International Journal of Innovative Research in Electronics and Communications (IJIREC)
Volume 1, Issue 7, October 2014, PP 18-24
ISSN 2349-4042 (Print) & ISSN 2349-4050 (Online)
www.arcjournals.org

Binary Plane Techniques for Super Resolution Image Reconstruction in Transform Domain

P.Ashok Babu
Dept of ECE
Malla Reddy Engineering College
Hyderabad, AP, INDIA
ashokbabup2@gmail.com

Dr K.V.S.V.R.Prasad
Dept of ECE
D. M.S.S.V.H college of Engineering
Machilipatnam, AP, INDIA
kvsvr@yahoo.com

Abstract: *Spatial resolution is a key parameter in many applications of image processing. In order to improve the spatial resolution we make use of super resolution algorithms. In this paper an SR image reconstruction algorithm is proposed using Integer wavelet transform (IWT) and Bit plane technique (BTP). The proposed method is analyzed in different color space transforms such as RGB, Ycbcr and CIELAB .The analysis is compared against conventional bi-cubic interpolation method. Qualitative analysis shows that the proposed method in CIELAB color space transforms has better performance.*

Keywords: *Super resolution, Bi Cubic Interpolation, Ycbcr, CIELAB, IWT, and BPT*

1. Introduction

Image super-resolution (SR) is a technique aiming the estimation of a high-resolution (HR) image from one or several low-resolution (LR) observation images which offers the promise of overcoming some of the inherent resolution limitations of low-cost imaging sensors (*e.g.*, cell phone cameras or surveillance cameras), and allow better utilization of the growing capability of HR displays (*e.g.*, HD LCDs).The problem of SR image reconstruction is first discussed in [1]. Conventional super-resolution approaches normally require multiple LR inputs of the same scene with sub-pixel motions. The SR task is thus cast as an inverse problem of recovering the original HR image by fusing the LR inputs, based on reasonable assumptions or prior knowledge about the observation model.

Ideally the low resolution images would differ only through small sub-pixel translations. In practice, the transformations may be more substantial and involve rotations or more complex geometric distortions, or the scene itself may change if the source images are in successive frames in a video sequence. Hence we focus our attention mainly on the static images [2].

In practice the images are degraded by many factors such as atmospheric effect, relative motion between the camera and the object, camera blur (due to hand shaking & improper calibration of lens), down sampling and noise. These factors can be mathematically represented as [8]

$$Y(m,n) = [H_{cam}(x,y) * F((H_{atm}(x,y) * X(x,y))] \downarrow + V[m,n] \tag{1}$$

The resultant *Y(m,n)* is degraded noisy and blurred image.

(a) Original image (b) Atmosphere Effect

(c) Motion effect

(d) down sample

(e) resultant degraded image

Figure 1. *Pictorial representation of equation (1) and resultant degraded images*

2. INTEGER WAVELET TRANSFORM

Integer wavelet transforms maps an integer data set into other integer data set. This transform is perfectly invertible and gives exactly the original data set. If the input data consists of sequences of integers, then the resulting filtered outputs no longer consist of integers which do not allow perfect reconstruction of the original image. However, with the introduction of Wavelet transforms that map integers to integers, we are able to characterize the output completely with integers. The best example of wavelet transforms that map integers to integers is the S-transform. The 2D Spatial transform can be computed for an image using equations (2a), (2b),(2c), and (2d). Of course the transform is reversible, i.e., we can exactly recover the original image pixels from the computed transform coefficients. The inverse is given in equations (3a), (3b), (3c), and (3d). The transform results in four classes of coefficients: (A) the low pass coefficients, (H) coefficients represent horizontal features of the image, (V) and (D) reflect vertical and diagonal information respectively. During the transform, we ignore any odd pixels on the borders [4][5][6].

$$\mathbf{A}_{i,j} = (\mathbf{I}_{2i,2j} + \mathbf{I}_{2i+1,2j}) / 2 \tag{2a}$$

$$\mathbf{H}_{i,j} = \mathbf{I}_{2i,2j+1} - \mathbf{I}_{2i,2j} \tag{2b}$$

$$\mathbf{V}_{i,j} = \mathbf{I}_{2i+1,2j} - \mathbf{I}_{2i,2j} \tag{2c}$$

$$\mathbf{D}_{i,j} = \mathbf{I}_{2i+1,2j+1} - \mathbf{I}_{2i,2j} \tag{2d}$$

$$\mathbf{I}_{2i\,,2j=}\mathbf{A}_{i,j} - [\mathbf{H}_{i,j} /2] \tag{3a}$$

$$\mathbf{I}_{2i,2j+1}=\mathbf{A}_{i,j}+[\ \mathbf{H}_{i,j+1})/2] \tag{3b}$$

$$\mathbf{I}_{2i+1,2j}=\mathbf{I}_{2i,2j+1} +\mathbf{V}_{i,j} -\mathbf{H}_{i,j} \tag{3c}$$

$$\mathbf{I}_{2i+1,2j+1}=\mathbf{I}_{2i+1,2j} + \mathrm{D}_{i,j} - \mathrm{V}_{i,j} \tag{3d}$$

