Research Paper

Volume : 2 | Issue : 10 | October 2013 • ISSN No 2277 - 8179

Proposed Feedback Scenes Image Fusion System

Computer Science

KEYWORDS : image fusions, noise removal, fusion evaluation and object alignment

Dr. Jane Jaleel

Iraqi Commission for Computer and Informatics, 2013.

ABSTRACT

This research concentrates on enhancing image fusion system by developing that system via three stages, first stage called fusion preprocessing including three image processing functions these are: unify images sizes, object alignment and noise removal. Second stage presents applying image fusion function. Third stage called fusion evaluation including two functions these are: comparison between the fused image and two source images, and feedback deciding. From comparison of obtained results of proposal with results of previous works, so the proposal reached noticeable enhancement in fusion process.

1. Introduction

Data fusion techniques combine data from different sources together. The main objective of employing fusion is to produce a fused result that provides the most detailed and reliable information possible. Fusing multiple information sources together also produces a more efficient representation of the data. Image fusion is a process which combines the data from two or more source images from the same scene to generate one single image containing more precise details of the scene than any of the source images [1, 2, 3].

Many publications have focused on how to fuse high resolution panchromatic images with lower resolution multispectral data to obtain high resolution multispectral imagery while retaining the spectral characteristics of the multispectral data. It has been proven that these methods seem to work well for many applications, especially for single-sensor single-date fusion. Most methods, however, exhibit significant color distortions for multitemporal and multisensoral case studies. Fusion technique has been designed to overcome these problems and has already proven its superiority over the standard pansharpening techniques such as IHS, PC, Brovey and multiplicative fusion methods [4, 5].

2. The Proposal

The proposal aim to enhance image fusion by develops it across three sequential levels with feedback capability, see figure (1), these levels will be introduced in the following subsections:

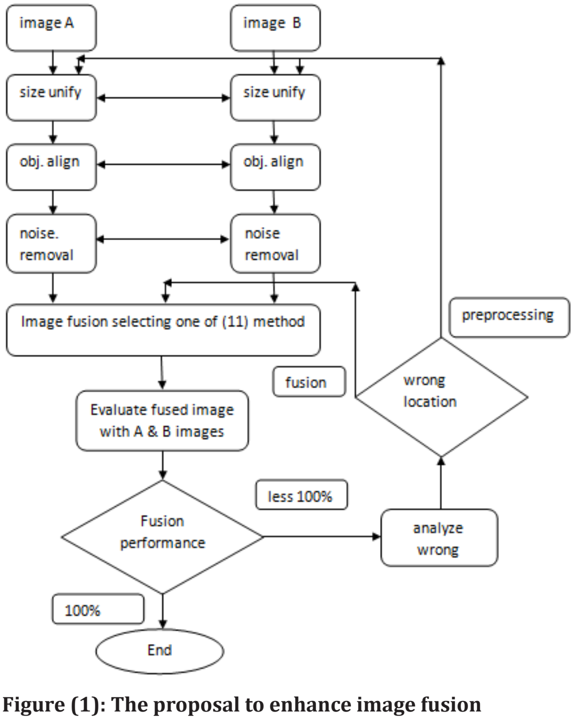

Figure (1): The proposal to enhance image fusion

2.1 Suggested Preprocessing Level

The preprocessing level necessary because the following points:

1. Images taken for same scene from different angles causes diffusion.
2. Objects are the same but the shapes change a little (in orientation, size and edges).

The preprocessing level has the following sequential steps:

1. Unify the size of both images. Images with the same size will be easy for fusing process.
2. Object alignment; make sure that each pixel at correlated images has the connection between images in order to fix the problem of diffusion.
3. Noise removal, to ensure the success of fusion.

2. 2 Image Fusing Level

In the Proposal will consider all the (11) best fusion methods, these are [6]:

