Performance Analysis Of Different Interpolation Technique Used For Improving PSNR Of Different Images Using Wavelet Transform

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Abstract

Improving PSNR of image is the top most priority. So, in this paper an efficient algorithm is proposed in which the PSNR increases. Wavelet transform plays a vital role in the image processing technique. In this paper, we introduce an algorithm which is based on interpolation of images obtained by discrete wavelet transform (DWT) and the input image. DWT is applied in order to decompose an input image into different subbands. The images are resolved by introducing stationary wavelet transform (SWT). Then the high frequency subbands as well as the input image are interpolated using various interpolation techniques. The estimated high frequency subbands are modified by using high frequency subband obtained by SWT. Then all these subbands are combined to generate a new resolved image using inverse DWT (IDWT). The quantitative and visual results after obtaining PSNR values using MATLAB shows the superiority of the proposed technique over the traditional one.

1. Introduction

Interpolation or scaling [1], [2] is an important tools for improving PSNR of image and wavelet is playing an influential role in the field of communication engineering to obtain the reconstructed image with improved PSNR. Communication system simulation on MATLAB can be easily operated. Image resolution enhancements i.e., improving PSNR are becoming an important aspect of an image. Interpolation has been widely used in many image processing applications such as facial reconstruction, multiple description coding, and super resolution. There are three well known interpolation techniques, namely, bilinear interpolation, bicubic interpolation and wavelet zero padding (WZP). DWT decomposes an image into different subband [2], [3]. But input image and the subband obtained by using DWT are interpolated [2] with factor $\alpha/2$ [1], [4]. In this paper, we mainly introduce an algorithm to obtain higher PSNR values. The proposed technique has been compared with conventional techniques. According to the quantitative and qualitative experimental results, the proposed technique over performs the aforementioned conventional technique. For this PSNR have been calculated and studied using various interpolation technique for different capture images.

The proposed algorithm [5] uses DWT to decompose a low resolution image into different subbands [3]. The interpolated high frequency subbands and the SWT high frequency subbands having same size which means they can be added with each other. The new corrected high frequency subbands can be interpolated further for higher enlargement. Then the three high frequency subband images have been interpolated using proposed methodology [5]. The high frequency subbands obtained by SWT of the input image are being incremented into the interpolated high frequency subbands in order to correct the estimated coefficients. In parallel, the input image is also interpolated separately. Finally, corrected interpolated high frequency subbands and interpolated input image are combined and reconstructed by using inverse DWT (IDWT) to get a high PSNR of output image.

2. System Model: Wavelet Decomposition, Reconstruction and Proposed Algorithm

Wavelets can be easily realized by filters iteration with rescaling. The PSNR of the images, which measures the pixel or elements contained in it, is determined by the filtering operations, and the scale is determined by up sampling and down sampling operations. These are determined in two stages, first one is the decomposition [6] and the second one is the reconstruction of the DWT signal [5]. The DWT is computed by successive low pass and high pass filtering of the discrete time-domain signal [7]. This is Mallat algorithm or Mallat-tree decomposition [8]. Its significance is in the manner it connects the continuous-time multiresolution to discrete-time filters. This is shown in figure 2.1.

The image is denoted by the sequence x[n], where n is an integer. The low pass filter is denoted by G_0 while the high pass filter is denoted by H_0. At each level, the

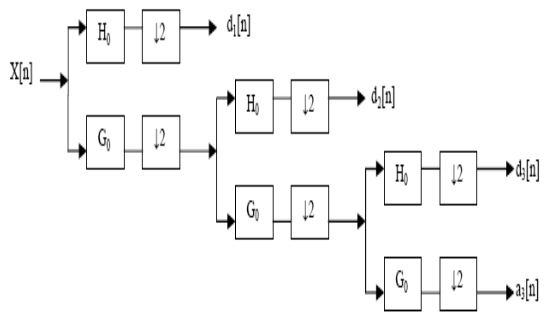

Fig. 2.1 Wavelet Decomposition Tree

high pass filter produces detail information d[n], while the low pass filter associated with scaling function produces coarse approximations, a[n]. The filtering and decimation process is continued until the desired level is reached. The maximum number of levels depends on the size of the image.

