Hybrid Approach to Enhance Single Image Resolution

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Abstract --- Microscopic analysis of images is more important for detail analysis of an image, Image super resolution (SR) reconstruction technique is increasing its attention from the image processing community, in the previous techniques, noise removal and smoothing techniques are used but image resolution improvement has been widely used in many applications such as remote sensing image, medical image, video surveillance and high definition television. The essential of image SR reconstruction technique is how to produce a clearly high resolution (HR) image from the information of one or several low resolution (LR) images. This project is dealing with hybrid approach of combining SWT and DWT to improve the resolution of the image by interpolation. The performance of the algorithm is compared with the PSNR, MSE.

Keywords*- High Resolution, SWT, DWT, Interpolation, Super Resolution*.

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I. Introduction

Super- resolution (SR) is the process of combining a sequence of low resolution images in order to produce a higher resolution image or sequence.Super-resolution (SR) are techniques that construct high-resolution (HR) images from several observed low-resolution (LR) images, thereby increasing the high frequency components and removing the degradations caused by the imaging process of the low resolution camera. The basic idea behind SR is to combine the non-redundant information contained in multiple low-resolution frames to generate a high-resolution image.

A closely related technique with SR is the single image interpolation approach, which can be also used to increase the image size. However, since there is no additional information provided, the quality of the single image interpolation is very much limited due to the ill-posed nature of the problem, and the lost frequency components cannot be recovered. In the SR setting, however, multiple low-resolution observations are available for reconstruction, making the problem better constrained.

The non-redundant information contained in the LR images is typically introduced by subpixel shifts between them. These subpixel shifts may occur due to uncontrolled motions between the imaging system and scene, e.g., movements of objects, or due to controlled motions, e.g., the satellite imaging system orbits the earth with predefined speed and path.

Each low-resolution frame is a decimated, aliased observation of the true scene. SR is possible only if there exists subpixel motions between these low resolution frames, and thus the ill-posed upsampling problem can be better conditioned. A simplified diagram describing the basic idea of SR reconstruction. In the imaging process, the camera captures several LR frames, which are down sampled from the HR scene with sub pixel shifts between each other. SR construction reverses this process by aligning the LR observations to sub pixel accuracy and combining them into a HR image grid.

The paper is arranged as Section I deals with need for improving resolution and the techniques that are exist are explained in section II, our proposed system with block diagram explained in section III, section IV have the results with discussion and conclude in section V.

II. Existing Techniques

Super-resolution, the process of obtaining one or more high-resolution images from one or more low-resolution images [1]. Regression algorithm is used to estimate the high resolution features from the set of images and give better efficiency by preserving the reconstructed quality of the image [2].The Discrete Wavelet Transform (DWT) obtained from DICWF is applied on the low-resolution image to obtain the high frequency sub-bands. Stationary wavelet transform (SWT) that are obtained using DICWFs is employed to minimize the loss due to the use of DWT it gives better resolution [3].By adding High frequency image components High resolution image achieved [4]. High frequency components are estimated using DWT and provide them to improve Image resolution [5].

III. Proposed Algorithm

In this paper we introduce an algorithm which uses bilinear interpolation to increase the image size. By using discretewavelet transforms high frequency components are constructed. To restore the stationary detail SWT is used and the resultant components are combined and reconstructed the image. Finally by back projecting the error, the high resolution image is achieved.

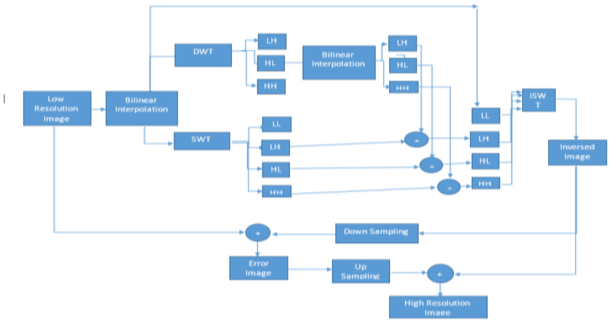


Fig 1: Block Diagram of Proposed System

A. Low resolution image

It is not sharply defined. This images will occur due to the sensor limits in the hardware.

B. Interpolation

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. Here we use bilinear interpolation for zooming the image.

