Survey of Image Enhancement Techniques in Wavelet Domain

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***Abstract*: Comparison of various image resolution enhancement techniquesin wavelet domains is studied. We analyze various wavelet domain based methods such as Wavelet Zero Padding, Dual Tree-Complex Wavelet Transform, Discrete Wavelet Transform, Cycle Spinning andUndecimated Wavelet Transform. The common feature of these algorithms is that they use the low resolution image (image in which no sharp edges are present) as an input image which is then decomposed into different sub band images by using a specific wavelet transform .The decomposed image contains high and low frequency components of original image. These sub band images are interpolated with the input image. All these images are combined to generate a new resolution enhanced image by using an inverse transform.**

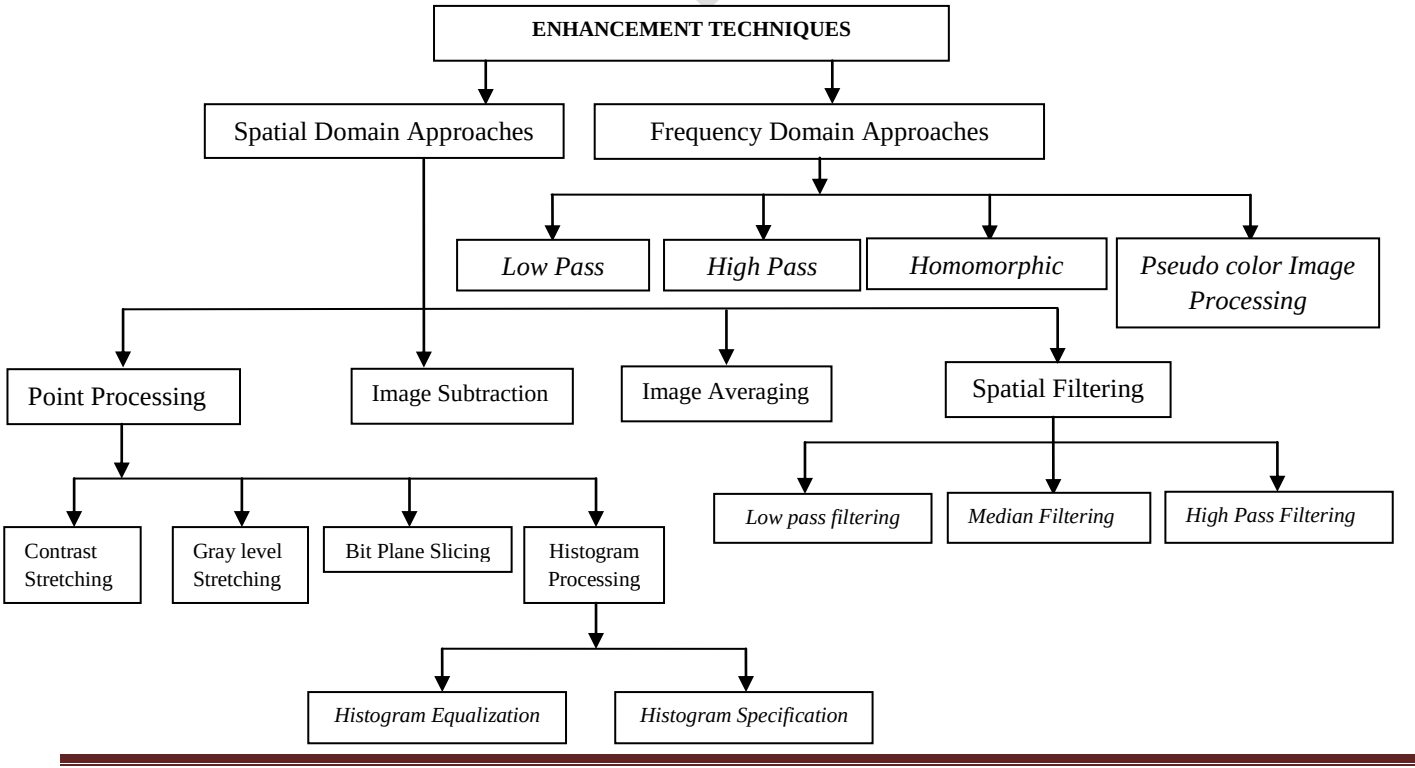
Keywords: Cycle Spinning (CS),De-noising, Discrete Wavelet Transform (DWT), Hidden Markov Tree (HMT), High Resolution (HR), Low Resolution (LR), Stationary Wavelet Transform (SWT), Wavelet Zero Padding (WZP)