Now, the DWT of the original image is obtained by collecting all the coefficients, a[n] and d[n], starting from the last level of decomposition. This is shown in figure 2.2.

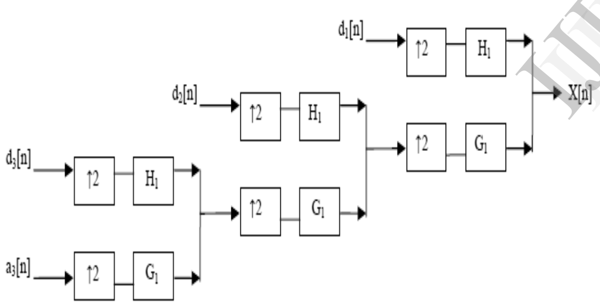

Fig. 2.2 Wavelet Reconstruction Tree

Above figure 2.2 shows the reconstruction of the original image from the wavelet coefficients. Basically, the reconstruction is the reverse process of decomposition. The approximation and detail coefficients at every level are up sampled by two, passed through the low pass and high pass synthesis filters and it is then added. This process is continued through the same number of levels as in the decomposition process to obtain the original image.

There are significant numbers of method for improving PSNR of the image. These methods include, bilinear interpolation (BLI), bicubic interpolation (BCI) and wavelet zero padding (WZP). The proposed technique algorithm [5], [9] is shown in figure 2.3.

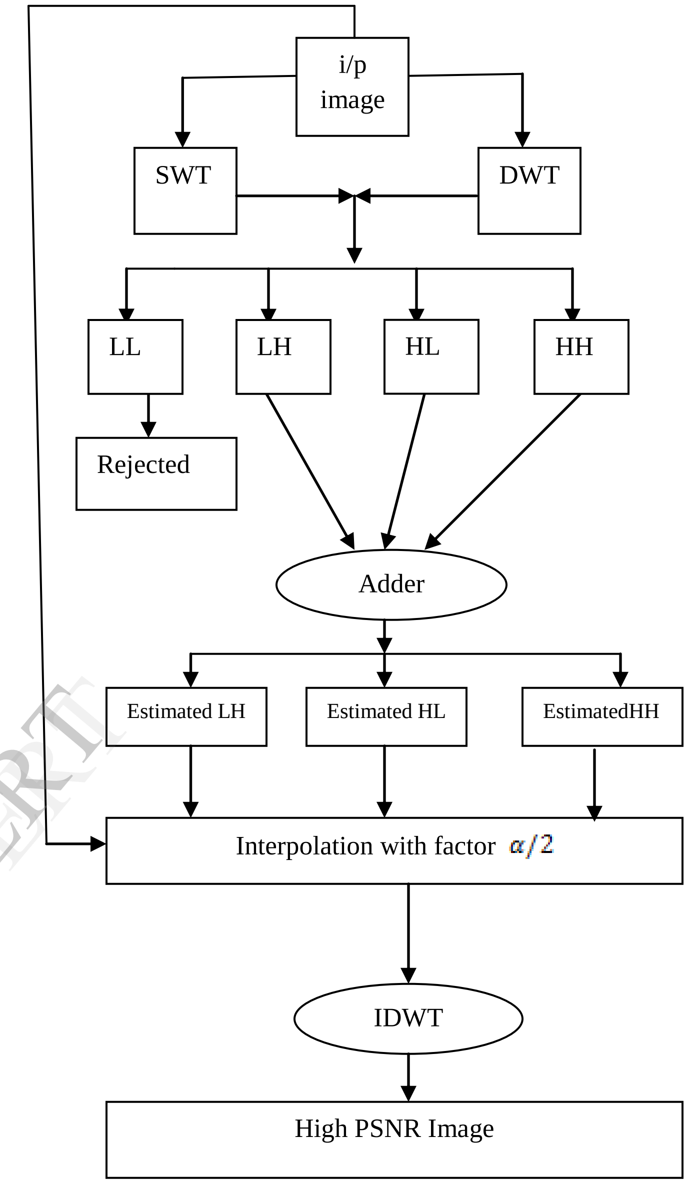

Fig. 2.3 Proposed Algorithm for PSNR Enhancement of Image.

