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Wavelet Based Image Reconstruction

Prof. Dhanshri Naiknaware[1], Prof.Kshetramala Pawar[2]
1(Electronics & Telecommunication, JSPM's ICOER,Pune)
2 (Electronics & Telecommunication, JSPM's ICOER,Pune)

Abstract:

Image reconstruction is process of combining the focus part of multiple images to obtain single image with well focus objects. An images captured by camera contain some part in focus which are at focus plane , so images reconstruction is a way to obtain focused image of same scene. The result of image reconstruction is an image which is more appropriatefor human and machine perception for further image-processing tasks such as segmentation, .feature extraction and object recognition. The scheme presented in this paper involved the wavelet transforms of the input images to combinedinformation effectively and inverse wavelet transform of fused wavelet coefficients to produce another single image

Keywords **— Image Reconstruction, Wavelet Basis,Fusion Operator**

I. INTRODUCTION

In digital India, researchers deal with the multi sensor data in many fields, such as remote sensing, medical imaging or machine vision, sensor fusion. Image reconstruction is useful technique for combining multi-focus images. Mostly the objects in front of the camera are focused and other background part is blurred. A effective method to solve this problem is image reconstruction, in fusion of multiple images with different focus is carried out to generate a image with all objects in focus. Generally, image reconstruction is carried out on gray color images [3].This paper involved image reconstruction of color images. The wavelet transform based reconstruction method is one of the most important methods in common usage[7][10]. Pixel based image fusion is recently used[11].There are two difficulties in image reconstruction area , selection of wavelet basis function and merging technique as this is heart of image reconstruction and it directly affect the speed and quality of resultant image. So, this paper gives solution to this two difficulties .The important thing of this method is it maintain the original data as much as possible, which provides the details that other gray level reconstruction methods cannot supply.

II. LITERATURE SURVEY

Reconstruction involves merging data from multiple images to get a single image by taking certain features from every image. W.Wright developed a fast image fusion with a markov random field[17].Currently, most of the image merging has been performed using pixel based methods [11].The simplest way of pixel level image fusion is to take the average of the two images pixel by pixel. However, this method usually leads to undesirable side effect such as reduced contrast. O.Rockinger also presents image fusion technique based on pixel level. Advantage of the pixel level image fusion is that images contain original information. Furthermore is easy to implement [11].L.J.Chipman presented a wavelet based image fusion [8].Dryden proposed image fusion method based on shape variability techniques.[4].Yang developed image fusion strategy for panchromatic high resolution image and multi spectral image in Nonsub sampled contour let (NSCT) domain[20].With the reference to above different method we have decided to go with wavelet based image reconstruction.

III. IMAGE RECONSTRUCTION SCHEME

The flow of image reconstruction is dependent on wavelet transform in which very first step is acquisition of images. We have taken images by adjusting focus of camera ,for one scene two or three images we have taken .For one scene first image is with one object in focus and other part is blurred likewise images are acquired.
Our proposed algorithm has used to develop single image which is well focus and retained original information in it. The flow of image reconstruction is as below .

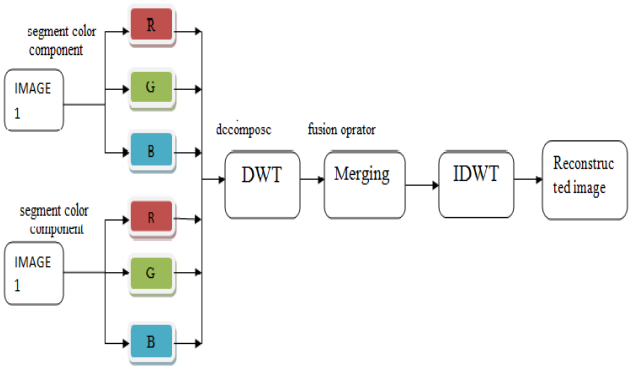

Fig1:Schematic Block Diagram of Proposed Scheme

Proposed Reconstruction Scheme involved following steps.

Step1. Image contains three colored components which are red, green and blue segment colored component of each image.

Step2. Carry out Discrete Wavelet Transform on each image by selecting proper wavelet basis.Output of DWT gives coefficients called as decomposition coefficients.

Step3. Merge each coefficient separately by using multiple fusion operator and finally we get coefficients contain more information of all images.

Step4. Perform inverse discrete wavelet transform[IDFT] to produce a single image which called as reconstructed image.

