International Journal of Engineering & Technology, 7 (4.6) (2018) 220-222

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Improvement of Image Fusion by Integrating Wavelet Transform with Principal Component Analysis

[1]C.Lokanath Reddy, [2]K.Sripal Reddy

[1]Assistant Professor, Dept of ECE, Vardhaman College of Engineering
[2]Assistant Professor, Dept of ECE, Vardhaman College of Engineering
**Corresponding author E-mail: k.sripalreddy@gmail.com*

Abstract

The process which combines the two or more than two related source images and gives a single output image is known as image fusion. Image fusion is mainly used to analyze the image areas where the pixel values i.e. information is low intensity. Fusion of Images has been used in different applications .Correlation property is important in image fusion analysis. Correlation can be controlled by distributing the Energy in different spectral bands. Broadly image fusion process can be categorized into three groups i.e. spatial, transform and statistical methods. The image fusion process should preserve suitable pattern information from all source (input) images. Average method, Principal component Analysis is comes under spatial domain method, which deals with directly changing the pixel values but the spatial domain method introduces a spatial distortion for fused image. Wavelet based image fusion is a transform domain method which gives better performance than the spatial method. We presented a novel fusion technique which is implemented by integrating the wavelet transform with Principal Component Analysis and compared the performance with respect to different performance metrics.

Keywords: *Fusion, Correlation, Wavelet, Principal Component Analysis*

1. Introduction

Basically there are three types[1] of image fusion ,based on level of processing i.e. feature level, signal level, and decision level fusion. The image fusion methods are application dependent. Signal level fusion deals with the direct visual information fusing related to each individual pixel in the input image into a fused image, where as a Feature level image fusion deals with different features, which are extracted from independent source images. In Decision level image fusion we should consider the integrated information which is taken from higher level. In this process we should combine multiple algorithm outputs to get a final fused image. Due to this combining, the decision level image fusion may not result accurate transfer of information. Spatial domain fusion technique mainly deals with changing of pixel values of input images such as Hue, saturation and intensity. Transform domain fusion is mainly depends on the wavelet based analysis.

2. Related Work

DWT is works on idea of wavelet, in which transformation can done on group of wavelet functions [2]. It gives better degree of discernible details in time as well as frequency domain. It can use the filters i.e. high pass and low pass. In this method two source images are considered as inputs and these inputs can be decomposed using sub -band coding method and then converts into higher and lower sub-bands. By using entropy method, Lower sub-bands are fused and higher sub-bands fusion can be done based on maximum selection approach. Then, Inverse transform is applied on these sub-bands to get the resultant image after fusion.

DWT is not time invariant, so stationary wavelet transform is came into picture to overcome the drawback. In DSWT there are no need of up-samplers and the down-samplers. Up-sample filtration can be done in DWT by adding zeroes between the coefficients. Filters are applied on the specified rows, and then on columns to generate transform coefficients.

Wavelet transform fusion

The general transform used for fusion is wavelet transform [4]. This approach involves calculation of transforms for two input source images by following the fusion rules. Then, the IWT is applied on fused output image to get the (original) reproduced image, as shown in Fig1.

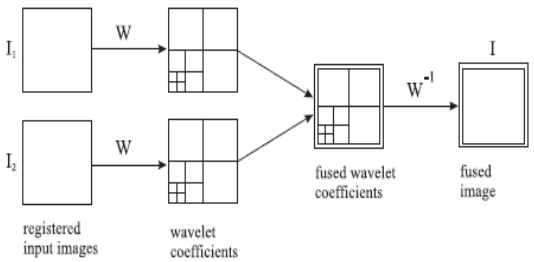


Fig1: two source images fusion using wavelets

Wavelets used in Image fusion method:

In multi resolution Analysis finite numbers of translations are used to get finite number of wavelet coefficients. In decimated algorithms the signal is down sampled at each level. The decimated algorithm can be looks as a pyramid, because keeping one of out of two rows and columns which makes the size is one quarter of the original image. In undecimated method we can address the issue of shift invariance by up sampling filters which inserts zeros between coefficients.

