Comparison of Different Algorithms for Image Fusion

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Abstract- **Image fusion is a technique of merging two or more images of the same location to find better results which may not be possible with one image. In this when different images are combined then with wavelet transformation it gives better spatial results. But problem in image fusion is that it is time consuming process when we have to combine high resolution images. In this paper different fusion techniques has been compared and a new technique on the basis of blocking has been proposed. By applying blocking algorithm we will be able to reduce image fusion computational time by ten time than the existing techniques.**

1. Introduction

Image fusion is a technique of merging two or more images of the same location to find better results which may not be possible with one image. In this when different images are combined then with wavelet transformation it gives better spatial results. The main objective of image fusion is to increase the quality of image. There are many methods we have to perform fusion of images. High pass filtering, wavelet transformation and Laplacian pyramid decomposition are mainly used methods of image fusion, but High pass filtering is the simple and basic method which is now a day not in use. In this paper we have proposed a blocking algorithm in which an image is divided into different blocks and then block wise mean square error is calculated and compared with the same block of different images. If the value in comparison have difference less then the threshold value then no fusion is performed for those blocks.

1.1 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].

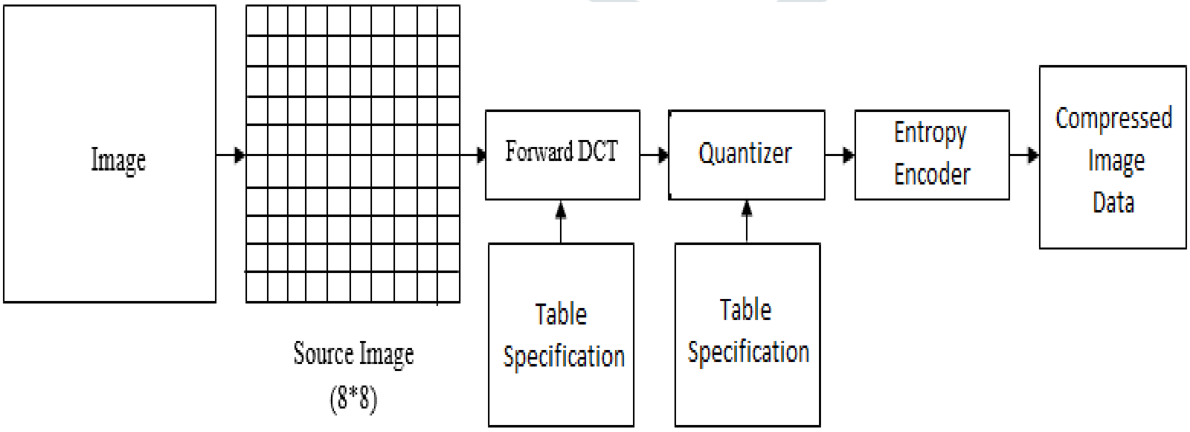


Figure 1: Block Diagram of DCT Algorithm

1.2 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.

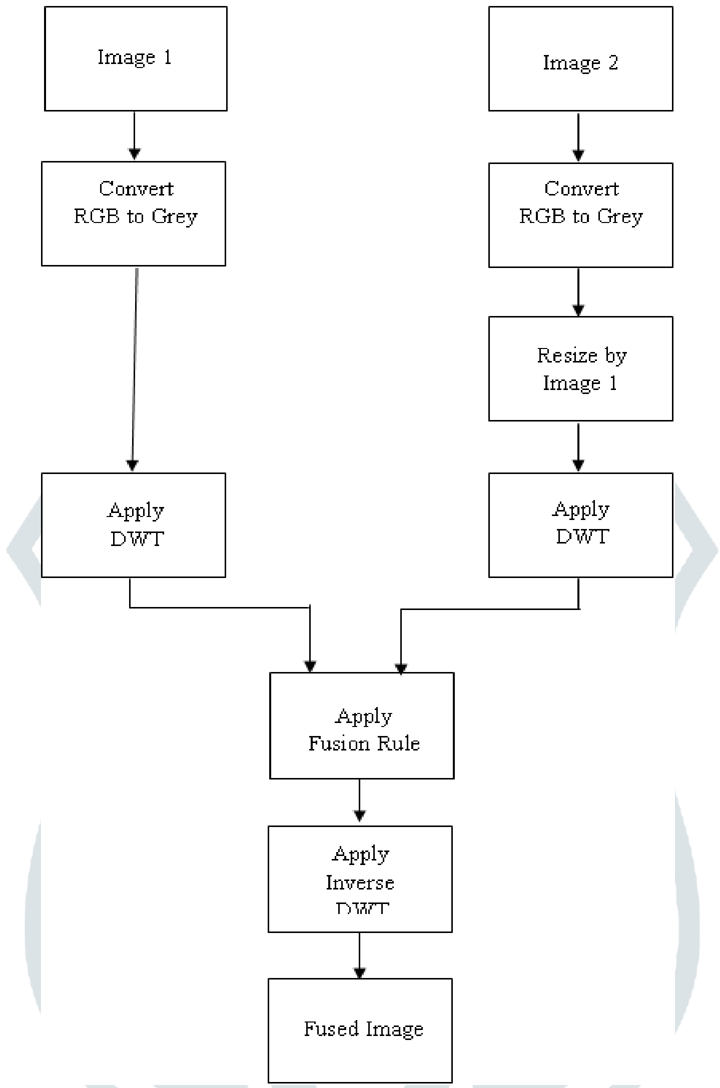


Figure 2: Block Diagram of DWT Algorithm

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.

1.3 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.

1.4 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.

1.4 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.

1.5 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.

1.6 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:

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

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

- 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.

- 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.

1.7 Fusion by Daub4 Transform using Minimum Pixel Replacement Method

Training steps

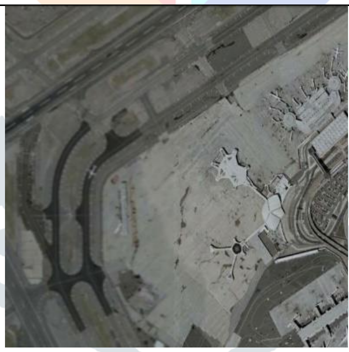
- Suppose two input images I and I1 are taken of size n * m.
- Apply row wise low pass and high pass filtering and calculate L1 and H1 for first image and L2 and H2 of second image by using the coefficients:

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

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

- 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.
- 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.

2.1 Experimental Data

Airport	 Image 1	 Image 2
Goldhill	 Image 1	 Image 2

Leena	 Image 1	 Image 2

2.2 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

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.

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