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A SURVEY ON SUPER RESOLUTION TECHNIQUES

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ABSTRACT

The main aim of super resolution image is to reconstruct a high-resolution(HR) image from low resolution images. Nowadays super resolution images are used in many applications such as, satellite image, medical image etc. In resolution enhancement of images the main loss is high frequency contents (edges) of the image. Hence in order to enhance the quality of image, preserving the edges is necessary. This paper compares various image resolution enhancement techniques such as discrete wavelet transform (DWT), stationary wavelet transform(SWT), dual tree complex wavelet transform (DT-CWT), wavelet zero padding (WZP), cycle spinning (CS), Vector-Valued Image Regularization with Partial Differential Equations (VVIR-PDE), Inter Sub band Correlation Technique (ISC).

Keywords: Discrete wavelet transform (DWT), Dual tree complex wavelet transform (DT-CWT), Stationary wavelet transform (SWT), Super resolution (SR)

INTRODUCTION

One of the most important feature of an image is Resolution. Low resolution images are processed to obtain more enhanced that is high resolution images. So, the process of converting high resolution images from low resolution images called super resolution. High resolution images are very essential in many applications especially satellite images, medical images. The main application area of super resolution images are satellite imaging, aerial imaging, medical image processing, ultrasound imaging, infrared imaging, facial image improvement, text images improvement, fingerprint image enhancement etc. For image resolution enhancement the most commonly used technique is Interpolation. In many image processing applications interpolation technique has been used widely such as super resolution, facial reconstruction, multiple description coding. Interpolation technique simply increases the number of pixels in the digital images. Here three well known interpolation techniques are define, bilinear interpolation, nearest neighbor interpolation and bicubic interpolation. By nearest neighbor interpolation jaggy effect produced that result in edge distortion. By bilinear interpolation produced smoother edges but some blurred effect present. And using bicubic interpolation we produced smooth edges and also much less blurring than the bilinear interpolation.

The techniques used for image enhancement as following:

- Interpolation techniques: bilinear, nearest neighbor, bicubic interpolation
- Vector-Valued Image Regularization with Partial Differential Equations (VVIR-PDE)
- Inter Sub band Correlation Technique (ISC)
- Wavelet zero padding (WZP)
- WZP and cycle-spinning (WZP CS)
- SWT based super resolution (SWT SR)
- DWT based super resolution (DWT SR)
- Dual tree complex wavelet transform based super resolution (DT CWT SR)
- SWT DWT based super resolution (SWT DWT SR)

INTERPOLATION METHODS

i) Nearest Neighbor interpolation

Nearest-neighbor interpolation is also known as proximal interpolation. It is a simple method of interpolation in one or more dimensions. It does not consider the values of neighboring points and selects the value of the nearest point. The Nearest neighbor interpolation is the simplest and fastest method. It simply takes the color of a pixel and assigns it to the new pixels which are created from that pixel. This simple approach leads to jaggy effect. So nearest neighbor interpolation is considered to be incapable for producing best quality images. Nearest neighbor

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does not have pixel accuracy so it generates strong discontinuities. The main property of this method is that it preserves the original noise in the transformed image, which is useful in some image analysis applications. This is used in-camera when reviewing and enlarging images to view details. It simply makes the pixels bigger, and the color of a new pixel is the same as the nearest original pixel.

ii) Bilinear Interpolation

Bilinear interpolation gets the information from four nearest pixels,which are located in diagonal directions from a given pixel. For find the appropriate color intensity values of that pixel. Bilinear uses simple and linear calculations. But the bilinear interpolation is not considered good enough to obtain best quality images. It produces fairly smooth results, but the images can become blurry.

iii) Bicubic Interpolation

Bicubic interpolation uses the information from an original pixel and sixteen of the surrounding pixels. This information used to determine the color of the new pixels that are created from the original pixel. Bicubic interpolation is an improvement over the nearest neighbour interpolation and bilinear interpolation methods for two reasons:

a. Bicubic interpolation uses data from a larger number of pixels and

b. It uses a bicubic calculation that is more sophisticated than the calculations of the previous interpolation methods.

The interpolated surface is much smoother than corresponding surfaces obtained by bilinear or nearest neighbor interpolation. So bicubic interpolation is capable of producing better quality results than others and is one of the most commonly used methods.

