IJCSC 0973-7391 Volume 7 • Number 2 March 2016 - Sept 2016 pp. 186-196 available online at www.csjournalss.com

Comparison of Different Algorithmsfor Image Fusion

Amit Kumar[1], Jatinder Kumar[2],

1) Student M.Tech(CSE), 2) Assistant professor , Department of Computer Science and Engineering, Sri Sai College of Engineering & Technology, VPO Manawala-143115, Amritsar.

amit_engg11@yahoo.com[1],jkteji@gmail.com[2]

Abstract- Image fusion is a process to combine two or more images so that fused image becomes more informative than input images. Fusion process provides the spectral and spatial information of image. But main problem occurs of computational time when high resolution images are fused. So this paper describes a comparison of DCT, DWT with Blocking Algorithm that is based on wavelet transform in which transform is applied after forming the image into different blocks. The algorithm divides the complete image into different blocks and thencomparing the images by finding the mean square error. By using the threshold value wavelet transform is applied to require block. The transformed blocks are fused by using different fusion algorithms like averaging method, maximum or minimum pixel replacement fusion algorithm. By applying inverse of wavelet transform fused image is constructed which is more informative than the input images. The quality of fused image is find out by comparing the fused image by the original image by finding mean square error and peak signal to noise ratio. The whole process of fusion is applied on the complete image and also by using blocking method then by finding the time parameters it can be conclude that the blocking algorithm reduces the computational time by 10 times to the existence method.

Keywords-DWT (Discrete Wavelet Transform), MSE (Mean Square Error), PSNR (Peak Signal to Noise Ratio).

Introduction

Image fusion is a process of combining two or more images to get one image which is more clear and informative than the input images. The fused image is more suitable for human vision and also for computer vision. Image fusion is a technique of combining data from remote sensing through image processing. The main purpose of image fusion is to improve the definition of image, enhancement of images and classifications. Image fusion has many applications such as object identification [1]. There are number of methods to fuse the images. The very basic method is high pass filtering but now a day wavelet transformation technique and Laplacian pyramid decomposition are mainly used. On the basis of fusion level fusion is of three types: Pixel level fusion, feature level fusion and decision level fusion. In pixel level fusion, fusion is done pixel by pixel manner and used to merge the different parameters. Feature level is used to recognize the object from various data sources. In decision level data is extracted from different images separately and then decision is done.

But pixel level fusion is mainly used because of its simplicity and linearity and used to detect undesirable noise, low complexity and fuses different images directly pixel by pixel to enhance the image. This method gives the more trueness of image and supply the information in details as compared to other methods. The basic principle of image fusion is to increase the required information only that's why by using different wavelet transforms low and high frequency components are split from the image so that the high frequency components can be neglected. By applying different wavelets each has their own advantages and disadvantages. Wavelet transform has a long series and can be applied for higher levels by which unwanted information can be reduced to large extent [2]. Fusion of images also reduces the data for storage so the memory requirement also reduces. But the main problem is to fuse two or more images is of computational time for the satellite or high resolution images because they requires high processing. In this paper the complete focus is on to reduce the computational time. The blocking algorithm becomes efficient in the reduction of computational time and the complexity.

Wavelet Transform

Wavelet transform is used to transform the image form time domain to frequency domain. So that Time and frequency both information are analysed [3]. Wavelet is nothing but the continuous signal which dies up after a particular time that is a waveform of limited duration and have zero average value. Wavelet transform is used to decompose the frequency components. In wavelet transform first row operation is applied on the image and then decimation factor is applied for down-sampling. By performing column operations approximation part LL is calculated. Similarly detail parts are calculated that are LH, HL and HH [4].