3. Measurement of Image Quality

Saying that one method provides a better quality image could vary from person to person. Image resolution enhancement or improving the visual quality of a digital image or increasing the picture element can be subjective. For this reason, it is necessary to establish empirical measures to compare the effects of image enhancement algorithms on image quality.

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There are various standards that are required to be study for the image quality. These can be studied by using signal to noise ratio (SNR), mean squared error (MSE) and peak signal to noise ratio (PSNR). Let in an image, the useful information is denoted by S(t), and the unwanted data, noise is denoted by N(t). When the signal is deterministic, its power P_s is defined by equation 1 as,

$$P_s=\int_0^T S^2(t)dt \qquad (1)$$

where, T is the duration of an observation interval.
Let P_N be the noise power, then SNR is given by equation 2.

$$SNR=\frac{Ps}{PN} \qquad (2)$$

In decibel unit, SNR in expressed in equation 3,

$$SNR_{dB}=10\log_{10}\frac{Ps}{PN} \qquad (3)$$

PSNR is most easily defined by the mean squared error (MSE). Given a noise free m×n monochrome image I(i,j) and its noisy approximation K(i,j), MSE is defined as The mean squared error (MSE) between two images I(i,j) and K(i,j) is given by the equation 4.

$$MSE=\frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[\,I(i,j)-K(i,j)]^2 \qquad (4)$$

Thus, MSE is the square of the difference between the two images, where m and n are the number of pixels of the two images respectively.
PSNR avoids many problem of measuring image quality by scaling the MSE according to the image range. It is defined by the equation 5

$$PSNR_{dB} = -10\log_{10}\frac{MSE}{S^2}$$

$$=20\log_{10}S^2-10\log_{10}MSE \qquad (5)$$

where, S is the maximum pixel value. PSNR is measured in decibels (dB). The PSNR measure is also not ideal, but is in common use. Its main failing is that the signal strength is estimated as S^2, rather than the actual signal strength for the image.

In the absence of noise, the two images I(i,j) and K(i,j) are identical, and thus the MSE is zero. In this case the PSNR is undefined.

4. Result

A. Image Resolution Enhancement Profile

The effectiveness of the proposed method over the conventional techniques of improving PSNR, can be proved with simulation of some images with different feature that are used for comparison.
Figure 4.1 shows that super resolved image of lena using proposed algorithm in (e) are much better than the input image in (a), super resolved image by using bilinear interpolation in (b), super resolved image by using bicubic interpolation in (c) and WZP in (d).


(a) Input Image


(b) Bilinear Interpolation Image (BLI)


(c) Bicubic Interpolation Image(BCI)


(d) Wavelet Zero Padding Image (WZP)

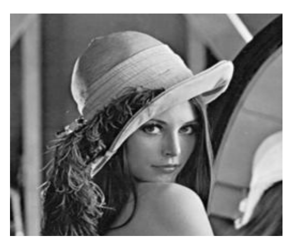

(e) Proposed technique

Fig. 4.1 View of lena using different PSNR improvement technique

Now, image resolution enhancement profile of Barbara is shown as,

(a) Input Image

(b) Bilinear Interpolation Image (BLI)

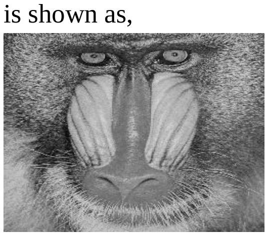
(c) Bicubic Interpolation Image (BCI)

(d) Wavelet Zero Padding Image (WZP)

(e) Proposed technique

Fig. 4.2 View of barbara using different PSNR improvement technique

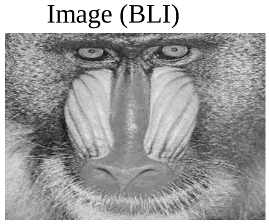
Now, image resolution enhancement profile of Baboon is shown as,



