ISSN 2395-1621

Image Enhancement by Using Direct and Indirect Interpolation technique in spatial domain

#1Faisal A Khan,#2 Prof S P Bhosale

1Faisal.a.fkhan@gmail.com
2Spbhosale23@rediffmail.com

#1Pune University, A.I.S.S.M.S's COE,
Kennedy Road, Pune
#2 Assistant Professor, Department of Electronics,
A.I.S.S.M.S's COE,
Kennedy Road, Pune

ABSTRACT

In this proposed project, we have considered the multi frame input image which is captured by the ordinary cameras. This input image is enhanced by the use of interpolation technique in spatial domain. The interpolation technique used is gradient based interpolation which is also called as directed algorithm which provides the interpolation along the edges of images. These techniques provide the better results than non directed linear interpolation methods.

Keywords-- interpolation; Bicubic; b-spline; zero padding; Evaluation Metrics

ARTICLE INFO

Article History

Received : 8th July 2015

Received in revised form :

9th June 2015

Accepted : 11th July 2015

Published online :

15th July 2015

I . INTRODUCTION

In many image-processing applications, digital images must be zoomed to enlarge image details and highlight any small structures present. This is done by making multiple copies of the pixels in a selected region of interest (ROI) within the image. Several algorithms are used to perform such an operation. The simplest and most accurate, known as a discrete replicating zoom, displays multiple copies of each pixel in the ROI. Because this algorithm operates in discrete steps, it can produce zoomed images at integral zoom factors of 2X, 4X, and higher. Depending on the spatial resolution of the image, individual pixels can become apparent at 4X or higher zoom factors.

Fractionally zoomed images can also be obtained by varying the number of copies made of each pixel in the ROI. The most common algorithm is the fractional replicating zoom, which operates by copying pixels from the source image into the zoomed image based upon an inexact spatial correspondence between the two. In effect, pixel addresses in the source image are calculated fractionally, based on the ratio between the zoomed image dimensions and the source image dimensions. Because the calculated pixel address is fractional, the effect of this fractional part can be determined by a number of interpolation methods.

II .RELATED WORK

In [1] authors used Depth Image Based Rendering (DIBR) is an approach to generate a 3-D image by the original 2-D color image with the corresponding 2-D depth map. Although DIBR is a quite convenient technique of converting 2D to 3D images, there is a big problem in DIBR system that it cannot reach real-time processing due to the computing time.[5] In this correspondence, the authors propose 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.[6] author consider the problem of high-quality interpolation of a single noise-free image. Several aspects of the corresponding super-resolution algorithm are investigated: choice of regularization term, dependence of the result on initial approximation, convergence speed, and heuristics to facilitate convergence and improve the visual quality of the resulting image.

[4] Here single image super resolution algorithm is presented which based on both spatial and wavelet domain and take the advantage of both. Algorithm is iterative and use back projection to minimize reconstruction error. Wavelet based de noising method is also introduced to remove noise.

III . PROPOSED ALGORITHM

A. Bicubic Interpolation:

For Bicubic interpolation, the block uses the weighted average of four translated pixel values for each output pixel value.

For example, suppose this matrix,

1 2 3

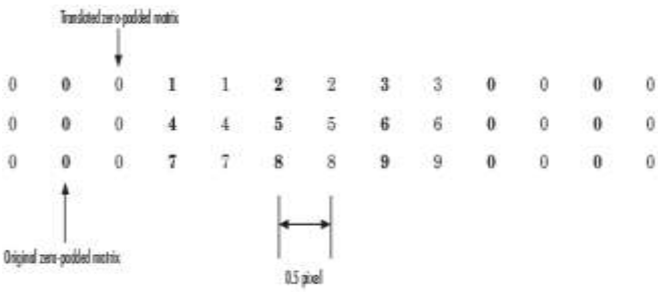
4 5 6

7 8 9

represents your input image. You want to translate this image 0.5 pixel in the positive horizontal direction using bicubic interpolation.

The Translate block's Bicubic interpolation algorithm is illustrated by the following steps:

- Zero pad the input matrix and translate it by 0.5 pixel to the right.



- Create the output matrix by replacing each input pixel value with the weighted average of the two translated values on either side. The result is the following matrix where the output matrix has one more column than the input matrix:

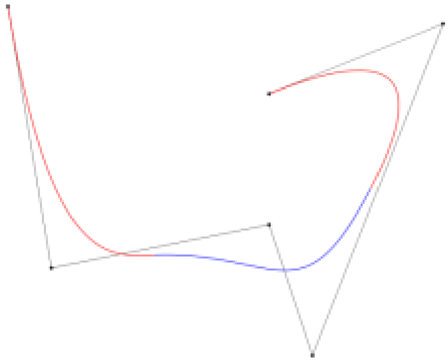
0.375	1.5	3	1.625
1.875	4.875	6.375	3.125
3.375	8.25	9.75	4.625

B. B -spline interpolation:

In the mathematical subfield of numerical analysis, a B-spline, or basis spline, is a spline function that has minimal support with respect to a given degree, smoothness, and domain partition. Any spline function of given degree can be expressed as a linear combination of B-splines of that degree. Cardinal B-splines have knots that are equidistant from each other. B-splines can be used for curve-fitting and numerical differentiation of experimental data.

