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Image Enhancement Using Various Interpolation Methods

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***Abstract* - Image Enhancement is found to be a very effective technique useful in today's digital image processing applications. Image Enhancement technique has some limitations due to which we often get low resolution images after Enhancing the Image [1]. Interpolation is a process by which we can generate bigger or High Resolution image from one or more Low Resolution or Smaller images [2]. Due to these obvious benefits many Interpolation methods have been developed.**

Here we have described basics of Interpolation and different methods of Interpolation available for image Enhancement. It is known that the traditional interpolation based approaches, such as Bilinear or Bicubic interpolation, blur the resultant images [2]. Also in color images, these interpolation based methods may have color infringing artifacts in the areas where the images contain sharp edges and fine textures. We have studied one wavelet based algorithm for doing Image Enhancement with the detail of discrete wavelet transform (DWT) and encoding scheme. In this paper, we present some interesting methods of Interpolation for Image Enhancement.

Keywords – Interpolation, Edge Guided, Up-Sampling, Discrete Wavelet Transform (DWT)

I. INTRODUCTION

Image Interpolation: Interpolation is the primary technique used for image scaling. Image scaling is the process of taking a source image and extending it to create a large image. The primary problem with enlarging images using interpolation is that the large result contains the same amount of discrete data as smaller source image [9].

Two Basic types of interpolation are bilinear and bicubic. Bilinear interpolation uses 2x2 neighbourhoods of data points to calculate pixel color between data points. Bicubic interpolation uses 4x4 neighbourhoods of data points to calculate pixel color between data points [2].

It has applications in medical imaging, remote sensing, digital photographs, etc. While the commonly used linear methods, such as pixel duplication, bilinear interpolation, and bicubic convolution interpolation, have advantages in simplicity and fast implementation [7]. The traditional linear interpolation methods do not work very well under the edge preserving criterion. Some nonlinear interpolation techniques were proposed in recent years to maintain edge sharpness. Generally, nonlinear interpolation methods are better at edge preservation than linear methods.

The Nonlinear interpolation approach performs significantly better than linear interpolation methods in preserving edge sharpness while suppressing artifacts, by adapting interpolation to local image gradient. A drawback of the nonlinear interpolation approach is its relatively high computational complexity. We have developed a simplified interpolation algorithm of greatly reduced computation requirement but without significant degradation in performance.

The paper is organized as follows. Section II describes Simple image interpolation algorithm by finding the average (Mean) of neighbor pixels. Section III presents Interpolation Algorithm for Image Up-sampling using DWT (Discrete Wavelet Transform). Section IV describes Edge Guided Interpolation Method. Whereas Section VI concludes.

II. BASIC INTERPOLATION METHOD

In Basic Interpolation method, the image will be expanded from its actual size to a larger size by finding the average (Mean) of its neighbor pixels. This can also be done by finding the Median & maximum of its neighbor pixels. But the problem by finding the Median is that it is very time consuming & complex [4]. Whereas in case of Maximum, the image quality is not as good as compared to that of the image quality we get by finding the Mean of its neighboring pixels. Here the image is expanded to size (2n-1) x (2m-1) as shown in the figure (1) & (2).

Original Image (m by n)
Figure (1)

X		**X**		**X**		**X**		**X**
X		**X**		**X**		**X**		**X**
X		**X**		**X**		**X**		**X**
X		**X**		**X**		**X**		**X**
X		**X**		**X**		**X**		**X**

Expanded Image (2m-1 by 2n-1)
Figure (2)

Then in the remaining three phases, the undefined pixels will be filled by taking the average values of the neighboring pixels. The method of obtaining the unfilled pixels is shown in the figures (3), (4) & (5). After first, second and third pass, all the unfilled pixels will be filled by taking the Mean values of the neighboring pixels.

A. Algorithm

Step 1: Take input image of size m x n.
Step 2: Take Interpolation matrix with all its element zero of size 2m-1 x 2n-1.
Step 3: Fill Interpolation matrix with the equation as given in figure below.