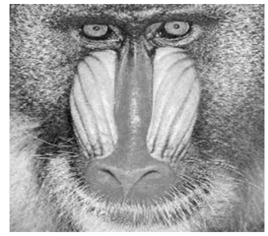
(a) Input Image

(b) Bilinear Interpolation Image (BLI)

(c) Bicubic Interpolation Image (BCI)



(d) Wavelet Zero Padding Image (WZP)



(e) Proposed technique

Fig. 4.3 View of baboon using different PSNR improvement technique

Now, image resolution enhancement profile of dolphin fountain is shown as,

(a) Input Image

(b) Bilinear Interpolation Image (BLI)

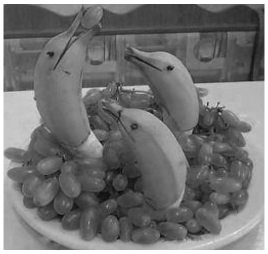
(c) Bicubic Interpolation Image (BCI)

(d) Wavelet Zero Padding Image (WZP)

(e) Proposed technique

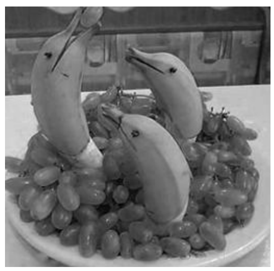
Fig. 4.4 View of dolphin fountain using different PSNR improvement technique.

Now, image resolution enhancement profile of banana grapes is shown as,


(a) Input Image


(b) Bilinear Interpolation Image (BLI)


(c) Bicubic Interpolation Image (BCI)


(d) Wavelet Zero Padding Image (WZP)

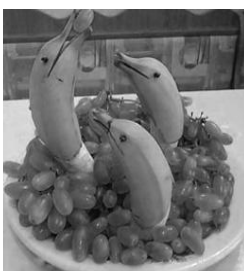
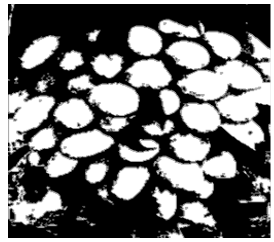

(e) Proposed technique

Fig. 4.5 View of banana grapes using different PSNR improvement technique

Now, image resolution enhancement profile of mangoes is shown as,


(a) Input Image


(b) Bilinear Interpolation Image (BLI)


(c) Bicubic Interpolation Image (BCI)


(d) Wavelet Zero Padding Image (WZP)


(e) Proposed technique

Fig. 4.6 View of mangoes using different PSNR improvement technique

Now, image resolution enhancement profile of swan is shown as,


(a) Input Image


(b) Bilinear Interpolation Image (BLI)


(c) Bicubic Interpolation Image (BCI)


(d) Wavelet Zero Padding Image (WZP)


(e) Proposed technique

Fig. 4.7 View of swan using different PSNR improvement technique

B. Performance Analysis of Image

The table 4.1 shows the obtained PSNR value using different interpolation technique for the different images. The values had been studied on MATLAB to get the PSNR values.

Images	METHOD ADOPTED FOR IMAGE DENOISING			
	BLI	BCI	WZP	Proposed Algorithm
Lena	29.2821	31.3053	36.4802	36.8774
Barbara	28.0735	30.1179	35.4011	35.7141
Baboon	27.7120	29.6868	34.8653	35.0445
Dolphin Fountain	27.0809	29.1138	34.4878	34.7375
Banana Grapes	29.0453	31.0113	36.5128	36.7065
Mangoes	28.4465	30.4988	35.9445	36.1950
Swan	29.5665	31.5532	37.1895	37.3663

5. Conclusion

Increasing the PSNR of image is the topmost priority. So, in this paper an efficient algorithm is proposed in which the PSNR increases. The superiority of the images is seen in ascending order in case of bilinear interpolation, bicubic interpolation and the wavelet zero padding images. The images resolution enhancement profile and the PSNR obtained during the performance analysis proved this.

As a future work, the current study can be extended for colour image as well as video quality enhancement.

6. References

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