3. LOSS LESS BINARY PLANE TECHNIQUE

The Method is based on Spatial Domain of the Image and is suitable for natural and synthetic image compression. The main aim of the technique is to use the repeated values in consecutive pixels positions. For a set of repeated consecutive values, only one value is retained. In the Binary Plane technique two codes are used to build the bit plane. The first part contains the codes as given below:

Code 1(one) is used to indicate the current pixel which is different from the previous pixel. In this case the current pixel is moved to the data table.

Code 0 (Zero) is used to indicate that the current pixel is exactly same as the previous pixel. This eliminates the storage of the current pixel.

The second part is the data table which holds only the essential pixel values that is for the set of consecutive repeated values, and only one value is stored in the data table. In the technique, the current values are stored in the table if it is not similar as previous value and not stored. If it is similar to the previous values and later the bit plane and data table are merged into one file. However, the main aim of this technique is acquiring benefits of the similar value in the consecutive pixels and instead of storing all of them. Moreover, the main advantage of binary plane technique is that it helps to maintain the gray scale value compression which provides better quality image as compared to other compression techniques[3][4][5].

4. COLOR SPACE TRANFORMS

(a) RGB to YCbCr

Y = 0.299*R + 0.587*G + 0.114*B (4a)

Cb = 128 – 0.1687*R – 0.3312*G + 0.5*B (4b)

Cr = 128 + 0.5*R – 0.4186*G – 0.0813*B (4c) [6]

(b) CIELAB

The *L*a*b** space consists of a luminosity layer *L**, a chromaticity-layer *a**, which indicates where color falls along the red-green axis, and a chromaticity-layer *b**, which indicates where the color falls along the blue-yellow axis

W = 0.4303*R + 0.3416*G + 0.1784*B (5a)

Y = 0.2219*R + 0.7086*G + 0.0713*B (5b)

Z = 0.0202*R + 0.1296*G+ 0.9393*B (5c)

$$L^* = 116(h(\frac{Y}{Y_s})) - 16 \tag{6a}$$

$$a^* = 500(h(\frac{W}{W_s})) - h(\frac{Y}{Y_s}) \tag{6b}$$

$$b^* = 200(h(\frac{Y}{Y_s}) - h(\frac{Z}{Z_s})) \tag{6c}$$

Where Y_s, W_s, Z_s are the standard stimulus coefficients.

$$\begin{cases} h(q) = 3\sqrt{q}, q > 0.0088 \\ 7.787q + \frac{16}{116}, q \leq 0.0088 \end{cases} \tag{7}$$

Both *a**and *b** layer contains all color information. [7]

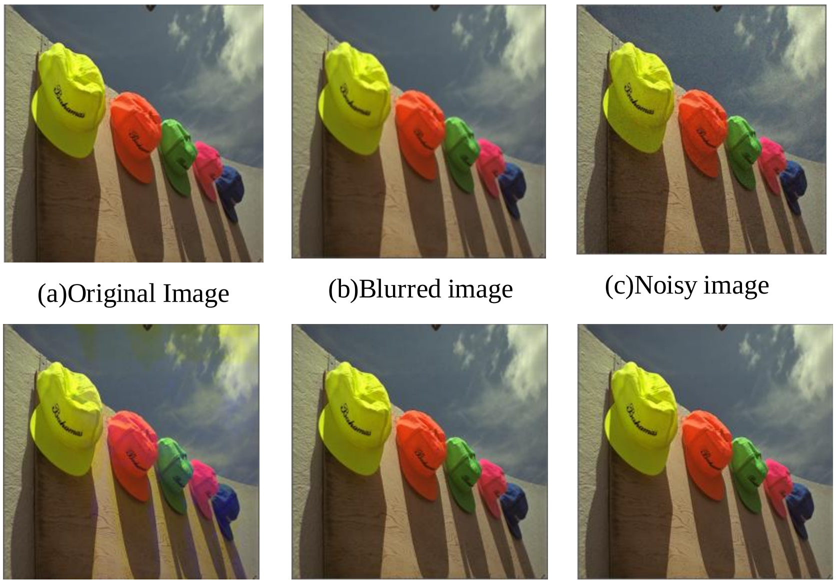
5. PROPOSED METHOD

The proposed method is applied for three color space domains such as RGB, Ycbcr and CIELAB. The method can be followed as The proposed methodology for super resolution image reconstruction is described in the following steps:

- Read a clean $I_1(x,y)$, Blurred $I_2(x,y)$ and Gaussian noise corrupted $I_3(x,y)$ LR images
- Apply IWT to all the three LR images and acquire the low frequency components
- Apply loss less BPT (threshold=0) to these low frequency components and consider the values in the data table
- Fuse these values with average fusing rule and obtain the modified values.
- The modified data table values along with the bit plane components of $I_1(x,y)$ are given for the inverse BPT to obtain the modified low frequency components
- Inverse IWT is applied for these components along with the high frequency components of $I_1(x,y)$
- Finally, Spline based interpolation is applied to obtain a SR reconstructed image.

6. Experimental Results

The proposed method is analyzed with LIVE image database considering the effect of blur and noise.



(a)Original Image (b)Blurred image (c)Noisy image

(d)SR image (RGB) (e)SR image (Ycbcr) (f)SR image (CIELAB)

Figure 2. *Results obtained with the proposed method under different color space transforms*

In order to measure the performance of super resolution algorithm, we have used the objective image quality measure such as PSNR and ISNR (Improvement in Signal to Noise Ratio).

a) Peak Signal to Noise ratio:

$$PSNR = 10\log_{10}\left(\frac{255}{MSE}\right)^2 \tag{8}$$

Where $MSE = \sum \frac{[f(i,j) - F(I,J)]^2}{N^2}$ f(i,j) is the clean image and F(I,J) is the SR reconstructed image which contains N×N pixels.

b) Improved Signal to Noise ratio:

$$ISNR = 10\log_{10}\frac{\sum_{i,j}[f(i,j) - y(i,j)]^2}{\sum_{i,j}[f(i,j) - g(i,j)]^2} \tag{9}$$

Where i,j are the total number of pixels in the horizontal and vertical dimensions of the image f(i,j),y(i,j) and g(i,j) are the clean ,degraded and the reconstructed SR images.

c) Homogeneity [9]

d) Blocking Effect [10]

(a)Caps

(b)Butterfly

(C)Parrots

(d)Woman

Figure 3. *Test Samples taken from LIVE image database*

Table 1. *Performance analysis of the proposed method in RGB Space domain*

Image	RGB Domain				
	$ISNR_b$	$ISNR_n$	PSNR	Homogeneity	Blocking effect
Caps	4.63	1.233	38.32	0.3103	0.023
Butterfly	11.12	9.087	47.64	0.4598	0.044
Parrots	1.99	0.499	39.02	0.1154	0.024
Woman	6.94	4.224	41.25	0.3975	0.028

Table 2. *Performance analysis of the proposed method in Ycbcr Space domain*

Image	Ycbcr Domain				
	$ISNR_b$	$ISNR_n$	PSNR	Homogeneity	Blocking effect
Caps	6.53	9.833	43.58	0.3090	0.023
Butterfly	8.19	6.187	44.74	0.4591	0.045
Parrots	4.78	6.261	45.72	0.1194	0.024
Woman	8.84	6.104	43.15	0.3915	0.029

Table 3. *Performance analysis of the proposed method in CIELAB Space domain*

Image	CIELAB Domain				
	$ISNR_b$	$ISNR_n$	PSNR	Homogeneity	Blocking effect
Caps	15.75	19.16	52.84	0.3247	0.023
Butterfly	16.80	14.76	53.32	0.4843	0.045
Parrots	11.41	12.90	52.43	0.1159	0.024
Woman	18.78	16.06	53.13	0.3771	0.029

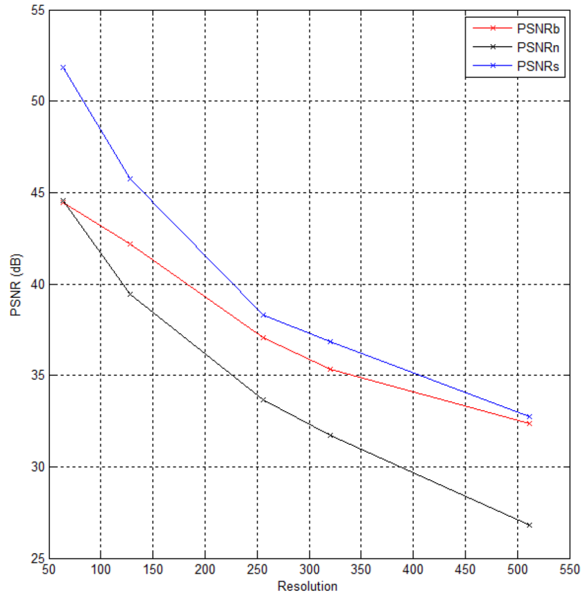


Figure 4. *Performance Analysis of Cap Image under different resolution for the proposed method*