A. Wavelet Transform

The transform of a signal is another kind of representation of the signal without modifying the data from in the input signal. It provides a time-frequency representation of the signal. It use to analyzed multiple frequencies with multiple resolution. The DWT is computed by sequential passing of signal from low pass and high pass filter as shown in fig 2

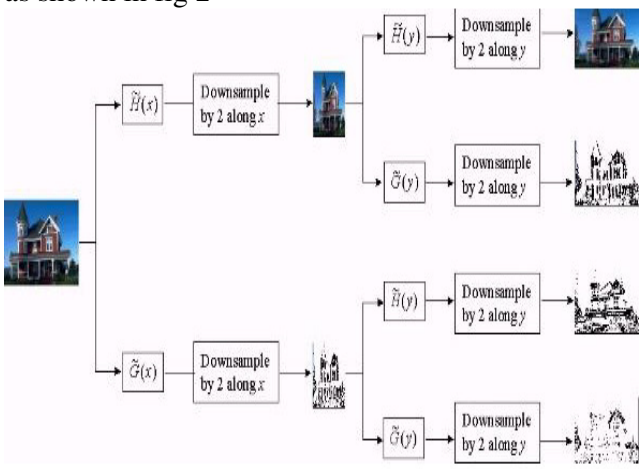

Fig 2:Schematic Representation of DWT

In the figure2, the image I, The low pass filter& high pass filter are H(x)& G(x) respectively. At every pass, the high pass filter gives detail information &low pass filter deal with scaling function generates coarse approximations. After decomposition of image through low pass and high pass filter four components are generated.
These four components are combination of the low and high band such as low-low band, low-high band, high-low band and high-high band. These bands are called as coefficient of wavelet. It contains different component of the image like approximate, horizontal, vertical and diagonal. We have used 50 kinds of wavelet basis functions at first which are tested and compared.In this paper comparison of different wavelet is done. Comparison is based on basis of quality of resultant image.For quality assessment performance measurements are used. Table 2 shows different wavelet basis function used in image reconstruction.

Table 1:Different kinds of Basis Functions used

Haar
db1,db2, db3, db4, db5, db6, db7, db8, db9, db10
sym2, sym3, sym4, sym5, sym6, sym7, sym8,
Coif1, Coif2, Coif3, Coif4, Coif5,
bior1.1, bior1.3, bior1.5, bior2.2, bior2.4, bior2.6, bior2.8, bior3.1, bior3.3, bior3.5, bior3.7, bior3.9, bior4.4, bior5.5, bior6.8,
rbio1.1, rbio1.3, rbio1.5, rbio2.2, rbio2.4, rbio2.6, rbio2.8, rbio3.1, rbio3.3, rbio3.5, rbio3

B. Fusion Operator

The key process in image reconstruction is coefficient combination which is known as fusion, operators used are known as Fusion Operator.To produce good quality reconstructed image the process of merging the coefficients in an appropriate way is very important. To combine coefficients of images different fusion operators are used .Basically three fusion operators are considered here as a primary operators, these are Mean, Max &Min. We have taken combination of these basic operators. Total 9 fusion operators are considered. In some wavelet-based application all coefficients are not considered, only important coefficients are further processed.

So it require to filter out unused elements through another process. Such process required thresholding, after this only the desired coefficients remain so it affects quality of resultant image.

In proposed technique we used all coefficient of DWT to retain important information from input images. Primary fusion operators are explained below.

Mean: Mean is average value of coefficient calculated using following formula

$$\mathbf{M(i,j)=\frac{\sum a1(i,j)+a2(i,j)}{N}}$$

Let us consider a1 & a2 two input images

N is total number of coefficient. Mean of coefficient gives average value from all coefficients to be merged. so the information of image is retained.

Max: This operator uses comparison to find out maximum value from coefficient .Equation of max operator.

mat= abs(a1)>=abs(a2) ; a=a1.*mat+a2.*(~mat)

Min: This operator uses comparison to find out minimum value from coefficient. Equation of min operator.

mat= abs(a1)<=abs(a2) ; a=a1.*mat+a2.*(~mat)

Result of discrete wavelet transform gives four frequency coefficient named as approximate, horizontal, vertical and diagonal

According to table shown below we applied fusion operator on coefficient of dwt. The fusion operators taken from combination of primary fusion operators are as below.

Table 2:Fusion operator.

Fusion Operator	Fusion Operator Operation on approx.image [a]	Operation on detailed images [h v d]
Maxmax	Max	Max
Maxmean	Max	Mean
Maxmin	Max	Min
Meanmax	Mean	Max
Meanmean	Mean	Mean
Meanmin	Mean	Min
Minmax	Min	Max
Minmean	Min	Mean
Minmin	Min	Min

IV. Inverse Wavelet Transform

Once the fusion operator applied on coefficient of DWT we got resultant coefficients which contain information of all images. Resultant image can be generated by applying inverse DWT. Inverse discrete wavelet transform reconstruct all four coefficient images. In this paper we used 50 types of wavelet basis used for Inverse discrete wavelet. The best wavelet basis can be obtained from quality assessment of reconstructed image. Resultant image

obtained from inverse DWT contains focused part of all images.This image is called as reconstructed image, in which original information is retained.