X 1		**X 2**		**X**		**X**		**X**
	1		**1**		**1**		**1**	
X 3		**X 4**		**X**		**X**		**X**
	1		**1**		**1**		**1**	
X		**X**		**X**		**X**		**X**
	1		**1**		**1**		**1**	
X		**X**		**X**		**X**		**X**
	1		**1**		**1**		**1**	
X		**X**		**X**		**X**		**X**

After 1st pass
1 = (x1+x2+x3+x4)/4
Figure (3)

X		**X**		**X**		**X**		**X**
	1	**2**	**1**	**2**	**1**	**2**	**1**	
X	**2**	**X**	**2**	**X**	**2**	**X**	**2**	**X**
	1	**2**	**1**	**2**	**1**	**2**	**1**	
X	**2**	**X**	**2**	**X**	**2**	**X**	**2**	**X**
	1	**2**	**1**	**2**	**1**	**2**	**1**	
X	**2**	**X**	**2**	**X**	**2**	**X**	**2**	**X**
	1	**2**	**1**	**2**	**1**	**2**	**1**	
X		**X**		**X**		**X**		**X**

After 2nd pass
2 = (x+x+1+1)/4
Figure (4)

X	**3**	**X**	**3**	**X**	**3**	**X**	**3**	**X**
3	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**3**
X	**2**	**X**	**2**	**X**	**2**	**X**	**2**	**X**
3	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**3**
X	**2**	**X**	**2**	**X**	**2**	**X**	**2**	**X**
3	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**3**
X	**2**	**X**	**2**	**X**	**2**	**X**	**2**	**X**
3	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**3**
X	**3**	**X**	**3**	**X**	**3**	**X**	**3**	**X**

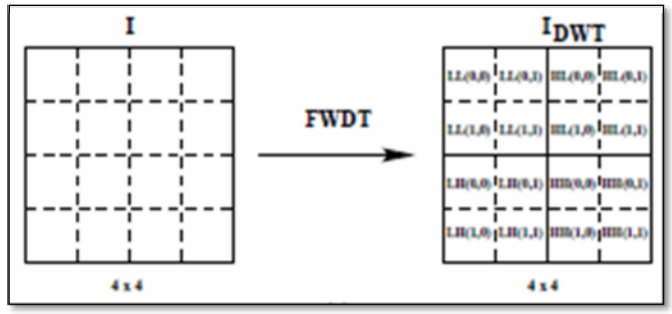
After 3rd pass
3 = (x+x+1)/3
Figure (5)

As seen in the figures above, we have taken the average of neighbour pixels. We can modify these equations and we can take maximum value or median value from neighbour pixels.

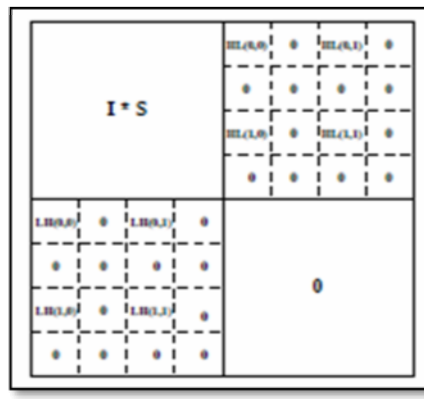
III. IMAGE UP-SAMPLING USING DISCRETE WAVELET TRANSFORM (IDWT)

The main goal of this algorithm is to do Image Enhancement using Wavelet based interpolation [5]. Here we up-sample an input image (I) of resolution m x n *shown* in Figure (6) (a) to an image (I') of resolution $2m \times 2n$. we transform the image using the forward discrete wavelet transform (FDWT) in order to decompose it into four subbands – one low Frequency subband (*LL*) and three high frequency subbands (*HL*, *LH* and *HH*), resulting in the wavelet coefficient image I_{DWT} of size $m \times n$ [9]. The *HL* and *LH* subbands contain edge Information whereas the HH subband is been dropped as it does not impact the perceptual quality of the up-sampled image [8] [11]. Figure (6)(a).