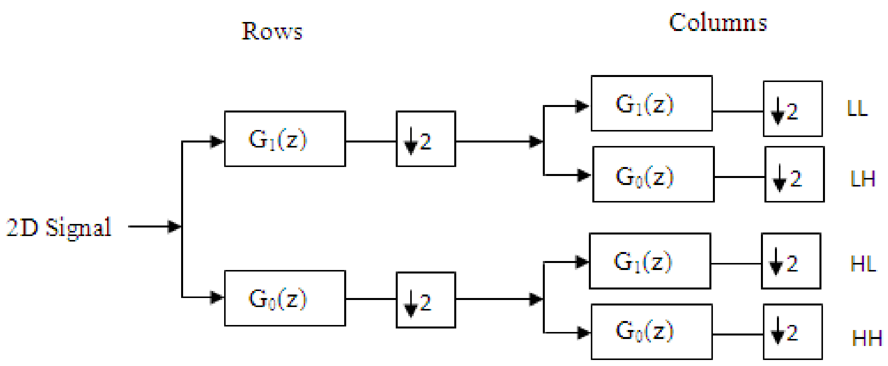

Figure: 1 Block diagram of Wavelet Transform

Fusion Algorithms

After applying wavelet transform fusion algorithms are used. For the fusion purpose averaging method, maximum pixel replacement method and minimum pixel replacement method are used. In averaging method just average of both the images has taken and in case of maximum pixel replacement method that pixel is considered for fusion whose value is greater and same as in minimum pixel replacement method. Maximum pixel replacement method can only be used for white shades images while minimum pixel replacement method can only be used for dark shades images [5].

DCT Algorithm

DCT is a transformation technique that is mainly used by JPEG to compress the image and to perform DCT in JPEG image is first divided into 8*8 blocks and each pixel is subtracted from mathematical value 128 and then quantization is applied to reduce magnitude and then entropy encoding process has been done. For the quantization process a quantization matrix is used. Each pixel value of image is divided by the corresponding value of quantization matrix. For entropy encoding process mostly Huffman coding is applied on both DC and AC components. DCT coefficients are calculated with the help of DCT equation and then all the coefficients are recorded in zig-zag manner. The DCT divides the image into different frequencies that is low frequencies lies on left top corner of image. That component which contains maximum information is known as DC component and others are known as AC components. On that DC component effect of noise is very less as compared to AC components [10].

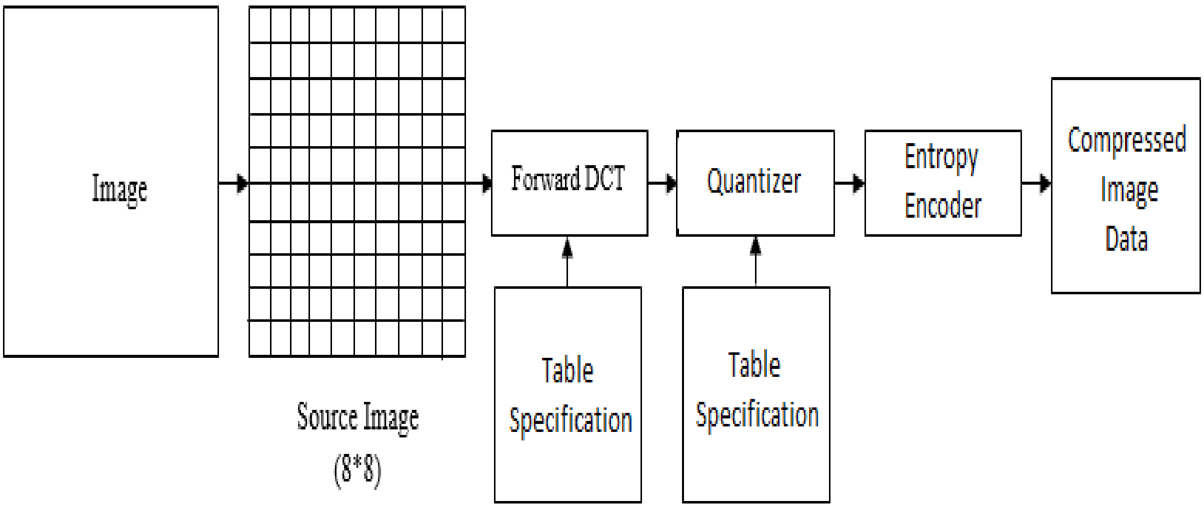

Figure 2: Block Diagram of DCT Algorithm

Discrete Wavelet Transform (DWT)

Fusion process has been done using DWT. In this dissertation for the fusion process only two images are taken as input images. Both the images are of same scene with different information. Both the images are satellite images having size 600*600 pixels. For the testing purpose the original image has been used from which both the input images are generated.

