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Resolution Enhancement of Image using Discrete Wavelet Transform and Absolute Maximum Fusion Rule

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***Abstract*— One of the most important quality factors in images comes from its resolution. Interpolation is a method to increase the resolution of a digital image. We propose a new image resolution enhancement technique based on the interpolation of the high-frequency sub bands obtained by discrete wavelet transform (DWT) and the input image. After getting enhanced images we use Absolute Maximum Fusion Rule to get fused enhanced output image. In resolution enhancement technique. Discrete wavelet transform is used to decompose the input image into different sub bands. Then, the input low resolution image and high-frequency sub band images has been interpolated, then by combining all these images to generate a new resolution-enhanced image by using inverse discrete wavelet transform. An Intermediate stage is used to achieve a sharper image. The proposed technique has been tested by using quantitative (peak signal-to-noise ratio and root mean square error) and visual results.**

Index Terms—Discrete wavelet transform (DWT), Interpola- tion, Image resolution enhancement, Image fusion.

I. INTRODUCTION

Image enhancement remains a very important topic because of its usefulness in virtually all image processing applications like feature extraction ,image analysis, and visual information display. The enhancement process itself does not increase the inherent information content in the data. It emphasizes certain specified image characteristics. In order to increase the quality if enhanced image preserving the edges is important. Resolution of an image has been always an important issue in many applications. Wavelets are playing a significant role in many image processing applications. The second level wavelet decomposition of an image is performed by applying the 1-D discrete wavelet transform (DWT) [2] along the rows first, and then the results are decomposed along the columns of an image. This results in four decomposed sub band images referred to low low (LL), low-high (LH), high-low (HL), and high-high (HH). The frequency components of those sub bands cover the full frequency spectrum of the original image.

Image fusion is used to combine relevant information from two or more images of the same scene into a single composite image which is more informative and is more suitable for human and machine perception.

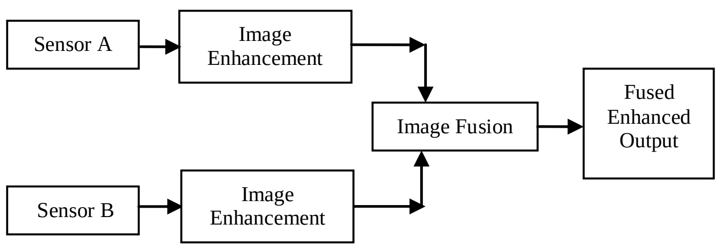

Fig 1: Overview of Project

II. SUB BAND CODING

Step 1: Row wise processing to get H and L [4]
H= (Ro-Re)
L= (Re+H/2)
Where Ro and Re is the odd row and even row wise pixel value.

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Step 2: Column wise processing to get LL,LH,HH and HL
Separate odd and even column of H and L
Namely,
Hodd:-odd column of H   Heven:-even column of H
Lodd:-odd column of L   Leven:-even column of L
LL = Leven + *LH / 2*
LH = Lodd – Leven
HL = Heven + *HH / 2*
HH = Hodd – Heven

