A Novel Method For Image Enhancement By Using SWT And DWT

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Abstract — **an image resolution enhancement technique based on interpolation of the high frequency sub band images obtained by discrete wavelet transform (DWT) and the input image. The edges are enhanced by introducing an intermediate stage by using stationary wavelet transform (SWT). DWT is applied in order to decompose an input image into different sub bands. DWT has been employed in order to preserve the high frequency components of the image. The redundancy and shift invariance of the DWT mean that DWT coefficients are inherently interpolable. Then the high frequency sub bands as well as the input image are interpolated. The estimated high frequency sub bands are being modified by using high frequency sub band obtained through SWT. Then all these sub bands are combined to generate a new high resolution image by using inverse DWT (IDWT).**

Index Terms—**Discrete wavelet transform, image super resolution, stationary wavelet transform.**

I. INTRODUCTION

Resolution has been frequently referred as an important aspect of an image. Images are being processed in order to obtain more enhanced resolution. One of the commonly used techniques for image resolution enhancement is Interpolation. Interpolation has been widely used in many image processing applications such as facial reconstruction, multiple description coding, and super resolution. There are three well known interpolation techniques, namely nearest neighbor interpolation, bilinear interpolation, and bicubic interpolation.

Image resolution enhancement in the wavelet domain is a relatively new research topic and recently many new algorithms have been proposed. Discrete wavelet transform (DWT) is one of the recent wavelet transforms used in image processing. DWT decomposes an image into different sub band images, namely low-low (LL), low high (LH), high-low (HL), and high-high (HH). Another Recent wavelet transform which has been used in Several image processing applications is stationary wavelet transform (SWT). In short, SWT is similar to

DWT but it does not use down-sampling, hence the sub bands will have the same size as the input

In this work, we are proposing an image resolution enhancement technique which generates sharper high resolution image. The proposed technique uses DWT to decompose a low resolution image into different sub bands. Then the three high frequency sub band images have been interpolated using bicubic interpolation. The high frequency sub bands obtained by SWT of the input image are being incremented into the interpolated high frequency sub bands in order to correct the estimated coefficients. In parallel, the input image is also interpolated separately. Finally, corrected interpolated high frequency sub bands and interpolated input image are combined by using inverse DWT (IDWT)to achieve a high resolution output image. The proposed technique has been compared with conventional and state- of-art image resolution enhancement techniques. The conventional techniques used are the following:

—interpolation techniques: bilinear interpolation and bicubic interpolation;

—wavelet zero padding (WZP).

The state-of-art techniques used for comparison purposes are the following: —regularity-preserving image interpolation; —new edge-directed interpolation (NEDI); —hidden Markov model (HMM);

—HMM-based image super resolution (HMM SR);

—WZP and cycle-spinning (WZP-CS);

—WZP, CS, and edge rectification (WZP- CS-ER);

—DWT based super resolution (DWT SR); — complex wavelet transform based super resolution (CWT SR).

According to the quantitative and qualitative experimental results, the proposed technique over performs the aforementioned conventional and state-of-art techniques for image resolution enhancement

II.PROPOSED IMAGE RESOLUTION ENHANCEMENT

In image resolution enhancement by using interpolation the main loss is on its high frequency components (i.e., edges), which is due to the smoothing caused by interpolation. In order to increase the quality of the super resolved image, preserving the edges is essential. In this work, DWT has been employed in order to preserve the high frequency components of the image. The redundancy and shift invariance of the DWT mean that DWT coefficients are inherently interposable. In this correspondence, one level DWT (with Daubechies 9/7 as wavelet function) is used to decompose an input image into different sub band images. Three high frequency subbands (LH, HL, and HH) contain the high frequency components of the input image. In the proposed technique, bicubic interpolation with enlargement factor of 2 is applied to high frequency subband images. Down sampling in each of the DWT sub bands causes information loss in the respective subbands. That is why SWT is employed to minimize this loss.

The interpolated high frequency subbands and the SWT high frequency subbands have the same size which means they can be added with each other. The new corrected high frequency subbands can be interpolated further for higher enlargement. Also it is known that in the wavelet domain, the low resolution image is obtained by low pass filtering of the high resolution image. In other words, 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, we are using the input image for the interpolation of low frequency subband image. Using input image instead of low frequency subband increases the quality of the super resolved image. Fig. 1 illustrates the block diagram of the proposed image resolution enhancement technique.