Bilinear Interpolation is a resampling method that uses the distance weighted average of the four nearest pixel values to estimate a new pixel value. The four cell centres from the input raster are closest to the cell centre for the output processing cell will be weighted and based on distance and then averaged.

x1 \ x2

A	B
C	D

A = x1'x2'
B = x1'x2
C = x1x2
D = x1x

x1x2 \ x3x4

A	A	B	B
A	A	B	B
C	C	D	D
C	C	D	D

A = x1'x3'
B = x1'x3
C = x1x3'
D = x1x3

C. Discrete Wavelet Transform

Wavelets convert the image into a series of wavelets that can be stored more efficiently than pixel blocks .Wavelets have rough edges, they are able to render pictures better by eliminating the blackness. In DWT, a timescale representation of the digital signal is obtained using digital filtering techniques.

For an input represented by a list of numbers, the Haar wavelet transform may be considered to pair up input values, storing the difference and passing the sum.

A complete orthogonal system of functions in$X_a[0,1], p \in \{0,\infty\}$ by taking the value from the set of $\{0, 2^j, j: N\}$ defined by Haar. It is having main advantage of discrete and not differentiable and give the information of sudden transition.

The Haar wavelet's mother wavelet function $\psi\,(\,x\,)$can be described as

$$\varphi(x) = \begin{cases} 1 & 0 \le x \le \frac{1}{2} \\ -1 & \frac{1}{2} \le x \le 1 \\ 0 & Other\ Wise \end{cases} \qquad (1)$$

Its scaling function is

$$\varphi(x) = \begin{cases} 1 & 0 \le x \le 1 \\ 0 & other\ wise \end{cases} \qquad (2)$$

DWT is not even achieve good resolution as they loss the detail components and stationary functions so to keep the detail components to improve the resolution further modification needed to the algorithm.

D. Stationary Wavelet Transform

To achieve better resolution detail components of the image pixels required to be highlighted that overcome the transient –invariant of the DWT.

The decomposition of the image using SWT is shown in the Fig. 2 where Translation-invariance is achieved by removing the down samplers and up samplers in the DWT and up sampling the filter coefficients by a factor of $2^{(j-i)}$ in this j is the level of the decomposition of the wavelet. The image size and the decomposed levels are having same size.

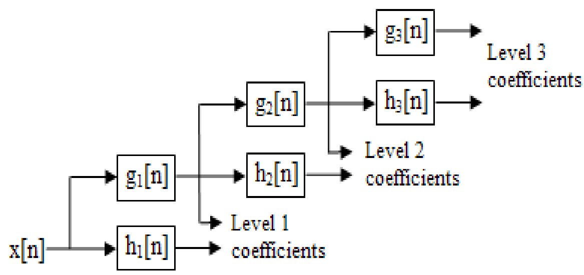


Fig 2: Decomposition of Stationary wavelet Transformation

IV. Result

We used 256x256 RGB images for analyze the algorithm; the images are converted into gray scale images. The resultant images are passed through Bilinear interpolation and further processed by D.W.T and S.W.T.

DWT resultant image produce LL, LH, HL, HH bands, with the size N/2xN/2, SWT Produce the LL, LH, HL, HH Band of same size of the bilinear image. They hold the detail components in LH, HL, HH. Resultant LH, HL, HH bands of DWT resultant image are interpolated and combined form a inverse image using ISWT. Error information is calculated between the resultant inverse image and original image based on the restoration of the components are carried

The resultant image and original image are compared with different statistical parameters such as PSNR, MSE, and similarity index of the original image and resultant image are calculated.

$$MSE = \frac{1}{mn}\sum_{x=0}^{m-1}\sum_{y=0}^{n-1}[I(x,y) - K(x,y)]^2 \qquad (3)$$

Where I is the resultant image K is the reference image m,n are size of the images.

$$PSNR = 20.\log_{10}\frac{MAX}{\sqrt{MSE}} \qquad (4)$$

Where MAX is the maximum intensity of the image and MSE is mean signal to error ratio of the images.

Fig 4(a), 4(b),4(c),4(d) are the original image and resultant Images after applying the proposed method and the clarity of the image is enhanced after the technique is applied.