If the orthogonality condition is relaxed to Bi-Orthogonality conditions, Wavelets with some special properties that are not possible with orthogonal Wavelets can be obtained. In the Bi-orthogonal transform, there are two multi-resolution analysis, a primal and a dual.

Steps involved in PCA

i. Representation of training Images **ii.** Computation of the mean Image iii. Each source image normalization in the data base. **iv**. Finding the covariance matrix [5] **v.** Corresponding Eigen values and vectors calculation. **vi**. Arrangement of the Eigen values and vectors **vii**. Choosing best 'N' Eigen vectors.

3. Mathematical Approach

Consider the input images are $I_1, I_2, \ldots I_M$. Each source image must be of same dimension (N×N).If it is not in the same size it should be resized for further process and images should be mean centered. Mean image can be obtained by adding the respective pixels in each image we can get the mean image .mathematically it is represented as

$$Mean = 1/N \sum_{k=1}^{M} I_k$$

Find the covariance matrix of order of N×N. Find the Eigen values of the covariance matrix Z by solving the equation (Zλ-I)=0.
The Binary decision is formulate based on approximations of maximum valued pixels. By combining the fused approximations find the new correlation coefficient matrix. Then apply the inverse stationary wavelet transform to get the fused image.

4. Simulation Results

Performance evaluation of image fusion is categorized as subjective evaluation and Objective evaluation. Based on statistical parameters like mean, standard deviation, correlation coefficient, objective evaluation is determined. Based on visual perception, some performance metrics like average rate of Information, image definition etc; the Subjective evaluations are concluded. Here some performance metric like mean, Information entropy, standard deviation, correlation coefficient are determined. In this paper wavelet based fusion methods and Integrated wavelet methods are analyzed with respect to correlation coefficient, mean and standard deviation. It shows that the integrated wavelet fusion method can give better results than conventional methods.

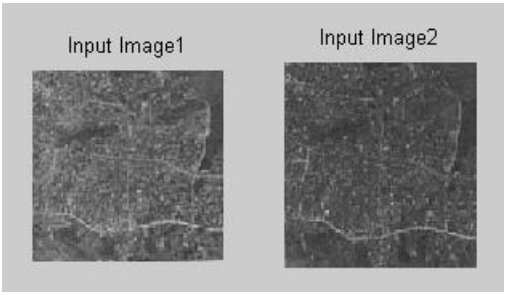
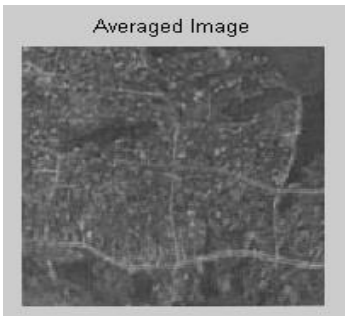
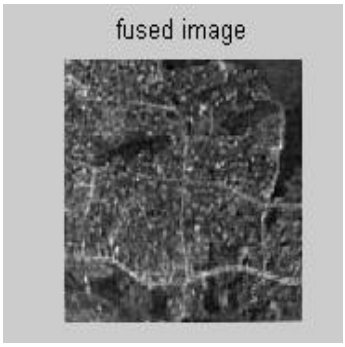


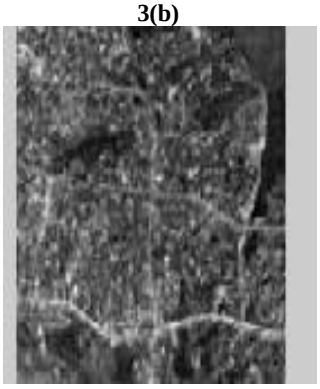
Fig2: Input Images



3(a)



3(b)



3(c)

Fig 3: Fused images (a) using Averaging method (b) Wavelet method (c) WPCA method

Table1: Tabular column for Results of satellite Images in different methods

Images	Entropy	Mean	Covariance	Correlation coefficient	Method
Test1 & Test2	5.9386	92.2814	421.0763	0.5105	Averaging Method
Test1 & Test2	6.9884	92.3909	0.3185	0.5652	Orthogonal wavelet
Test1 & Test2	6.9884	92.3909	0.3185	0.8481	Bi-orthogonal wavelet