SUPER RESOLUTION METHODS

1. Vector-Valued Image Regularization with Partial Differential Equations (VVIR-PDE)[14]

This method is used in order to control the local smoothing behavior of image. The vector edges which have high vector variants to preserve the image information while removing the noise. So, the VVIR-PDE technique is used for image denoising. This VVIR-PDE technique mainly uses smoothing to preserve the features of vector images. It is used in wide range of applications such as color image restoration, to remove the noise, color image inpainting, to remove the text in an image, color image magnification to remove bloc effects of an image, etc.

2. Inter Sub band Correlation Technique (ISC)[11]

This method which uses same phase for the sub bands. So, the sampling phase is considered. The method has the filter bank to estimate the sub bands. The sub bands have correlation that is between low frequency band and high frequency band. If we have different phases, the sub bands will have low correlation with one another. This method has three steps. They are,

a. First apply the wavelet transform to all different phases of each sub band.

b. The filters are used to estimate the bands in higher level.

c. Inverse wavelet transform is applied to enhance the resolution of an input image.

Thus, using the same phase for estimating the sub bands, this method will produce a time consuming process.

3. Wavelet zero padding (WZP)[6]

Wavelet zero padding is one of the simplest method for resolution enhancement. Here the wavelet transform of a LR image is taken first, after which zero matrices are embedded into the transformed image by neglecting the high frequency sub bands through the inverse wavelet transform and thus the high resolution image is obtained.

4. WZP Cycle Spinning (CS)[12]

This constructs a HR image by adopting the following steps:

a. First an intermediate HR image is obtained through WZP method.

b. After that N numbers of images are obtained through spatial shifting, wavelet transforming and discarding the high frequency component.

c. Then WZP process is applied to all LR images to obtain a number of HR images.

d. These HR images are realigned and averaged to obtain a final HR image.

5. Stationary Wavelet Transform (SWT)[2]

SWT is a wavelet transform technique which does not use after the decomposition of images into different frequency sub bands. First WZP is applied to obtain HR image. Then SWT is apply on the estimated HR image. So the image is decomposed into two bands called estimated details and approximation coefficients. Then approximation coefficients are replaced by initially estimated HR image and inverse SWT that is ISWT is taken to obtain the final HR image.

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6. Discrete Wavelet Transform (DWT)[5]

Discrete wavelet transform based technique is one of the widely used techniques for performing image interpolation. DWT is used to decompose a low resolution input image into 4 subband images namely, LL, LH, HL and HH. LH, HL, and HH subband images contain the high-frequency components of the input image. The high-frequency components of image are then interpolated by bicubic interpolation. The LL subband image is the low-resolution of the original image. So instead of using LL, the input image is used for interpolation as it contains more information than the LL sub band. The input image is interpolated with the high frequency subbands. So it increases the quality of the super-resolved image. The final HR image is generated by using the IDWT of the interpolated subband images and the input image. The output image will contain sharper edges than the interpolated image obtained by interpolation of the input image directly.

7. Dual tree complex wavelet transform(DT CWT)[3]

The DT-CWT has good directional selectivity and has the advantage over discrete wavelet transform (DWT). It also has limited redundancy. DT-CWT is also used to decompose an input image into different subband images. Six complex-valued high-frequency subband images contain the high-frequency components of the input image. Then, the high-frequency subband images and the input image are interpolated. After that combining all these images to generate a new high-resolution image by using inverse DT-CWT. The resolution enhancement is achieved by using directional selectivity provided by the CWT, where the high-frequency subbands in six different directions contribute to the sharpness of the high-frequency details, such as edges.

8. SWT DWT RE[2]

The main loss in image resolution enhancement by using interpolation is on its edges which are the high frequency components, which is due to the smoothing caused by interpolation. Edges plays very important role in image. To increase the quality of the super resolved image, it is necessary to preserve all the edges in image. In work, DWT has been used in order to preserve the edges. One level DWT is used to decompose an input image into different subband images. As stated earlier, three high frequency subbands (LH, HL, and HH) contain the edges. In this technique, bicubic interpolation is applied to high frequency subband images. Information loss occurs in the subbands. So SWT is used to minimize this loss. The new corrected high frequency subbands can be interpolated. Low pass filtering of the high resolution image produce the low resolution image. Hence, low frequency subband is the low resolution of the original image. Therefore, instead of using low frequency subband, which contains less information than the original high resolution image used the input image for the interpolation of low frequency subband image. The quality of the super resolved image increases using input image instead of low frequency subband. And final by applying IDWT, the output image contains sharper edges than the interpolated image obtained by interpolation of the input image directly.