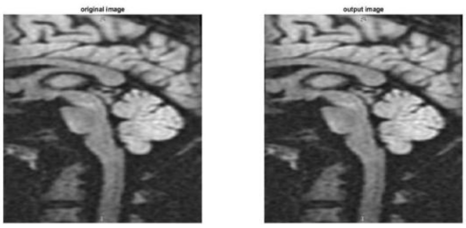


Fig 4(a)

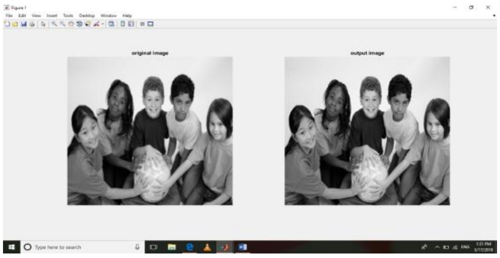


Fig 4(b)

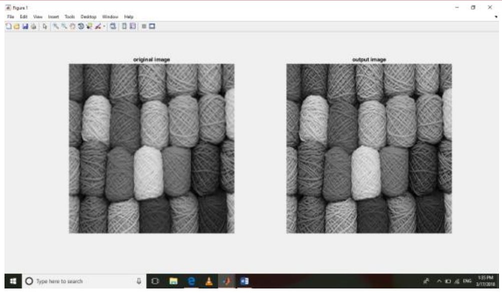


Fig 4(c)

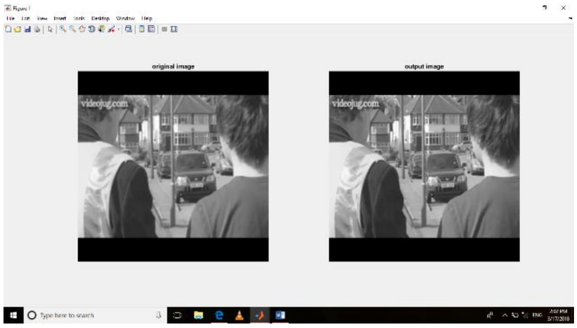


Fig 4(d)

Fig 4(a), (b),(c) and (d) Low resolution Input images and the resultant High Resolution Images

Table 1(a)Comparison of the PSNR and MES at different Levels of Decimation

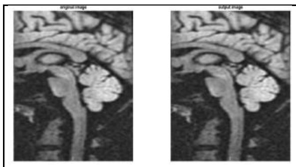
	DECIMATION LEVEL	PSNR	MSE
	2	46.1416	39.0489
	4	47.1389	40.0380
	6	47.5046	40.4020

Table 1(b) Comparison of the PSNR and MES at different Levels of Decimation

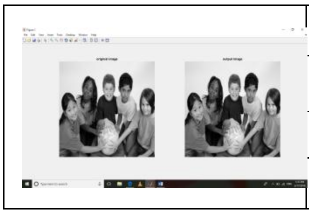
	DECIMATION LEVEL	PSNR	MSE
	2	38.7471	34.5305
	4	40.1632	35.9439
	6	40.5237	36.3041

Table 1(c) Comparison of the PSNR and MES at different Levels of Decimation

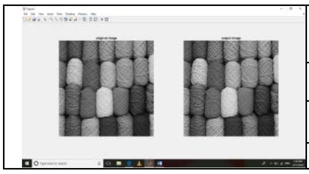
	DECIMATION LEVEL	PSNR	MSE
	2	34.1356	27.4539
	4	35.7121	29.0257
	6	36.0104	29.3223

Table 1(d)Comparison of the PSNR and MES at different Levels of Decimation

	DECIMATION LEVEL	PSNR	MSE
	2	39.3612	32.6259
	4	40.9144	34.1733
	6	41.3061	34.5647

From Table 1 (a), (b),(c) and (d) it is observed that even the decimation is increased the PSNR is improved and produce clear image than compare to the original image. It leads to even the image become clearer if it get zoomed. Edge components are enhanced, approximate components are retained by this technique.

V. Conclusion

In this paper, we conclude that the image clarity is enhanced with a simple technique and give better results for different applications. In this paper we used bilinear interpolation, DWT and SWT and the resultant image is compared with the original high resolution image and calculated PSNR, MSE of the enhanced image.

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