In the computer-aided design and computer graphics, spline functions are constructed as linear combinations of B-splines with a set of control points.

A B-spline is a piecewise polynomial function of degree <n in a variable x. It is defined over a domain t 0 ≤ x ≤ tm, m = n. The points wherex = t j are known as knots or break-points. The number of internal knots is equal to the degree of the polynomial if there are no knot multiplicities. The knots must be in ascending order. The number of knots is the minimum for the degree of the B-spline, which has a non-zero value only in the range between the first and last knot. Each piece of the function is a polynomial of degree <n between and including adjacent knots. A B-spline is a continuous function at the knots.[note 1] When all internal knots are distinct its derivatives are also continuous up to the derivative of degree n-1. If internal knots are coincident at a given value of x, the continuity of derivative order is reduced by 1 for each additional knot.



C. Zero padding Interpolation:

It is one of the simplest methods for image resolution enhancement. It assumes that the signal is zero outside the original support. The most common form of zero padding is to append a string of zero-valued samples to the end of some time domain sequence Zero padding is used in spectral analysis with transforms to improve the accuracy of the reported amplitudes, not to increase frequency resolution. Without zero- padding, input frequencies will be attenuated in the output.

Zero padding in the time domain is equivalent to optimal interpolation in the frequency domain, which restores the correct amplitudes. Since the wavelet transform is defined for infinite length signals, finite length signals are extended before they can be transformed. One of the common extension methods is zero padding. Zero padding shifts the inter sample spacing in frequency of the array that represents the result.

Zero padding consists of extending a signal (or spectrum) with zeros. It maps a length N signal to a length M>N signal, but need not divide M. Zero Pad M, m(x) = x (m), 0≤m≤N-1 0, N≤m≤M-1 For example, ZeroPad10([1,2,3,4,5])=[1,2,3,4,5,0,0,0,0,0] The above definition is natural when x(n) represents a signal starting at time 0 and extending for N samples. If, on the other hand, we are zero-padding a spectrum, or we have a time domain signal which has nonzero samples for negative time indices, then the zero padding is normally inserted between samples (N- 1)/2 and (N+1)/2 for N odd and similarly for N even that is for spectra, zero padding is inserted at the point Z=-

1(w=πf0). Below figure illustrates the second form of zero padding. It is also used in conjunction with zero-phase FFT window.

The same signal interpolated over the domain k є [-(N-1)/2,(N-1)/2] which is more natural for interpreting negative frequencies fig d Zeropad11(X) plotted over the zero centered domains. In image resolution enhancement, wavelet transform of a low resolution (LR) image is taken and zero matrices are embedded into the transformed image, by discarding high frequency sub bands through the inverse wavelet transform and thus high resolution (HR) image is obtained.

D. Evaluation Metrics:

Peak signal-to-noise ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale.

PSNR is most commonly used to measure the quality of reconstruction of lossy compression codecs (e.g., for image compression). The signal in this case is the original data, and the noise is the error introduced by compression. When comparing compression codecs, PSNR an *approximation* to human perception of reconstruction quality. Although a higher PSNR generally indicates that the reconstruction is of higher quality, in some cases it may not. One has to be extremely careful with the range of validity of this metric; it is only conclusively valid when it is used to compare results from the same codec (or codec type) and same content.[1][2]

PSNR is most easily defined via the mean squared error (*MSE*). Given a noise-free $m \times n$ monochrome image I and its noisy approximation K, MSE is defined as:

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

The PSNR (in dB) is defined as:

$$\begin{aligned} PSNR &= 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \\ &= 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \\ &= 20 \cdot \log_{10}(MAX_I) - 10 \cdot \log_{10}(MSE) \end{aligned}$$

Here, MAX_I is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255. More generally, when samples are represented using linear PCM with B bits per sample, MAX_I is 2^B-1. For color images with three RGB values per pixel, the definition of PSNR is the same except the MSE is the sum over all squared value differences divided by image size and by three. Alternately, for color images the image is converted to a different color space and PSNR is reported against each channel of that color space, e.g., YCbCr or HSL.

RMSE:

RMSE is the square root of the mean square error of an image.