I. INTRODUCTION

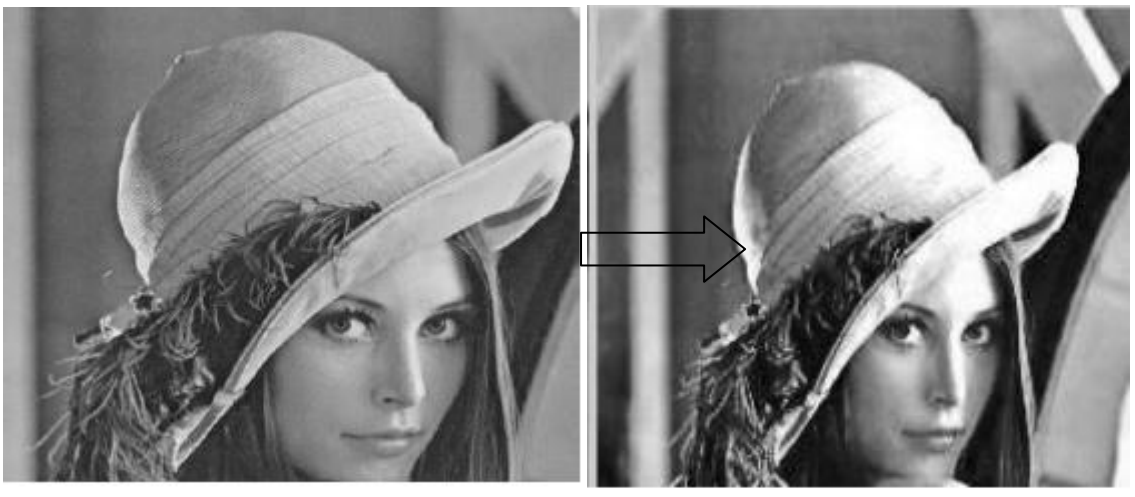
Enormous number of pictures ranging from biomedical images to the images of natural surroundings and activities around us enrich our daily visual experience. All these images create elegant perception in our sensory organs. These images contain important information and convey particular meanings in many domains of application. When such images are converted from one form to another by process such as imaging, scanning or transmitting, the quality of the output image obtained may be inferior to that of the original input picture. So, arises a need to improve the quality of such images, such that the output image is visually more pleasing to human observers from a subjective point of view. To perform this task, it is important to increase the dynamic range of the chosen features in the image, which is essentially the process of image enhancement.

Enhancement also undoes the degradation effects which might have been caused by the imaging system or the channel characteristics. The growing need to develop automated systems for image interpretation necessitates that the quality of picture to be interpreted should be free from noise and other aberrations. Thus preprocessing operations on the image need to be performed so that the resultant preprocessed image is better suited for machine interpretation. Image enhancement thus has both a subjective and an objective role and may be viewed as a set of techniques for improving the subjective quality of an image and also for enhancing the accuracy rate in automated object detection and picture interpretation. Enhancement refers to accentuation or sharpening of image features, such as contrast, boundaries, edgesetc.The process of image enhancement, however, in no way increases the information content of the image data. It increases the dynamic range of the chosen features with the final aim of improving the image quality. The realm of image enhancement covers contrast and edge enhancement, noise filtering, feature sharpening and so on.

FLOW CHART FOR IMAGE ENHANCEMENT TECHNIQUES:



Wavelet transform has been widely applied to the image enhancement. Some image enhancement algorithms only consider the enhancement and do not care about noise reduction.



Showing Effect of Image Enhancement

II. LITERATURE REVIEW

Research work of some eminent authors along with short description has been presented in this section. All the methods are used for Image enhancement using wavelet transform. Fundamental idea of wavelet transform is that the transformation should allow changes only in time extension but not shape.

A. H.Demirel and G.Anbarjafari (2011)**"*Discrete wavelet transform-based satellite image resolution enhancement"[1]***proposed resolution enhancement technique using DWT to decompose input image into different subbands.Then the HF subbandimages and the input low-resolution image have been interpolated, followed by combining all these images to generate a new-resolution enhanced image by using inverse DWT.In order to achieve a sharper image, an intermediate stage for estimating the high frequency subbands has been proposed. The quantitative and visual results show the superiority of proposed technique over the conventional and state-of-art image resolution enhancement techniques.

B. H. demirel and G. Anbarjafari (2010)***"Image resolution enhancement by using discrete and stationary wavelet decomposition" [2]***proposed an image resolution enhancement technique based on interpolation of high frequency subband 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 subbands. Then the high frequency subbands as well as input image are interpolated. The estimated high frequency subbands are being modified by using high frequency subband obtained through swt.

