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IMAGE RESOLUTION ENHANCEMENT BY USING WAVELET TRANSFORM

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Abstract: *The Wavelet domain image resolution enhancement is to process a given input which is low resolution image to produce the result more desirable than the original image for a given specific application. In this, we have proposed an image resolution enhancement technique that generates high resolution and sharper output image. The proposed technique uses DWT for decomposing low resolution image in separate sub-bands. Discrete wavelet transformer is used to decompose an input image into different sub bands. Interpolation technique mostly used in image processing applications such as multiple descriptions coding, facial reconstruction, in super resolution, medical field. Higher frequency bands produced by SWT of the low resolution image are then increased into the interpolated higher frequency bands in order to correct the coefficients. Estimated interpolated higher frequency bands and interpolated input image are mixed by utilizing inverse DWT (IDWT) for getting enhanced output image. After that there is a comparison between the conventional techniques for image enhancement and state-of-the-art image enhancement techniques. One level DWT having Daubechies 9/7 as the wavelet function is utilized to decompose given input image into separate band images. The three higher frequency bands (L-H, H-L, and H-H) has the higher frequency contents of the given input image. Discrete wavelet transform is used to decompose low resolution image and stationary wavelet transform is used to preserve edges.*

Key Words: **Discrete wavelet transform, Interpolation, Image resolution enhancement, stationary wavelet transform , Inverse descrete wavelet transform.**

1. INTRODUCTION

Digital imaging systems have a variety of applications for commercial, medical and recreational purposes. In these applications, a high quality image is required to allow human interpretation or machine perception. However, sometimes the spatial resolution of image is limited by technical considerations of the imaging system in which the image is captured. Therefore signal processing techniques are used to create a higher resolution image that will allow for better identification and interpretation of details. Resolution has been often referred as an important aspect of an image. Images are being processed in order to obtain more improved resolution. Fig. 1 shows Block Diagram of Image Resolution enhancement Technique [27]. The technique us DWT and SWT for decomposing low resolution image. The edges are enhanced by introducing an intermediate stage by using stationary wavelet transform SWT and DWT is applied in order to decompose an input image into different sub bands.

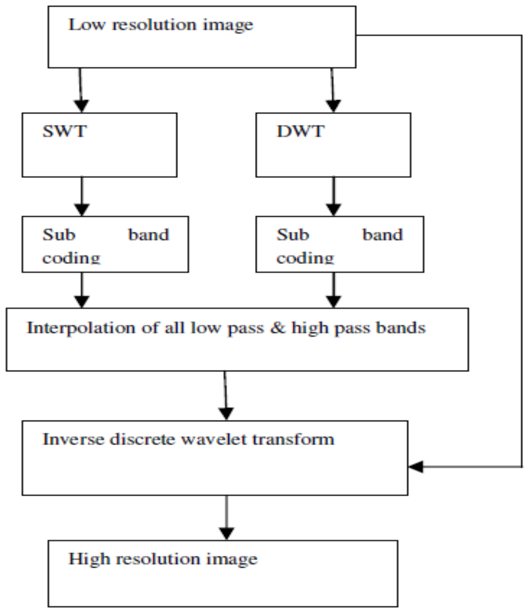

Fig.1 Block Diagram of Image Resolution enhancement Technique [27]

Next step is to use Interpolation technique. Interpolation is one of the commonly used techniques for image resolution enhancement. Digital image process has advantage in term of cost, speed and flexibility. The objective is to bring out information from the scene being viewed. Digital image processing can be classified in following subareas on the basis of nature of application.

Image Enhancement

Image Restoration

Image Compression

Image Segmentation

Image Understanding

There are conventional interpolation techniques, namely bilinear interpolation, and bi-cubic interpolation. The proposed technique has been compared with conventional and the state-of-art image resolution enhancement techniques. Measuring the performance characteristics of the techniques some parameters are used namely PSNR and MEAN. The conventional techniques used are the following:

Bilinear Interpolation

Bilinear interpolation [28], [29] considers the closest 2x2 neighborhood of known pixel values surrounding the unknown pixel. It then takes a weighted average of these 4 pixels to arrive at its final interpolated value.