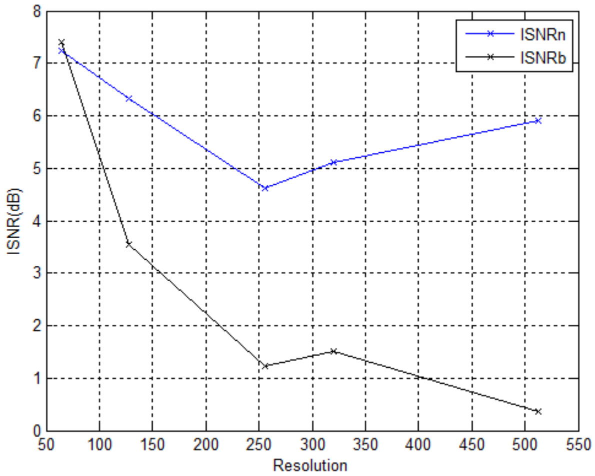


Figure 5. *ISNR Analysis of Cap Image under different resolution for the proposed method*

ISNRn: Calculated with Clean, noisy and reconstructed images

ISNRb: Calculated with Clean, blurred and reconstructed Images

The qualitative analysis clearly predicts that the proposed method perform in CIELAB domain. As the metrics shows an increment of about 9 dB PSNR on average from RGB color space to LAB as well as a good improvement in ISNRn The method is computationally efficient since no complicated transforms are involved and the algorithm can be implemented without storing the entire image in memory, which makes embedded implementations easier.

7. Conclusion

SR image reconstruction with IWT and BPT is proposed in the present context and a qualitative analysis is evaluated for different test samples taken from the LIVE image database under different color space transforms. From the data obtained we can conclude that the present method in CIELAB domain has got better results when compared to other color space transformations. The proposed method proved to be the best in color domain under different transformations.

References

[1] T. S. Huang and R. Y. Tsai, “Multi-frame image restoration and registration, ” Adv. *Comput. Vis. Image Process.*, vol. 1, pp. 317–339, 1984

[2] M. E. Tipping and C. M. Bishop, “Bayesian image super-resolution,” in *Advances in Neural Information and Processing Systems 16*, 2003

[3] Dr. M.Ashok and Dr. T. Bhaskar Reddy, "Color image compression based on Luminance and Chrominance using Binary Wavelet Transform (BWT)and Binary Plane Technique (BPT)," *International Journal of Computer Science and Information Technology & Security (IJCSITS)* , vol. 1, no. 2, pp. 2249-9555 , 2012.

[4] N. Subhash Chandra et al., "LOSS LESS COMPRESSION OF IMAGES USING BINARY PLANE, DIFFERENCE AND HUFFMAN CODING (BDH TECHNIQUE) ," *Journal of Theoretical and Applied Information Technology*, vol. 3, no. 1, pp. 3-56, 2008.

[5] P.Ashok Babu,Dr.K.V.S.R.Prasad,” A lossy color image compression using IWT and BPT”,Graphics & Vision Vol:12,Iss:15,2012

[6] R.C.Ganzalez “Digital Image Processing”, Pearson Education India, 01-Sep-2004

[7] Ming-Ni Wu; Chia-Chen Lin; Chin-Chen Chang; , "Brain Tumor Detection Using Color-Based K-Means Clustering Segmentation," *Third International Conference on Intelligent Information Hiding and Multimedia Signal Processing, 2007. IIHMSP 2007.* vol.2, no., pp.245-250, 26-28 Nov. 2007

[8] S. Farsiu, M. D. Robinson, M. Elad, and P. Milanfar, “Fast and robust multiframe super-resolution,” *IEEE Transactions on Image Processing*, vol. 13, pp. 1327–1344, 2004.

[9] N. Idrissi, J. Martinez, and D. Aboutajdine, “Selecting a discriminant subset of co-occurrence matrix features for texture-based image retrieval,” in *Proc. ISVC05*, 2005, pp. 696–703.

[10] Zhou Wang; Sheikh, H.R.; Bovik, A.C.; , "No-reference perceptual quality assessment of JPEG compressed images," *International Conference on Image Processing Proceedings. 2002* vol.1, no., pp. I-477- I-480 vol.1,2002