MMSE:

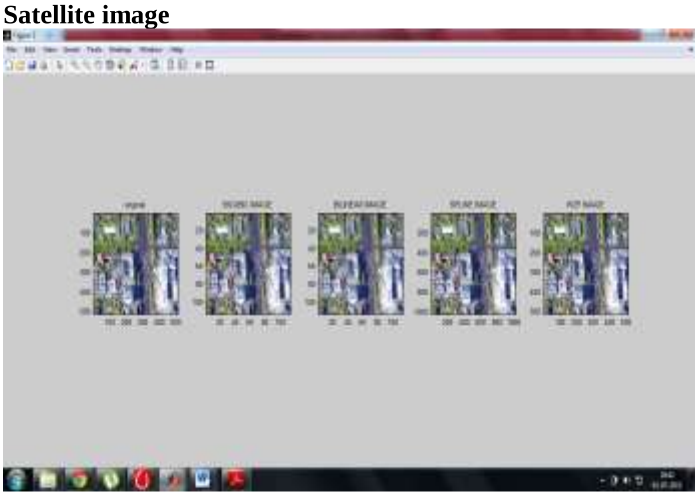
In statistics and signal processing, a minimum mean square error (MMSE) estimator is an estimation method which minimizes the mean square error (MSE) of the fitted values of a dependent variable, which is a common measure of estimator quality.

The term MMSE more specifically refers to estimation in a Bayesian setting with quadratic cost function. The basic idea behind the Bayesian approach to estimation stems from practical situations where we often have some prior information about the parameter to be estimated. For instance, we may have prior information about the range that the parameter can assume; or we may have an old estimate of the parameter that we want to modify when a new observation is made available; or the statistics of an actual random signal such as speech.

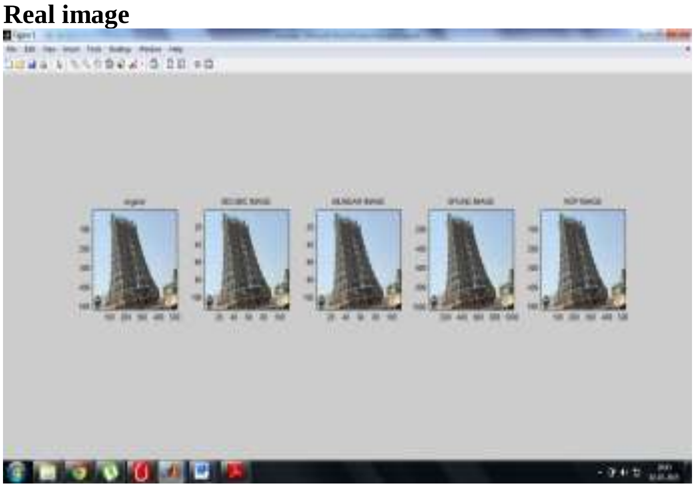
IV . SIMULATION RESULTS

The simulation studies involve the analysis of interpolation techniques in natural, satellite and test image. The proposed algorithm is implemented with MATLAB. We used the same size o. Proposed algorithm is compared between metricsPSNR, MMSE and RMSE on the basis of images.

Satellite image



Real image



Test image

Tabulation:

For Satellite Image:

Method	PSNR	RMSE	MMSE
Bicubic Interpolation	22.3116	19.5415	0.022035
Bilinear Interpolation	22.0545	317.2076	0.022035
B-spline Interpolation	35.0956	123.5214	0.0050551
WZP	**35.3324**	**94.3906**	**0.0049163**

For Real Image:

Method	PSNR	RMSE	MMSE
Bicubic Interpolation	25.3968	13.6994	0.015446
Bilinear Interpolation	25.1793	222.482	0.015446
B-spline Interpolation	**38.2555**	**82.1222**	**0.0035134**
WZP	35.0638	72.8286	0.0050687

For Test Image:

Method	PSNR	RMSE	MMSE
Bicubic Interpolation	29.0978	8.9464	0.010087
Bilinear Interpolation	28.854	164.0064	0.010087
B-spline Interpolation	42.5816	58.1593	0.0021349
WZP	**42.1836**	**36.5299**	**0.0022337**

V. CONCLUSION AND FUTURE WORK

The simulation results showed that the WZP performs better in the satellite and test images based on the performance metrics. And for the real image it is shown that the b-spline interpolation performs better than the other methods. In future , we like to perform a zeropadding interpolation based on the other wavelets.

REFERENCES.

[1] Chin-Hsie,Wes-Hancheng; “Spatial Domain complexity reduction Method for Depth Image Based Rendering using wavelet” IEEE 2013.

[2] Marwa Moustafa,Halu M. Bbied,Ashraf Helmy; “Analysis of shift Estimation for Super resolution applied to Satellite ” IEEE2013.

[3] Georgios Georgis, George Lentaris and Dionysios Reisis; “Single Image super Resolution using Complexity Adaptive Iterative Back Projection” IEEE 2013.

[4] Sapan Naik; Nikunj Patel; “ Single image resolution in spatial and wavelet Domain’’ IJMA august 2013.

[5] Hasan Demirel ; Gholamreza Anbarjafari; “Image Resolution based on interpolation of wavelet high frequency sub images and spatial domain input Images” ETRI June 2010

[6] Alex Lukin,Andrew S.Krylov; “Image Interpolation by Super Resolution” IJTR 2011