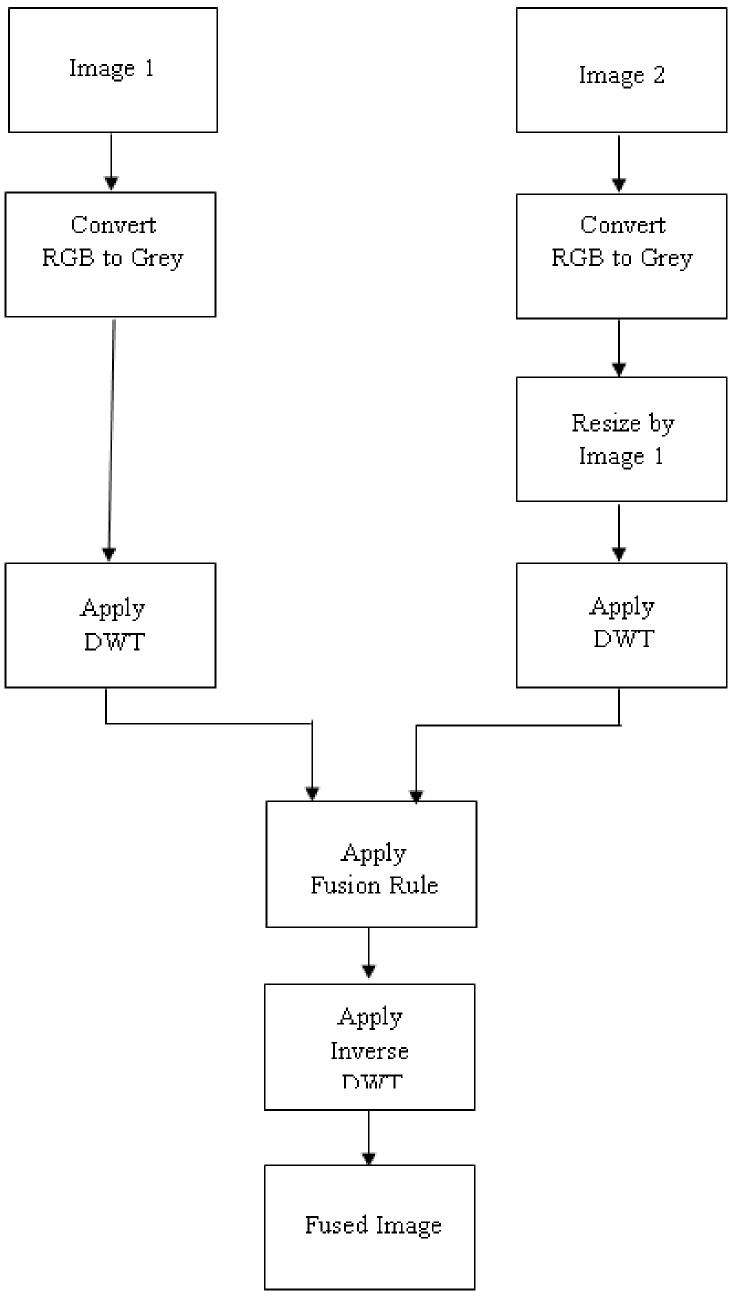

Figure 3: Block Diagram of DWT Algorithm

Fusion by DWT Algorithm

- Take two input images of size m x n, both the images are of same scene.
- Convert the images in grey scale image as this dissertation is done on grey scale images only.
- Find the size of first image and resize the second image by first image.
- Calculate the DWT coefficients (LL, LH, HL and HH) of both the images.
- Take the LL components of both the images.
- Apply the fusion rule on them.
- Take inverse DWT of fused image.
- Get the final fused image which is more informative then the input images.

Fusion by Haar Transform using Averaging Method

Training steps

- Suppose two input images I and I1 are taken of size n * m.
- Apply row wise low pass and high pass filtering and calculate L1 and H1 for first image and L2 and H2 of second image by using the coefficients:

$$h(n) = \left[\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right]$$

$$g(n) = \left[\frac{1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}\right]$$

- Apply column wise low pass and high pass filtering and calculate LL1 and LH1 of first image and LL2 and LH2 of second image.
- Apply column wise low pass and high pass filtering and calculate HL1 and HH1 of second image and HL2 and HH2 of second image.
- Take the average of LL1 and LL2 and form one new LL.
- Take the inverse Haar transform by using LL, LH1, HL1, HH1 and get the fused image.

