Comparative Study of Different Wavelet Based Interpolation Techniques

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Abstract. Images are used in many fields. One of the major issues of image is zooming. Zooming is used to increase the image resolution. Zooming is done through various interpolation methods. Interpolation is used for image scaling and zooming. Image zooming is process to extending an image to create a large image. There are several techniques of zooming. Wavelet transform is used due to the reason to obtain the image without distortion. This paper starts with the study of image zooming, their need and use of image zooming. This paper presents a review on different wavelet based interpolation techniques and their comparisons.

Keywords: zooming, interpolation, wavelet transform, wavelet based interpolation, zoomed image.

I. Introduction

Image zooming simply means enlarging an image. So that the details of the image became more clear and visible. Zooming is used in many applications including the World Wide Web, digital video, DVDs and scientific imaging. When pixels are inserted into an image in order to expand the size of an image then the major task is the interpolation of new pixels from the surrounding original pixels. There are many reasons to be interested to zooms an image retaining as most as possible of the information it contains. Image zooming is done through interpolation methods. There are several types of zooming techniques are used. Linear techniques, non - linear techniques, transform techniques, statistical techniques, wavelet transform techniques and PDE based techniques. Linear techniques use linear space invariant filters to interpolate the high resolution zoomed image. Non linear technique use non linear optimization process. Transform techniques are focused on the used of multi resolution decomposition. Statistical techniques estimate the high resolution image based on the properties of low resolution image. The wavelet transform techniques decompose a digital image into some frequency sub images. Each sub image represented with frequency resolution. PDE based approaches are used to interpolation using geometric diffusion equation. There are some important requirements for image zooming or interpolation. Zoomed or interpolated image should be clear and smooth. Zooming operation should be on high speed. The interpolated image performance is measured on the basis of the peak signal to noise ratio (PSNR) and mean square error (MSE). PSNR value should be high and MSE value should be low. The wavelet transform is very good technique for image zooming. It provides a high quality image results. This paper proposing comparative study of image interpolation using wavelet based interpolation techniques.

II. Literature Review

T. M Lehmann et al. [2] presents a literature review on comparison of sinc, nearest neighbor, quadric, linear, cubic, Gaussian interpolation and approximation techniques with kernel sizes from 1 * 1 up to 8 * 8.

A. Gotchev et al. [3] produces a method that investigates the applicability of modified B-spline function. This method is a computationally efficient method based on the use of modified forrow structure.

H. Chen et al. [4] propose a new FIR image interpolation filter. The goal of this method is to minimize the ripple response around edges. This approach shows better result than bilinear interpolation and cubic convolution interpolation.

S. E. Reichenbach et al. [5] develops two dimensional piecewise cubic convolution for image interpolation. This approach develops a closed form derivation for a two parameters, 2-D PCC kernel.

H. jiang et al. [6] presents a novel image interpolation method based on variational models. This method had very low complexity and it is useful for real time applications.

B. S. Morse et al. [7] introduces a method for smoothing of artifacts. This method is similar to iterative reconstruction algorithm and to Bayesian reconstruction techniques.

H. Aly et al. [8] presents a new formulation of the regularized image up sampling problem.

Y. Takahashi et al. [9] proposed the image enlargement method. This method is based on laplacian pyramid which can get only a two times enlarged image.

X. Lu et al. [10] introduce a method that uses angular orientation of image features to enhance the subjective quality of an image. The subjective quality of this method is improved to conventional methods.

R. R. Schultz et al. [11] proposed a method for non linear expansion. This method preserves the discontinuities of an image and producing improved expanded images of this method will be shown quantitatively better than standard methods.

C. B. Atkins et al. [12] introduces an approach called resolution synthesis. In this approach, the pixels are interpolated in the context of neighboring pixels and the corresponding high resolution pixels are obtained by filtering.

Xin. Li. et al [17] has given the hybrid approach by combining the bilinear interpolation and covariance based adaptive interpolation.

Yu. Len Huang [18] presents a neural network interpolation method which is based on wavelets. This method is very easy to implement and flexible.