Bicubic Interpolation

Bicubic produces noticeably sharper images than the previous two methods, and is perhaps the ideal combination of processing time and output quality. Bicubic [28] goes one step beyond bilinear by considering the closest 4x4 neighborhood of pixels for a total of 16 pixels. Since these are at various distances from the unknown pixel, closer pixels are given a higher weighting in the calculation.

Wavelet Zero Padding (WZP)

It is one of the methods for image resolution enhancement. It assumes that the signal is zero outside the original support. Zero padding in the time domain is similar to the optimal interpolation in the frequency domain, which can restores the correct amplitudes. Since the wavelet transform is defined for infinite length signals, finite length signals are extended before they can be transformed.

1.1 Literature Survey

Yinji Piao et al [5] 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

C.B. Atkins et al. [6] proposed optimal image scaling using pixel classification. A new approach is introduced to optimal image scaling called resolution synthesis (RS). In resolution synthesis, the pixel interpolated is first classified in the context of a window of neighbouring pixels; and the corresponding high resolution pixels are obtained by filtering with coefficients that depend upon the classification.

Hasan Demirel et al[4] 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 highfrequency subbands has been proposed to achieve a sharper image.

Yi Wan et al. [25] has described enhanced Histogram equalization in wavelet domain to enhance an image is very important task such as image enhancement and normalization. Presented a wavelet based method that simultaneously achieves the exact specification of histogram and good image enhancement performance. It does so through a carefully designed strict ordering of pixel process, for the image enhancement purpose the wavelet coefficient are fine tuned. Compared to previous work, this approach takes into account not only local mean intensity values, but also local edge information. Other advantages include fast pixel ordering, better image enhancement performance and good statistical models. Experimental results and comparison with state-of-the-art methods are presented.

Ercelebi, E. et al. [26] proposed method utilizes the multi-scale characteristics of the wavelet transform and local statistics of each sub ands. By using this proposed method transformation of an image take place into the wavelet domain using lifting based wavelet filter and applies a wiener filter in the wavelet domain and finally transform the result into the spatial domain. When the peak to signal ratio (PSNR) is low, image is transforming into the lifting based wavelet domain and then applying the wiener filter in the wavelet domain produce better result than directly applying wiener filter in spatial domain.

2. SYSTEM IMPLEMENTATION

In wavelet domain image resolution enhancement is a research topic and recently many new algorithms are proposed. Fig 2 shows structure of wavelet decomposition. Discrete wavelet transform i.e. DWT is one of the recent wavelet transforms used in image processing. DWT decomposes an original low resolution image into different sub-band images, namely low-low (LL), high-low (HL), low-high (LH), and high-high (HH) [27]. Another wavelet transform which has been used in various image processing applications is stationary wavelet transform (SWT). It means SWT is similar to DWT but it is not used down-sampling. Fig 3 is Structure of DWT decomposition & Fig. 4 is Structure of SWT decomposition.

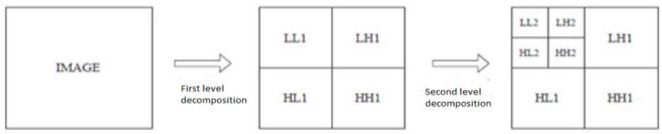

Fig.2 Structure of Wavelet Decomposition [27]

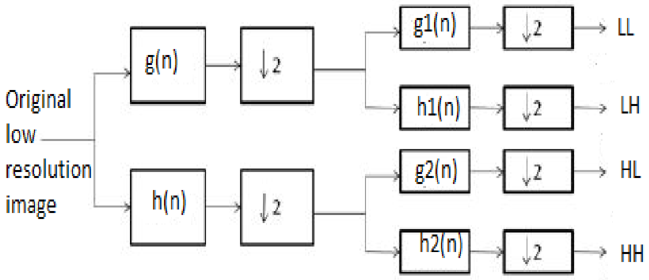

Fig.3 Structure of DWT Decomposition

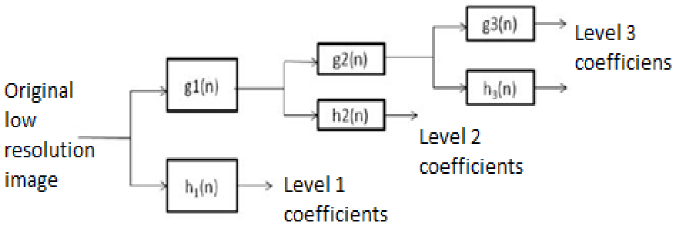

Fig.4 Structure of SWT Decomposition [27]