Fusion by Haar Transform using Maximum Pixel Replacement Method

Training steps

- Suppose two input images I and I1 are taken of size n * m.
- Apply row wise low pass and high pass filtering and calculate L1 and H1 for first image and L2 and H2 of second image by using the coefficients:

$$h(n) = \left[\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right]$$

$$g(n) = \left[\frac{1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}\right]$$

- Apply column wise low pass and high pass filtering and calculate LL1 and LH1 of first image and LL2 and LH2 of second image.
- Apply column wise low pass and high pass filtering and calculate HL1 and HH1 of second image and HL2 and HH2 of second image.
- Compare the LL1 and LL2 and put the maximum value from them in new LL.
- Take the inverse Haar transform by using LL, LH1, HL1 and HH1 and get the fused image.

Fusion by Haar Transform using Minimum Pixel Replacement Method

Training steps

- Suppose two input images I and I1 are taken of size n * m.
- Apply row wise low pass and high pass filtering and calculate L1 and H1 for first image and L2 and H2 of second image by using the coefficients:

$$h(n) = \left[\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right]$$

$$g(n) = \left[\frac{1}{\sqrt{2}}, \frac{-1}{\sqrt{2}}\right]$$

- Apply column wise low pass and high pass filtering and calculate LL1 and LH1 of first image and LL2 and LH2 of second image.
- Apply column wise low pass and high pass filtering and calculate HL1 and HH1 of second image and HL2 and HH2 of second image.
- Compare the LL1 and LL2 and put the minimum value from them in new LL.

- Take the inverse Haar transform by using LL, LH1, HL1 and HH1 and get the fused image.

Fusion by Duab4 Transform using Averaging Method

Training steps

- Suppose two input images I and I1 are taken of size n * m.
- Apply row wise low pass and high pass filtering and calculate L1 and H1 for first image and L2 and H2 of second image by using the coefficients:

$$h(n) = \left(\frac{1+\sqrt{3}}{4\sqrt{2}}, \frac{3+\sqrt{3}}{4\sqrt{2}}, \frac{3-\sqrt{3}}{4\sqrt{2}}, \frac{1-\sqrt{3}}{4\sqrt{2}}\right)$$

$$\mathrm{g(n)} = \left(\frac{1-\sqrt{3}}{4\sqrt{2}}, \frac{-3+\sqrt{3}}{4\sqrt{2}}, \frac{3+\sqrt{3}}{4\sqrt{2}}, \frac{-1-\sqrt{3}}{4\sqrt{2}}\right)$$

- Apply column wise low pass and high pass filtering and calculate LL1 and LH1 of first image and LL2 and LH2 of second image.
- Apply column wise low pass and high pass filtering and calculate HL1 and HH1 of second image and HL2 and HH2 of second image.
- Take the average of LL1 and LL2 and form one new LL.
- Take the inverse Haar transform by using LL, LH1, HL1, HH1 and get the fused image.

Fusion by Daub4 Transform using Maximum Pixel Replacement Method

Training steps

- Suppose two input images I and I1 are taken of size n * m.
- Apply row wise low pass and high pass filtering and calculate L1 and H1 for first image and L2 and H2 of second image by using the coefficients:

$$h(n) = \left(\frac{1+\sqrt{3}}{4\sqrt{2}}, \frac{3+\sqrt{3}}{4\sqrt{2}}, \frac{3-\sqrt{3}}{4\sqrt{2}}, \frac{1-\sqrt{3}}{4\sqrt{2}}\right)$$

$$g(n) = \left(\frac{1-\sqrt{3}}{4\sqrt{2}}, \frac{-3+\sqrt{3}}{4\sqrt{2}}, \frac{3+\sqrt{3}}{4\sqrt{2}}, \frac{-1-\sqrt{3}}{4\sqrt{2}}\right)$$

- Apply column wise low pass and high pass filtering and calculate LL1 and LH1 of first image and LL2 and LH2 of second image.
- Apply column wise low pass and high pass filtering and calculate HL1 and HH1 of second image and HL2 and HH2 of second image.
- Compare the LL1 and LL2 and put the maximum value from them in new LL.
- Take the inverse Haar transform by using LL, LH1, HL1 and HH1 and get the fused image.