Hasan Dermiral et al. [19] present a DWT and SWT technique. DWT is used to decompose an input image into different sub bands. But some information loss occurs in sub bands of DWT due to down sampling. To overcome this problem SWT is used as a redundant technique because SWT contains the same number of outputs as input.

Joachim Weichert [21] presents a PDE based approach that using the geometric diffusion equation.

III. Proposed Work

Wavelets are "small waves". These waves have varying frequency and limited duration. Wavelet transforms are used to represent an image in multiple resolutions. Wavelets cut up data into

different frequency component and study each component. Wavelets are better than traditional Fourier methods.

In wavelet based interpolation, image pixels are interpolated using wavelets. Wavelet based interpolation is used because of the main two properties of wavelets: admissibility and regularity conditions. In this multi resolution framework (MRA) is used for interpolation. In MRA, a high resolution image is decomposed into a low resolution image and three wavelets detail images with horizontal, vertical and diagonal edge information are produce at each scale. There are four types of wavelet families are used in wavelet based interpolation: haar, daubechies, dual tree complex wavelet transform and bi orthogonal.

In this experiment four types of wavelet interpolation methods are examined: NEDI, wavelet based image interpolation using multilayer perceptrons, DWT based image interpolation and SWT based image interpolation.

A. NEDI

NEDI stands for new edge directed image interpolation. This is a hybrid approach. It is combination of bilinear interpolation and covariance based adaptive interpolation. Covariance based adaptive interpolation is applied to edge pixels and simple bilinear interpolation is applied on non edge pixels.

B. Wavelet based Image Interpolation using Multilayer Perceptron

This technique uses the neural network which is based on wavelets. This is a non linear interpolation technique. In this, the neural networks are trained with wavelet decomposition. The pixels are used as input signal in the low resolution image of the neural network to estimate the sub images of the wavelets with high resolution image.

C. DWT based Image Interpolation

DWT (discrete wavelet transforms) is used to decompose input image into different sub bands. There are three frequency sub bands (LH, HL, HH), which contains high frequency components of given input image. The enlargement factor of 2 with bi cubic interpolation is applied to high frequency sub band images.

D. SWT based Image Interpolation

Information loss occurs in DWT due to down sampling. To overcome this loss, SWT (stationary wavelet transforms) is used. SWT is a redundant technique. The output of each level of SWT contains same samples as the output.

IV. Result and Discussion

This work provided wavelet based interpolation techniques and after comparison of different wavelet based image interpolation techniques used in image interpolation, NEDI provide effective image results. There results are also compared for the processing of different images.

Table 1: Interpolation evaluation of multiple methods using the PSNR and MSE

METHODS	PSNR	MSE
NEDI	35.95467102	16.50491374
Wavelet based image interpolation using multilayer perceptron	32.24370901	38.78907831
DWT based image interpolation	6.964075288	130.96046
SWT based image interpolation	11.49916374	46.303965

Fig.1. Image interpolation results obtained using the NEDI

Fig.2. Image interpolation results using wavelet based image interpolation using multilayer perceptrons

Fig.3. Image interpolation results using DWT

Fig.4. Image interpolation results using SWT

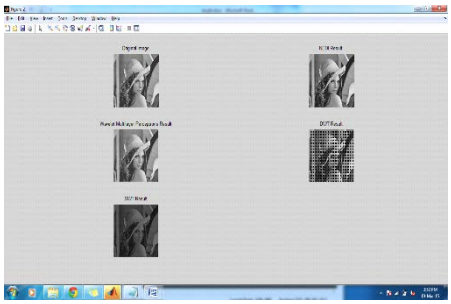

Fig.5. Combined results

V. Conclusions

It is possible to interpolate an image using wavelet transform with different interpolation techniques. Wavelet transform has made great progress in the last few years. In this study, the DWT technique gives bad picture quality. Neural networks should be used to increase the picture quality. Results have shown that the NEDI is effective technique for interpolation.

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