By interpolating input image by a and high frequency subbands by 2 and a in the intermediate and final interpolation stages respectively, and then by applying IDWT, as illustrated in Fig. 1, the output image will contain sharper edges than the interpolated image obtained by interpolation of the input image directly. This is due to the fact that, the interpolation of isolated high frequency components in high frequency subbands and using the corrections

Obtained by adding high frequency subbands of SWT of the input image, will preserve more high frequency components after the interpolation than interpolating input image directly.

III.RESULTS AND DISCUSSIONS
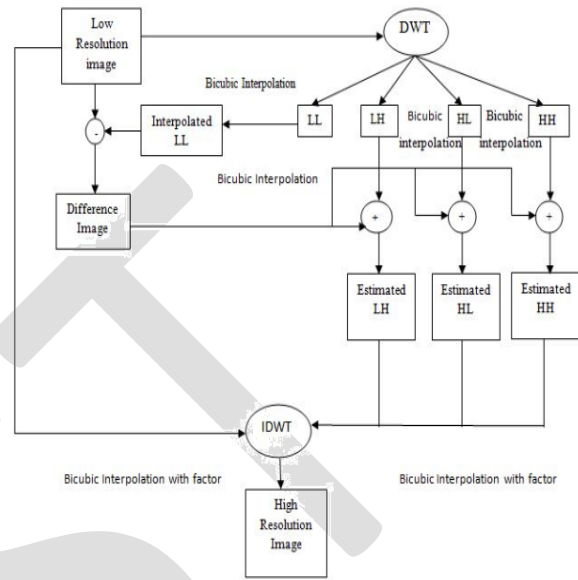
Fig .1. Block diagram of the proposed super resolution algorithm

(d) are much better than the low resolution image in (a), super resolved image by using the interpolation (b),and WZP (c). Note that the input low resolution images have been obtained by down-sampling the original high resolution images. Ignored to show the effectiveness of the proposed method over the conventional and state-of-art image resolution enhancement Techniques, four well-known test images (Lena, Elaine, Baboon, and Peppers) with different features are used for comparison. Table I compares the PSNR performance of the proposed technique using bicubic interpolation with conventional and state-of- art resolution

Fig2:a)Original low resolution boolean image. b)Bicubic interpolated image.c)Super resolved image using WZP.d)Proposed technique.

PSNR (DB) RESULTS FOR RESOLUTION ENHANCEMENT FROM 128x128 TO 512x512 OF THE PROPOSED TECHNIQUE COMPARED WITH THE CONVENTIONAL AND STATE-OF-ART IMAGE RESOLUTION ENHANCEMENT TECHNIQUES

Enhancement techniques: bilinear, bicubic, WZP, NEDI, HMM, HMMSR, WZP- CS,WZP-CS-ER, DWT SR, CWT SR, and regularity-preserving image interpolation. Additionally, in order to have more comprehensive comparison, the performance of the super resolved image by using SWT only (SWT-SR) is also included in the table. The results in Table I indicate that the proposed technique over- performs the aforementioned conventional and state-of-art image resolution enhancement techniques. Table I also indicates that the proposed technique over-performs the aforementioned conventional and state-of-art image resolution enhancement techniques.

IV. CONCLUSION

This work proposed an image resolution enhancement technique based on the interpolation of the high frequency subbands obtained by DWT, correcting the high frequency sub band estimation by using SWT high frequency subbands, and the input image. The proposed technique uses DWT to decompose an image into different subbands, and then the high frequency sub band images have been interpolated. The interpolated high frequency Sub band coefficients have been corrected by using the high frequency subbands achieved by SWT of the input image. An original image is interpolated with half of the interpolation factor used for interpolation the high frequency subbands. Afterwards all these images have been combined using IDWT to generate a super resolved image. The proposed technique has been tested on well-known benchmark images, where their PSNR and visual results show the superiority of proposed technique over the conventional and state-of-art image resolution enhancement technique.

	PSNR(db)			
Technique/images	Baboon	Elaine	Lena	Pepper
Bilinear	26.34	25.38	20.51	25.16
Bicubic	26.86	28.93	20.61	25.66
WZP (db.9/7)	28.84	30.44	21.47	29.57
Regularity-Preserving Image Interpolation	28.81	30.42	21.47	29.57
NEDI	28.81	29.97	21.18	28.52
HMM	28.86	30.46	21.47	29.58
HMM SR	28.88	30.51	21.49	29.60
WZP-CS	29.27	30.78	21.54	29.87
WZP-CS-ER	29.36	30.89	21.56	30.05
DWT SR	34.78	32.73	23.29	33.19
CWT SR	33.74	33.05	23.12	31.03
SWT SR	32.01	31.25	22.74	29.46
Proposed Technique	34.82	35.01	23.87	33.06

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