9. DT-CT NLM SR[1]

In this method decomposition of the LR input image in different subbands (C_i and W_i^j, where I € {A,B,C,D} and j € {1,2,3}) is performed using DT-CWT. C_i denotes the image coefficient subband values, and W_i^j denotes the wavelet coefficient subbands values. W_i^j values are interpolated by factor β and using bicubic interpolation and also combined with the β/2 interpolaed low resolution input image. Since C_i contains low pass filtered image which losing high frequency information of LR input image For this reason we have used the low resolution image instead of C_i. Now the DT-CWT having the property of shift invariance, however it may produce artifacts after the interpolation process of W_i^j. So to reduce this artifacts NLM filtering is used. After interpolation of W_i^j all values are passed through NLM filter. At the end we apply the inverse DT-CWT decomposition to these filtered subbands, with the interpolated low resolution input image to reconstruct the high resolution image.

CONCLUSION

In the literature survey, several methods of super resolution have been introduced, which shows the importance of these methods in many applications. However, for image super-resolution many methods have been introduced still there are ongoing researches in this field. And also every day many new articles are published on this subject that indicates of its importance. So in this paper image super resolution techniques are classified and also introduced to an overview of them has been provided.

REFERENCES

[1] Muhammad Zafar Iqbal, Abdul Ghafoor, and Adil Masood Siddiqui, “Satellite Image Resolution Enhancement Using

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Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 2.114

Dual-Tree Complex Wavelet Transform and Nonlocal Means" , IEEE 2013
[2] H. Demirel and G. Anbarjafari, "Image resolution enhancement by using discrete and stationary wavelet decomposition,",IEEE 2011.
[3] H. Demirel and G. Anbarjafari, "Satellite image resolution enhancement using complex wavelet transform," ,IEEE 2010.
[4] Saranya P, Fatimakani K, Kanchanadevi P, Venkatesan S, Govindaraju S "A Survey on Wavelet Domain Techniques for Image Super Resolution", International Journal of Computer Science and Mobile Computing, IJCSMC 2014
[5] Chakravarthy, H. Demirel and G. Anbarjafari, "Discrete wavelet transform-based satellite image resolution enhancement," IEEE 2011
[6] Saranya P, Fatimakani K, Kanchanadevi P, Venkatesan S, Govindaraju S "A Survey on Wavelet Domain Techniques for Image Super Resolution", International Journal of Computer Science and Mobile Computing, IJCSMC 2014
[7] H. Zheng, A. Bouzerdoum, and S. L. Phung, "Wavelet based non-localmeans super-resolution for video sequences," IEEE 2010
[8] I. W. Selesnick, R. G. Baraniuk, and N. G. Kingsbur, "The dual-tree complex wavelet transform," IEEE 2005.
[9] M. Protter, M. Elad, H. Takeda, and P. Milanfar, "Generalizing the nonlocal-means to super-resolution reconstruction", IEEE 2009.
[10] P.Suganya, N.Mohanapriya, B.Kalaavathi, "Satellite image resolution enhancement using multi wavelet transform and comparison of interpolation techniques", IJRET 2014
[11] Yinji Piao , ll-hong Shin, HyunWook Park, "Image Resolution Enhancement using Inter-Subband Correlation in Wavelet Domain" IEEE 2007
[12] Alptekin Temizel, Theo Vlachos, "Wavelet domain image resolution enhancement using cycle spinning and edge modelling", 2005.
[13] G. Anbarjafari and H. Demirel, "Image super resolution based on interpolation of wavelet domain high frequency subbands and the spatial domain input image," ETRIJ 2010
[14] D. Tschumperle and R. Deriche, "Vector-valued image regularization with PDE's: A common framework for different applications," IEEE Trans., Apr. 2005.
[15] P.Suganya, N.Mohanapriya, A.Vanitha, "Survey on Image Resolution Techniques forSatellite Images",IJCSIT 2013