C. A. Temizel (2007)***"Image resolution enhancement using wavelet domain hidden markov tree and coefficient sign estimation" [3]***proposed method hidden markovtree (HMT) based methods using Gaussian mixture models to produce promising results. However, one drawback of these methods is that, as the Gaussian is symmetrical around zero, signs of the coefficients generated using this distribution function are inherently random, adversely affecting the resulting image quality. In this paper it is demonstrated that, sign information is an important element affecting the results and a method is proposed to estimate signs of these coefficients more accurately.

D. FU, J.C and Wan, Y (2007)**"*Joint Exact Histogram specification and Image Enhancement through the wavelet transform"[4]***used the improved histogram equalization in wavelet domain to enhance the image. A wavelet-based method is presented that simultaneously achieves the exact histogram specification and good image enhancement performance. It does so through a carefully designed strict pixel ordering process, during which the wavelet coefficients are fine tuned for the image enhancement purpose. 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, good statistical models, and better image enhancement performance.

E. Xiao, D (2007***) "Contrast Enhancement of Color images based on wavelet Transform and Human visual System" [5]***presented an algorithm toenhance the contrast of an image by modifying both coarse and detail coefficients.The RGB (red, green, and blue) values of each pixel in a color image are converted to HSV (hue, saturation and value) values. To the V (luminance value) components of the color image, Wavelet Transform is applied so that the V

components are decomposed into the approximate components and detail components. The obtained coefficients of the approximate components are converted by a grey-level contrast enhancement technique based on human visual system. Then, inverse Wavelet transform is performed for the converted coefficients so that the enhanced V values are obtained. The S components are enhanced by histogram equalization. The H components are not changed, because changes in the H components could degrade the color balance between the HSV components. The enhanced S and V together with H are converted back to RGB values

F. Heric, D., Potocnik, B. (2006)***"Image Enhancement by using Directional Wavelet Transform Journal of Computing in Information Technology" [6]***introduced a novel image enhancement technology based on the multiscale singularity detection with an adaptive threshold whose value is calculated via the maximum entropy measure in the directional wavelet domain.

G. Temizel, A (2006)***"Wavelet Domain Image Resolution Enhancement."[7]*** Proposed two algorithms to enhance an image resolution by estimation of detail wavelet coefficients at high resolution scales and cycle spinning methodology in the wavelet domain respectively.

H. A.Temizel and T.Vlachos (2005)***"Wavelet domain image resolution enhancement using cycle spinning and edge modelling"[8]***proposed directional variant of the cycle spinning methodology. Estimates of local edge orientation are obtained from a wavelet decomposition of the available low-resolution image and this information is used to influence the choice of cycle spinning parameters that are employed for resolution upscaling.Experimental results show that the proposed method outperforms competing methods for a wide range of images offering modest but consistent improvements both in objective as well as subjective terms.Some image enhancement algorithms only consider noise reduction and do not care about detail enhancement for example;

I. Ercelebi, E. (2006)***"Lifting-based Wavelet Domain Adaptive Wiener Filter for Image Enhancement" [9]*** proposed methodutilizes the multi-scale characteristics of the wavelet transform and the local statistics of each subband. The proposed method transforms an image into the wavelet domain using lifting-based wavelet filters and then applies a Wiener filter in the wavelet domain and finally transforms the result into the spatial domain. When the peak signal-to-noise ratio (PSNR) is low, transforming an image to the lifting-based wavelet domain and applying the Wiener filter in the wavelet domain produces better results than directly applying Wiener filter in spatial domain.

J. PengxinZeng (2004)***"An approach for wavelet based image enhancement"[10]*** proposed a wavelet based algorithm for image contrast enhancement.De-noising has an important role in enhancing, The approach developed herein processes wavelet coefficients individually, and treats the correlation between wavelet planes as providing an indication of the likelihood that noise is present, then, modifies the wavelet transform coefficients at different scales in different degrees by a point wise nonlinear transformation. The algorithm is simple to implement in software, achieving an excellent balance between the enhancement of subtle image detail, and the avoidance of noise amplification.

CONCLUSION

This paper presents a short description of various enhancement methods in order to describe the various parameters that cause image degradation and various methods for enhancement of blurred images, noise removal, setting brightness and contrast. Interpolation causes loss on high frequency components because of smoothing caused by interpolation. Fundamental idea of wavelet transform is that the transformation should allow changes only in time extension but not in shape. The **second-generation wavelet transform** (SGWT) has a number of advantages over the classical wavelet transform in that it is quicker to compute (by a factor of 2) and it can be used to generate a multiresolution analysis that does not fit a uniform grid. Using a priori information the grid can be designed to allow the best analysis of the signal to be made. The transform can be modified locally while preserving invertibility; it can even adapt to some extent to the transformed signal.

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