Test1 & Test2	6.9884	92.3909	0.3185	0.8481	Decimated Orthogonal wavelet
Test1 & Test2	6.9884	92.3909	0.3185	0.8480	Undecimated Orthogonal wavelet
Test1 & Test2	6.7281	92.3909	0.3185	0.9410	WPCA

Above Table indicates two identical satellite images Test1 & Test2. Test1 is a image with high degree of discernible details and Test2 is image with low degree of discernible details. The computational metrics like Entropy, Mean, Standard deviation, Covariance and Correlation coefficient are calculated by Averaging process, Wavelet transform method (like orthogonal wavelet transform, Bi-orthogonal wavelet transform, Decimated orthogonal wavelet and undecimated orthogonal wavelet) and Principal Components Analysis with wavelet transform.

Performance Comparison for Medical Images Using different Image fusion Methods

Two identical Medical images one image is with high discernible details and another with low discernible details. By integrating these two source images by using different image fusion methods like Averaging method, wavelet transform method and Principal Components Analysis with wavelet transform method, it is observed performances of fused or integrating image.

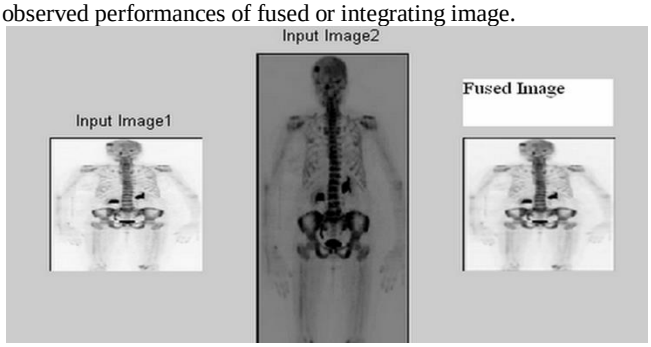


Fig4: Fused medical image

Table2: Tabular column for Results of medical Images in different methods

Images	Entropy	Mean	Covariance	Correlation coefficient	Method
Input1 & Input2	6.0487	161.2799	2.1171	0.8558	Averaging Method
Input1 & Input2	6.3545	161.6488	1.6018	0.8851	Orthogonal wavelet
Input1 & Input2	6.3545	161.6488	1.6018	0.9613	Bi-orthogonal wavelet
Input1 & Input2	6.3545	161.6488	1.6018	0.9513	Decimated Orthogonal wavelet
Input1 & Input2	6.3545	161.6488	1.6018	0.9613	Undecimated Orthogonal wavelet
Input1 & Input2	1.5792	161.6488	1.6018	0.9800	WPCA

5. Conclusion

The performance of different methods i.e. spatial and frequency domain methods are compared with respect to different performance metrics. The spatial details can be extracted by Wavelet based fusion for high intensity images. Due to this we can reduce the color distortion up to some level and the fused image looks like a HPF mage. From the above analysis the wavelet integrated method can improve visual quality by greatly reducing the spectral distortion.

References

[1] A. Ardeshir Goshtasby and Stavri Nikolov, "*Image fusion: advances in the state of the art," Inf. Fusion*, vol. 8, no. 2, pp. 114–118, 2007

[2] Huaxun Zhang and Xu Cao. "A way of image fusion based on wavelet transform", in 9*th* *International Conference on Mobile Ad-hoc and Sensor Networks*, IEEE, 2013.

[3] Mingjing Li and Yubing Dong. "Review on technology of pixel-level image fusion." *In International Conference on Measurement, Information and Control (ICMIC),*vol. 1, IEEE, 2013.

[4] Arathy Menon N.P and Arunvinodh,"Comparative Analysis of Transform Based Image Fusion Techniques for Medical Applications" *2nd International Conference on Innovations in Information Embedded and Communication Systems*,IEEE,2015.

5] Deepali Sale, Pallavi Sonare, and Dr. M. A. Joshi, "PCA Based image fusion for multispectral palm enhancement," in *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, vol. 3, no. 2, 2014, pp. 7501–7508

[6] Rishu Garg, Preeti Gupta and Harvinder Kaur "Survey on Multi-focus Image fusion algorithms", *In Proceedings of RAECS UIET Panjab University Chandigarh*, IEEE, 2014.