1. **Wavelet Transform** For image fusion, a wavelet transform is applied to the panchromatic image resulting in a four-component image: a low-resolution approximation component (LL) and three images of horizontal (HL), vertical (LH), and diagonal (HH) wavelet coefficients which contain information of local spatial detail.
2. A reverse wavelet transform AWL method is one of the existing multiresolution wavelet-based image fusion techniques. It was originally designed for a three-band red-green-blue (RGB) multispectral image.
3. The **multiplicative** method is derived from the four component technique of. In this paper Crippen argued that of the four possible arithmetic methods only the multiplication is unlikely to distort the colors by transforming an intensity image into a panchromatic image.
4. The **Brovey** transformation was developed to avoid the disadvantages of the multiplicative method. It is a combination of arithmetic operations and normalizes the spectral bands before they are multiplied with the panchromatic image. The spectral properties, however, are usually not well preserved
5. The **color normalization** (CN) spectral sharpening is an extension of the Brovey algorithm and groups the input image bands into spectral segments defined by the spectral range of the panchromatic image. The corresponding band segments are processed together in the following manner: Each input band is multiplied by the sharpening band and then normalized by dividing it by the sum of the input bands in the segment.
6. To fuse the images with the intensity-hue-saturation **(IHS)** fusion, three bands of a multispectral image are transformed from the RGB domain into the IHS color space. The panchromatic component is matched to the intensity of the IHS image and replaces the intensity component.
7. The **Ehlers** fusion is based on an IHS transform coupled with a Fourier domain filtering. This technique is extended to include more than 3 bands by using multiple IHS transforms until the number of bands is exhausted. A subsequent Fourier transform of the intensity component and the pan-

chromatic image allows an adaptive filter design in the frequency domain.

8. The **principal component** (PC) transform is a statistical technique that transforms a multivariate dataset of correlated variables into a dataset of uncorrelated linear combinations of the original variables. For images, it creates an uncorrelated feature space that can be used for further analysis instead of the original multispectral feature space.
9. The **Gram Schmidt** fusion simulates a panchromatic band from the lower spatial resolution spectral bands. In general, this is achieved by averaging the multispectral bands. As the next step, a Gram Schmidt transformation is performed for the simulated panchromatic band and the multispectral bands with the simulated panchromatic band employed as the first band.
10. For the **high pass filtering** (HPF) fusion, first the ratio between the spatial resolution of the panchromatic and the multispectral image is calculated. A high pass convolution filter kernel is created and used to filter the highresolution input data with the size of the kernel based on he ratio.
11. To apply the **University of New Brunswick** (UNB) fusion algorithm, a histogram standardization is calculated for the multispectral and panchromatic bands of the input images. The multispectral bands in the spectral range of the panchromatic image are selected and a regression analysis is calculated using a least square algorithm.

2. 3 Suggested Evaluation Level

The aim of evaluation is the verification of the preservation of spectral characteristics and the improvement of the spatial resolution.

Proposed Performance Evaluation of Image Fusion

In the following will explain some of standard methods used in testing original images with suspected stego images. But Here in the proposal used for evaluating the fused image reliability.

a. Average Absolute Difference (AD) Test

The Average of the difference between color of pixels in original images and fused image can be calculated as:

$$AD = \frac{1}{XY}\sum_{x,y}\left|p_{x,y} - \tilde{p}_{x,y}\right| \quad (1)$$

where

X,Y: The height and width of images.

x, y: The pixel coordinate in x-axis and y-axis.

$P_{X,Y}$: The values of pixel color in location x and y of the original image. $\tilde{P}_{X,Y}$: The values of pixel color in location x and y of the fused image.

The absolute value used for difference to get accurate results of summation difference out put.

Note: These values definition will be used for below statistical tests.

b. Mean Squared Error (MSE) Test

To calculate the Mean Squared Error between the original image and fused image, must know the difference of pixel color in the two images. The result will be the square amount of errors depending on the size of these images.

The equation that used to calculate (MSE):

$$MSE = \frac{1}{XY}\sum_{x,y}\left(p_{x,y} - \tilde{p}_{x,y}\right)^2 \quad (2)$$

c. Laplacian Mean Squared Error (LMSE) Test

Use Laplacian Mean Squared Error as matrices to calculate the mean square error as follows:

$$LMSE = \sum_{x,y}\left(\nabla^2 p_{x,y} - \nabla^2 \tilde{p}_{x,y}\right)^2 / \sum_{x,y}\left(\nabla^2 p_{x,y}\right)^2 \quad (3)$$

d. Signal-to-Noise Ratio (SNR) Test

Use the below equation to calculate the (SNR) between two images as follows:

$$SNR = \sum_{x,y} p^2_{x,y} / \sum_{x,y}\left(p_{x,y} - \tilde{p}_{x,y}\right)^2 \quad (4)$$

e. Peak Signal- to- Noise Ratio (PSNR) Test

Use the below equation to calculate maximum Peak Signal-to-Noise Ratio between the two images as follows:

$$PSNR = X \max_{x,y} p^2_{x,y} / \sum_{x,y}\left(p_{x,y} - \tilde{p}_{x,y}\right)^2 \quad (5)$$

f. Normalized Cross-Correlation (NCC):

This metrics is important for seeing the amount of correlation between the original image and the fused one.