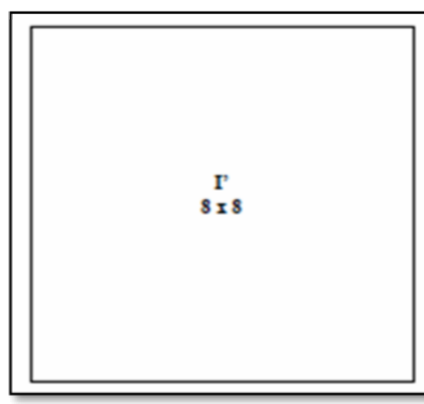
Then the next aim is to form a new wavelet coefficient image I'_{DWT} of size $2m \times 2n$. Here the *LL* subband is the original input image I with each pixel multiplied by a *scaling factor* ***s***. The scaling factor is determined by the DC gain of the low pass filter coefficients used in the DWT. As shown in Figure (6)(b), the new *HL* and *LH* subbands of the virtual DWT image (I'_{DWT}) are generated from the original *HL* and *LH* subbands by inserting zeros in alternate rows and columns. Finally we inverse transform (IDWT) this virtual DWT image (I'_{DWT}) that we formed. The resultant image after IDWT is the desired up-sampled image I' of resolution $2m \times 2n$ [5].



(a)



(b)



(c)
Figure (6)

A. Algorithm

Step 1: As shown in figure Initialize a matrix I'_{DWT} of dimensions 2m× 2n with all its elements as zeros.

Step 2: Set the original image to a matrix I of dimension m× n.

Step 3: Multiply I by the scale factor **s** to produce a matrix ILL. Replace the top-left quadrant of I'_{DWT} by ILL.

Step 4: Apply the high-pass wavelet filter (without down-sampling) in each row of I followed by the low-pass filter in each column. Set alternate rows and columns of the resulting matrix to zeros to produce a matrix IHL. Replace the top-right quadrant of the matrix I'DWT by this IHL.

Step 5: Apply the low-pass wavelet filter (without down-sampling) in each row of I followed by the high-pass filter in each column. Set alternate rows and columns of the resulting matrix to zeros to produce a matrix ILH. Replace the bottom-left quadrant of matrix I'_{DWT} by this ILH.

Step 6: Apply the inverse DWT on matrix I'_{DWT} to produce I' [8] [10].

The above algorithm for image Up-sampling using DWT has been obtained with the fix scaling factor as 2. But its results can be improved by varying the value of Scaling factor (S). Hence it proves that the resolution of the above algorithm mainly depends on the Value of Scaling factor. The value of S can be modified depending upon the Image so as to obtain the better enhanced Image [11].

IV. EDGE GUIDED INTERPOLATION METHOD

In interpolation method the main issue is to find out information of missing pixels from neighboring pixels as shown in figure(7).

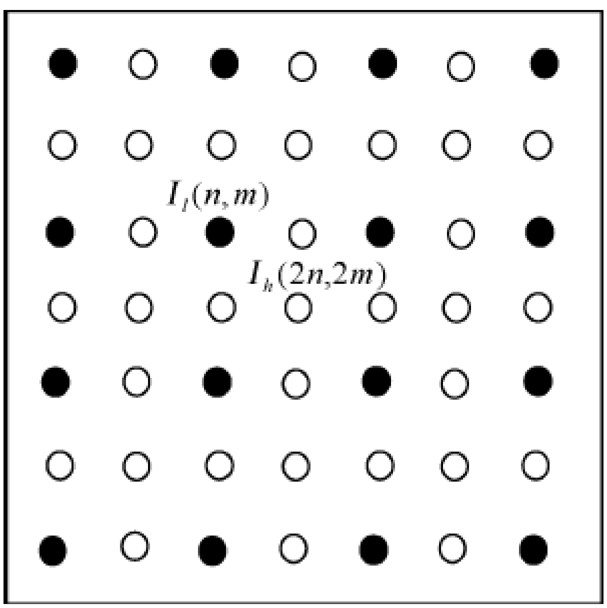


Figure (7)

The black dots represent the LR image pixels and the white dots represent the missing HR samples.