V. Performance Measurement

Assessment of performance of reconstructed image is also one of the important part in image reconstruction. Since reconstructed images are used to enhance visual information for human users, performance assessment of image reconstruction should be first judged by the users based on the mission of specific applications.

In these situations, it is hard to take decision about the quality of resultant image. Performance measures be a useful tool to assist human users. We give two performance measures which is helpful in quality assessment of reconstructed image. Different performance measures used are similitude measure, difference index.The details about performance measure are as following.

a. Similitude Measure (SM)

Similitude Measure measures the similarity between reconstructed image and the ideal image.

$$SM= 2 * \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} F(i,j)R(i,j)}{\sum_{i=1}^{M}\sum_{j=1}^{N}[F(i,j)^2 + R(i,j)\text{^}2]}$$

Where, M, N indicate the matrix dimension of the image F(i, j)& (i, j) indicate the gray value of the pixel which is in the row i and in the column j of the image. The more close value of SM gives relevance with reconstruction effect .Ideal value of SM is 1.Using SM we can easily calculate which wavelet is efficient and which fusion operator is good.

b. Difference Index (D)

Difference Index shows the match between the reconstructed image and the original images in spectral domain

$$D = \frac{1}{MN}\sum_{i=1}\sum_{j=1}^{N}\frac{F(i,j)-R(i,j)}{R(i,j)}$$

Where, M, N indicate the matrix dimension of the image which is M×N, F (i, j), R (i, j) indicate the gray value of the pixel which is in the row i and in the column j of the image.

VI. Result

Reconstruction is totally depend upon wavelet basis & fusion operator so we have used fifty kinds of wavelet basis & nine fusion operator to achieve best quality image .From performance measurement parameter SM we got the Haar as a good wavelet basis function & meanmax as efficient fusion operator. After applying algorithm on different test images we conclude that Haar wavelet and meanmax fusion operator gives the best results.

Result after applied on color image was also good and closer to original image containing all important information of input images.Quality assessment of resultant images are tested by performance measurement.Threshold value of Similitude measure is 1.We got SM value closer to 1for different images.

All experimental value gives best wavelet name and good fusion operator .Depend upon value of performance measure quality of image is evaluated figure 3 shows graph of value of SM to the wavelet basis function used.

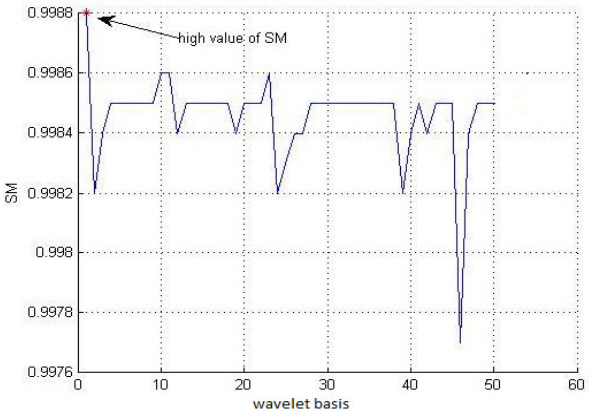

Fig 3:Graphical representation of relation between wavelet & SM

Figure gives relation between wavelet & SM value for different wavelet basis function used in testing.

If value of SM is high then that wavelet for which we got high value is best basis.Value of SM should be upto 1.In graph x axis represents wavelet name and y axis represents value of SM.Arrow indicates

high value of SM .From this we concluded that Haar is best wavelet basis.

(a)

(b)

(c)

Fig 4:Reconstruction result of color images
(a)First input image with upper side in focus plane
(b)Second input image with lower side in focus plane
(c)Reconstructed image

(d)

(e)

(f)

Fig 5:Reconstruction result of gray scale images
(d)First input image with right side in focus plane
(e)Second input image with left side in focus plane
(f) Reconstructed image

VII. Conclusion

Image reconstruction is used to explore detailed information from multiple input images of the same scene resulting to single image, so that the generated image is more useful further process. The paper gives an effective technique for reconstruction of multi-focus images. For image reconstruction, the algorithm used has got very good integration results. The use of Similarity Measure (SM) as image fusion analysis criteria, additional intuitively reflects the reconstruction results. Finally we have summarized the most effective wavelet & the most effective fusion operator from 50 wavelet basis and 9 fusion operators. The reconstructed images we got images ,they were nearly similar to the perfect pictures since the similarity measures of them were all close to 1, that is far additional precise than alternative result. Algorithm has checked on gray scale images with colored images .Use of multiple wavelet basis and fusion operator gives more elaborated and comprehensive result.

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