Fusion by Daub4 Transform using Minimum Pixel Replacement Method

Training steps

- Suppose two input images I and I1 are taken of size n * m.
- Apply row wise low pass and high pass filtering and calculate L1 and H1 for first image and L2 and H2 of second image by using the coefficients:

$$h(n) = \left(\frac{1+\sqrt{3}}{4\sqrt{2}}, \frac{3+\sqrt{3}}{4\sqrt{2}}, \frac{3-\sqrt{3}}{4\sqrt{2}}, \frac{1-\sqrt{3}}{4\sqrt{2}}\right)$$

$$g(n) = \left(\frac{1-\sqrt{3}}{4\sqrt{2}}, \frac{-3+\sqrt{3}}{4\sqrt{2}}, \frac{3+\sqrt{3}}{4\sqrt{2}}, \frac{-1-\sqrt{3}}{4\sqrt{2}}\right)$$

- Apply column wise low pass and high pass filtering and calculate LL1 and LH1 of first image and LL2 and LH2 of second image.
- Apply column wise low pass and high pass filtering and calculate HL1 and HH1 of second image and HL2 and HH2 of second image.
- Compare the LL1 and LL2 and put the minimum value from them in new LL.
- Take the inverse Haar transform by using LL, LH1, HL1 and HH1 and get the fused image.

IJCSC 0973-7391 Volume 7 • Number 2 March 2016 - Sept 2016 pp. 186-196 available online at www.csjournalss.com

Experimental Data

Airport	 Image 1	 Image 2
Goldhill	 Image 1	 Image 2
Leena	 Image 1	 Image 2

Results

Image Name	Algorithm	MSE	PSNR	Time
Airport	DCT DWT Haar DWT Daub	1.1384e+04 52.8643 50.8556	7.5679 29.4239 31.0674	9.9229 14.4508 66.3123
Goldhill	DCT DWT Haar DWT Daub	1.5158e+04 28.4081 28.4081	6.3243 32.3949 33.6061	7.7508 5.7750 47.5362
Leena	DCT DWT Haar DWT Daub	1.7534e+04 67.8909 67.8909	5.6919 30.9150 29.8127	2.8646 1.2671 1.0705

IJCSC 0973-7391 Volume 7 • Number 2 March 2016 - Sept 2016 pp. 186-196 available online at www.csjournalss.com

Output of DCT	Output of DWT Haar	Output of DWT Daub
 Airport	 Airport	 Airport
 Goldhill	 Goldhill	 Goldhill
 Lena	 Lena	 Lena

Conclusion

After giving the brief theory and results it can be easily conclude that the DWT Haar and DWT Daub algorithms works efficiently as compare to other existing techniques like DCT. DCT can give results better when the images are of low resolution but the fusion technique is applied more only on the images of high resolution. Even the DWT techniques works better and gives good results but there is always some conditions in which DWT do not give effective results and required another technique to improve it.

References

[1] C. T. Kavitha, C. Chellamuthu and R. Rajesh, "Medical Image Fusion using combined wavelet and ripplet transforms" Elsevier, 2012,pp. 813-820

[2] Naveen S and R.S Moni, "A robust novel method for Face recognition from 2D Depth Imagesusing DWT and DCT Fusion" Elsevier, 2015,pp. 1518-1528

[3] Yong Yang, "A Novel DWT Based Multi-focus Image Fusion Method" Elsevier, 2011,pp. 177-181

[4] Yong Yang, "A Novel DWT Based Multi-focus Image Fusion Method" Elsevier, 2011, pp. 177-181

[5] Qifan Wang, ZhenhongJia, Xizhong Qin, Jie Yang and Yingjie Hu, "A New Technique for Multispectral and Panchromatic Image Fusion" Elsevier, 2011, pp. 182-186

[6]Hongbo Wu and Yanqiu Xing, " Pixel-based Image Fusion Using Wavelet Transformfor SPOT and ETM+ Image" IEEE Transaction, 2010 pp. 936-940

[7] MirajkarPradnya P. and Ruikar Sachin D." Wavelet based Image Fusion Techniques" IEEE International Conference on Intelligent Systems and Signal Processing (ISSP), 2013 pp. 77-81

[8] Chaunte W. Lacewell, Mohamed Gebril, Ruben Buaba, and AbdollahHomaifar "Optimization of Image Fusion Using GeneticAlgorithms and Discrete Wavelet Transform" IEEE Transaction, 2010 pp. 116-121

[9] YifengNiu and LinchengShen" A Novel Approach to Image Fusion Based onMulti-Objective Optimization" IEEE Transaction, 2006 pp. 9911-9915.

[10]Feig, E.; Winograd, S. (September 1992). "Fast algorithms for the discrete cosine transform". IEEE Transactions on Signal Processing40 (9): 2174–2193.