The edge direction is the most important information for the interpolation process. Interpolation method for HR image reconstruction suffers from aliasing problem if signal of LR image is down sampled and exceeds Nyquist sampling limit. In spatial locations our human visual system is very sensitive to the edges in image so it is important to suppress interpolation artifacts at the same time maintaining the sharpness and geometry of edges [6].

Here we have used An Edge-Guided Image Interpolation Algorithm via Directional Filtering and Data Fusion. We can use wavelet based Interpolation method also to do Image Enhancement. For edge information we have partitioned pixels into two: directional and orthogonal subsets. Directional interpolation is made for each Subset and two interpolated values are fused [6]. Algorithm presented before works for gray scale images only. So we have done some modification so that it will work for RGB images. As shown below, We have stored each R, G and B components of one image into three different images of two dimension (same as grayscale image) and give that as a input to original algorithm. Finally we have merge all three output arrays into single RGB image.

```
for i=1:m
for j=1:n
R(i,j)=Input(i,j,1);
G(i,j)=Input(i,j,2);
B(i,j)=Input(i,j,3);
end
end
for i=1: (2*m)
for j=1: (2*n)
RGB (i,j,1)=Output(i,j);
end
end

% same way RGB (i,j,2)and RGB(i,j,3)is
achieved
```

.

V. CONCLUSION

In this paper, we have done the modifications in various methods of Interpolation for Image Enhancement. Initially we discussed the basic Interpolation methods like Bilinear and Bicubic methods and their applications. Then we presented the Basic Adaptive Interpolation method which uses the neighboring pixels for finding the unfilled pixels in the image. Here we proved that by taking the mean of the neighboring pixels, we can get a good quality image even after expanding in compared to that of Median and Maximum.

In section III we used the Image Up-sampling Algorithm using DWT where we proposed that depending upon the image, if we change the fix scaling factor (S) to variable, then we can get a better resolution image at the end of

Enhancement. And finally in section IV, we described the Edge Guided Interpolation Method where we proposed a new Algorithm for Color images. Till now Edge Guided Interpolation Method was only used for Gray-scale images.

References

[1] Ankit Shah, Parth Bhatt, Prof. Kirit J. Modi. Image Enhancement Techniques by Texture Synthesis.

[2] Parth Bhatt, Ankit Shah, Sunil Pathak. Real Time Image Enhancement using Texture Synthesis (RETS).

[3] Dong-Hak Shin and Hoon Yoo. Image quality enhancement in 3D computational integral imaging by use of interpolation methods.

[4] Liyakathunisa, C.N.Ravi Kumar. A Novel and Efficient Lifting Scheme based Super Resolution Reconstruction for Early Detection of Cancer in Low Resolution Mammogram Images.

[5] Ping-Sing Tsai, Tinku Acharya. Image Up-Sampling Using Discrete Wavelet Transform.

[6] Lei Zhang, *Member, IEEE*, and Xiaolin Wu, *Senior Member, IEEE*. An Edge-Guided Image Interpolation Algorithm via Directional Filtering and Data Fusion.

[7] Liyakathunisa and C.N.Ravi Kumar, “Advances in Super Resolution Reconstruction of Low Resolution Images" International Journal of Computational Intelligence Research.

[8] M. Antonini, M. Barlaud, P. Mathieu, and I. Daubechies, “Image coding using wavelet transform,” IEEE Trans. on Image Processing,

[9] S.K.Mohiden, Perumal,Satik, “Image Denosing using DWT”.

[10] T. Acharya and P.-S. Tsai, “Edge enhanced image up-sampling algorithm using discrete wavelet transform,”

[11] Sapan Naik and Viral Borisagar, “ Super-resolution using Interpolation and Wavelet Lifting Scheme”