D. Adjacent Pixel Algorithm (APA)
- E. Inter Sub band Correlation Technique (ISC)
- F. Singular Value Decomposition (SVD) Transform
- G. Hybrid Directional Lifting (HDL) Technique
- H. Dual-Tree Complex Wavelet Transform (DT-CWT)

Earlier numbers of techniques are used for rising the quality of images in a variety of applications. Every technique produces dissimilar artifacts as well as result.

As per Robert G. Keys[10] Cubic convolution interpolation is imitative as of set of conditions which are applied on interpolation kernel. Interpolation kernels are design to maximize accuracy for given level of computation factor. In conditions of storage as well as computing time cubic convolution is added effective than cubic splines.

A.Temizel and T. Vlachos[11] primary approximation to HR image is generating by wavelet domain zero padding. In this process wavelet transform is applied among filters. Image enhancement by means of cycle spinning reduces ringing with perceptual quality of compressed image is improved. Inverse wavelet transform is followed with High resolution image is generated with zero padding of high frequency subbands. Low resolution images are followed through wavelet domain resolution enhancement with zero padding i.e. during spatial shifting of WZP to produce output high resolution image.

Yinji Piao et al [12] Intersubband correlation in wavelet domain uses correlation of subband with dissimilar sampling phases in DWT. And DWT is taken into consideration in such enhancement technique sampling phase. With analyzing correlation among lower level subband as well as higher level subbands, interpolation filters are design. Primary filter are approximate by exploiting wavelet transform to low resolution image. Estimated filters are used to estimate bands in higher level. And at last inverse wavelet transform is performed to improve the resolution of input image.

Turgay Celik and Huseyin Kusetogullari[13] The DTCWT technique is used to decompose the original input image into different subband images. Using LR image, initial approximation to unknown HR image is reconstructed using zero padding of high frequency subbands followed by ICWT. Deformations to initial estimation are applied using edge preserving smoothing filtering (EPSF).

Alexander Hildebrand[14] Time multiplexed attainment generate set of low resolution CFA image undergoes single frame demosaicing algorithm. After that single frames be undergoes through monochromatic super resolution to produce high resolution color images. Hasan Demirel et al [15] in their paper represented Complex Wavelet Transform (CWT) is used in image processing. CWT of an image forms two complex-valued low-frequency subband images as well as six complex valued high-frequency subband images. DT-CWT decomposes original image into dissimilar subband images. Then high frequency subband images along with original low frequency image are undergoes the interpolation. These two real-valued images are used as the real components furthermore imaginary components of the interpolated complex LL image, respectively, for the IDT-CWT operation. This method does not interrupt the innovative image but also interpolates high frequency subband image resulting from DT-CWT. The concluding output image is high resolution of the original input image. Quality and PSNR of the super resolved image is also improves in this method.

Hasan et al [16] represented that Discrete and stationary wavelet decomposition method based on interpolation of high frequency

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subbands images ensuing from DWT. High frequency components of images are enhanced by stationary wavelet transform. This system produces comparatively greater results.

Hasan Demirel et al [17] represented that DWT technique is for interpolating the images. But the images get from DWT as well as IDWT technique is not sharper compare to previous technique and comparatively low PSNR.

S.Venkata Ramana et al[18] proposed a novel method to improve the resolution of the satellite images based on discrete wavelet transform along with interpolation. 2D-DWT decomposes the satellite image into LL, LH, HL, HL sub bands. The LL band conserve the information of image, remaining sub bands preserves edges information. In proposed method, the high frequency subbands (LH,HL,HH) also the input low resolution sub band(LL) have been interpolated using bicubic interpolation, followed by addition all these sub bands to produce a new improved resolution image by using IDWT. In order to get sharp image an intermediate stage has been used.

P. Karunakar et al[19] propose a new satellite image resolution enhancement technique based on discrete wavelet transform(DWT) and the input image which is obtained by the interpolation of the high-frequency sub bands. The planned resolution enhancement process uses DWT to decompose the input image into dissimilar sub bands. Then, the high-frequency sub band images as well as the input low-resolution image have been interpolated, followed by combining all images to generate a new resolution enhanced image by using inverse DWT.

E. Mohan et al[20] proposed in their paper, a new resolution enhancement technique is proposed. This method is based on interpolation of the huge frequency sub-bands which are obtained by performing Discrete Wavelet Transform (DWT) on input image. DWT separates the image in to dissimilar sub-band images namely, low-low (LL), low-high (LH), high-low (HL) and high-high (HH). Interpolation can be functional to these four sub-band images. With the help of low-pass filtering of the high-resolution image in the wavelet area the low-resolution image is obtained. The low-resolution image (LL sub-band) is used as input for the planned resolution enhancement method. The high frequency sub-bands enclose the high frequency components of image.

O.Harikrishna et al[21] proposed a new satellite image resolution enhancement method based on the interpolation of the high-frequency sub bands obtained by discrete wavelet transform (DWT) and the input image.

Hasan Demirel et al[22] proposed resolution enhancement method uses DWT to crumble the input image into dissimilar subbands. Then, the high-frequency subband images with the input low-resolution image have been interpolated, followed by combining all these images to produce a new resolution-enhanced image by using inverse DWT. An intermediate stage for estimating the high-frequency subbands has been proposed to achieve a sharper image.

### III. ADVANTEGES AND DISADVANTAGES OF IMAGE RESOLUTION TECHNIQUES

In this part the performance of various image resolution techniques have been exacting advantages and disadvancetages in the below Table I.

TABLE I. ADVANTAGES / DISADVANTAGES OF IMAGE RESOLUTION TECHNIQUES

Resolution Techniques	Advantage / Disadvantage
DWT	Gives Sharper image /Loses high frequency contents.
SWT	Redundant / Disortion may occur to the image.
VVIR-PDE	Removes the noise / Loses edge information.
APA	Gives clear view of an image / Loses linear features.
ISC	Less computational complexity / Sometimes have low correlation.
SVD	Improves the brightness of an image / Cannot give clear image.
HDL	Denoise the image / Unwanted oscillation of signal leads to error.
DT-CWT	Reduces Artifacts / Not much suitable for hyper spectral images.



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## IV. CONCLUSION

This paper analyses the presentation of various resolution techniques. Resolution Enhancement (RE) schemes, which are not based on wavelets have the disadvantage of losing high-frequency contents, which marks in blurring. In this paper we view on different image resolution enhancement methods. All these techniques are pretend and implemented by authors are having their possess results along with artifacts. In image enhancement method resolution is one of the major aspect. In command to create high quality super resolution image all high frequency mechanism of images are requisite to protect. To improve the resolution of the image in wavelet domain produces moderately better results.

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