A sharp high resolution image produced by proposed resolution enhancement technique.. The technique utilizes DWT to decompose a low resolution image into different sub-bands [27]. After that three high frequency sub bands are interpolated. Then interpolation with enlargement factor of 2 is applied to high frequency sub band images. Down sampling in each step of the DWT sub bands causes information loss in the respective sub bands. Hence SWT is used to minimize this loss. The interpolated high frequency sub bands and the SWT high frequency sub bands have the same size so that they can be added with each other. High frequency sub bands which are new corrected can be interpolated further for higher enlargement. The low frequency sub band is the low resolution of the original image. Hence, instead of using low frequency sub band, which contains less information than the original high resolution image, the input image for the interpolation of low frequency sub band image is used. Quality of input image instead of low frequency sub band increased. Fig. 5 illustrates the detail Block Diagram of Image Super resolution using wavelet analysis [1]. Inverse DWT (IDWT) is used for getting a high resolution output image by combining all improved interpolated high frequency sub-bands and interpolated input image

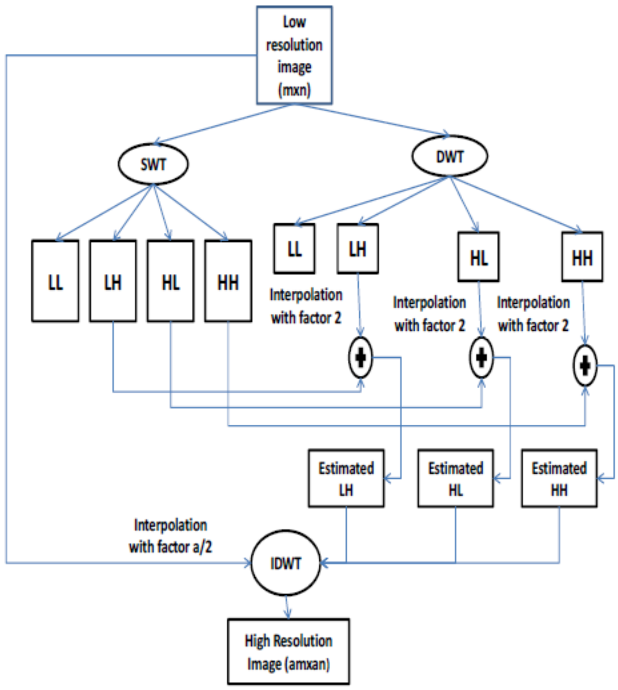

Fig.5 Detailed Block Diagram of Image Super resolution using wavelet analysis [1]

3. APPLICATION AREA

Resolved images are being used in many areas such as:
(i) Remote sensing: several images of the same area are provided, and an improved resolution image can be sought.
(ii) Surveillance video: frame freeze and zoom/focus region of interest (ROI) in video for human perception (e.g. look at the license plate in the image), resolution enhancement for automatic target recognition (e.g. try to recognize a criminal's face).
(iii) Video standard conversion, e.g. from NTSC video signal to HDTV signal.
(iv) Medical imaging (CT, MRI, Ultrasound etc): several images limited in resolution quality can be acquired, and SR technique can be applied to enhance the resolution.

4. CONCLUSION

This work proposed an image resolution enhancement technique based on the interpolation of the high frequency sub-bands obtained by DWT, correcting the high frequency sub-band estimation by using SWT high frequency sub-bands, and the input image. The proposed technique uses DWT to decompose an image into different sub-bands, 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 generated by SWT of the input image. An original image is interpolated with half of the interpolation factor used for interpolation the high frequency sub-bands. Super resolved image is generated by combining using IDWT. The proposed technique is 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 techniques.

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