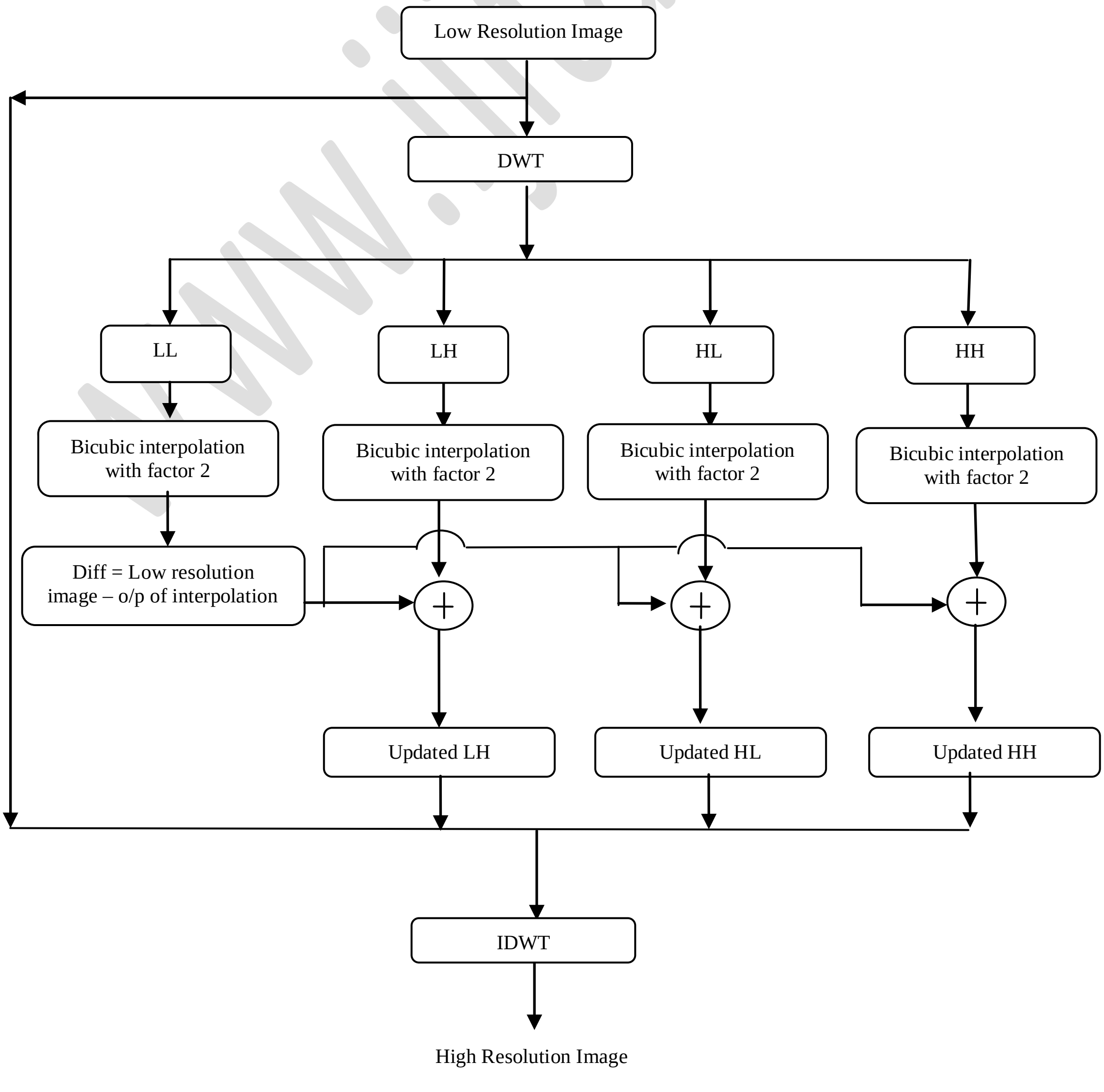
III. INTERPOLATION

Interpolation [3] in image processing is method to increase the number of pixels in digital image. Interpolation has been used in many images processing application like facial reconstruction, resolution enhancement, and multiple description coding. There are three well known Interpolation techniques, namely nearest neighbor, bilinear, and bicubic.

IV.Overview of Project:

After Resolution enhancement the high frequency components lost due to interpolation .So in order to increase the quality of enhanced image, preserving the edges is impor-tant.DWT separates the image into different sub band images. High-frequency sub bands contain the high frequency components of the image. Interpolation is applied to sub band images. To obtain the sharper enhanced image we use an intermediate stage in high frequency sub band interpolation process. As shown in fig.2 the low resolution input image and interpolated LL image with factor 2 are highly correlated. High frequency components are obtained by the difference between the LL sub band image and low resolution input image. This difference is used to correct the estimated high frequency components. Interpolation with factor α/2 is used to reach the required size for IDWT process. After getting enhanced images we use absolute maximum fusion rule to fuse these two images to get fused enhanced output image.

Fig 2: Block diagram of the resolution enhancement algorithm



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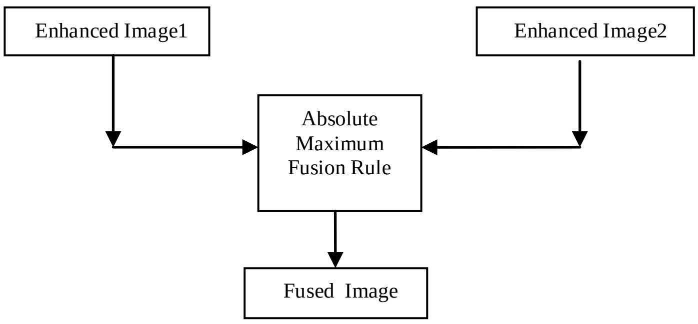

Fig 3: Block diagram of Absolute Maximum fusion

V. FUSION RULE

In the image fusion [6], we have fused the wavelet coefficients by the absolute maximum selection fusion rule. Suppose I1(x,y) and I2(x,y) are the two images to be fused and their wavelet coefficients are W1(m,n) and W2(m,n) respectively, then Absolute Maximum Selection Rule is used to combine the wavelet coefficients as below

$$W(m,n) = \begin{cases} w1(m,n), \text{if } |w1(m,n)| \geq |w2(m,n)| \\ w2(m,n), \text{if } |w2(m,n)| \geq |w1(m,n)| \end{cases}$$

V.Result of image enhancement using DWT:

Input Low Resolution Image

Fig 4: Result for image enhancement using DWT

VI.Equations for the Quantitative comparison:

For quantitative comparison purpose we are using Peak signal to noise ratio(PSNR)and Root mean square error(RMSE PSNR can be obtained by using formula:[2]

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$$PSNR=10\log_{10}(R^2/MSE)$$

Where R is the max fluctuation in the input image.

MSE is representing the Mean square error between the given input image Iin and the original image Iorg.
MSE can be obtained by using formula:

$$MSE=\frac{\sum(Iin(i,j)-Iorg(i,j))^2}{M \times N}$$

Where M and N are the size of images. RMSE is the square root of MSE.

$$RMSE=\sqrt{\frac{\sum(Iin(i,j)-Iorg(i,j))^2}{M \times N}}$$

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