The Normalized Cross-Correlation can be measured from the following equation:

$$NC = \sum_{x,y} p_{x,y}\,\tilde{p}_{x,y} / \sum_{x,y} p^2_{x,y} \quad (6)$$

g. Correlation Quality (CQ) Test

Quality of correlation can be measured between the original image and the fused one depending on the size of these images by using the following equation:

$$Q = \sum_{x,y} p_{x,y}\,\tilde{p}_{x,y} / \sum_{x,y} p_{x,y} \quad (7)$$

h. Histogram Similarity (HS) Test

The histograms act as distributed frequency colors for image pixels. The similarity and difference of Histograms between the original image and the fused one can be calculated as follows:

$$HS = \sum_{c=0}^{255}\left|\int_I(c) - \int_{\tilde{I}}(c)\right| \quad (8)$$

where I(c) is the relative frequency of level c in 256-level image.

In proposed system, the similarity and difference in histogram are used. The difference and similarity results will be shown in statistical test results as number of difference in pixels. Because of the importance of histogram similarity, add a histogram test to show the histograms of images and histogram difference between images.

3. Implementation

The motivation behind fusing multimodality, multi-resolution images is to create a single image with improved interpretability. the implementation here take the following steps:

1. take two sources images as in figure (a and b), these two images has some of distortion in different sides of them.
2. the proposal take each of the two images and apply the size standardization, object alignment, and finally noise removal.
3. after process the two source images as in point (2) will apply on them all the (11) fusion methods as in figures (c, d, e, f, g, h, I, j, k, l, m) then evaluate the fusion by all the (7) proposed test methods.
4. table (1) give the final results of evaluations. seen these results very closely that return to the preprocessing level proposed.

Volume : 2 | Issue : 10 | October 2013 • ISSN No 2277 - 8179


a


b


c


d


m


e


f


g


h


i


j


k


l

Fusion/ Evaluation	Average Absolute Difference (AD) Test	Mean Squared Error (MSE) Test	Laplacian Mean Squared Error (LMSE) Test	Signal-to-Noise Ratio (SNR) Test	Peak Signal-to- Noise Ratio (PSNR) Test	Normalized Cross-Correlation (NCC)	Correlation Quality (CQ) Test	Histogram Similarity (HS) Test
Wavelet Transform	0.90	0.92	0.97	0.92	0.94	0.90	0.91	0.92
A reverse wavelet transform AWL	0.92	0.95	0.97	0.90	0.90	0.90	0.97	0.91
multiplicative	0.91	0.97	0.95	0.92	0.90	0.90	0.94	0.94
Brovey	0.90	0.94	0.90	0.90	0.97	0.91	0.95	0.90
color normalization (CN)	0.95	0.92	0.94	0.91	0.94	0.94	0.97	0.90
intensity-hue-saturation (IHS)	0.90	0.91	0.97	0.94	0.92	0.95	0.94	0.97
Ehlers	0.94	0.94	0.91	0.94	0.94	0.92	0.97	0.95
principal component (PC)	0.94	0.97	0.94	0.92	0.91	0.90	0.95	0.94
Gram Schmidt	0.97	0.90	0.92	0.91	0.90	0.95	0.90	0.97
	0.90	0.91	0.90	0.97	0.94	0.92	0.90	0.94
high pass filtering (HPF)	0.94	0.95	0.91	0.90	0.90	0.90	0.97	0.92
University of New Brunswick (UNB)	0.91	0.94	0.94	0.94	0.95	0.94	0.92	0.94

4. Conclusion

1. Fusion aim to sharpen multispectral images, to improve geometric corrections, to enhance certain features not visible in either of the single image alone.
2. The quality of Fusion method depends on the used images to be fused, from their resolution, noise and bands.
3. As a result of the validation of fusion using proposed test it is clearly emphasised that a suitable fusion methods has to be chosen with respect to the used spectral characteristic of the multispectral bands and the intended application.

REFERENCE

1. M. Jian, J. Dong and Y. Zhang, "Image fusion based on wavelet transform," Proc., 8th ACIS International Conference on Software Engineering, Artificial Intelligence, Networking, and Distributed Computing,, Qingdao, China, July 2007. | 2. Prakash NK, "Image Fusion Algorithm Based On Biorthogonal Wavelet", International Journal of Enterprise Computing and Business Systems, Vol. 1 Issue 2 July 2011. | 3. Ehlers, M.,. "Beyond Pansharpening: Advances in Data Fusion for Very High Resolution Remote Sensing Data", Proceedings, ISPRS Workshop 'High-Resolution Earth Imaging for Geospatial Information', Hannover2005. | 4. Ehlers, M., Greiwe, A., & Tomowski, D., "On image fusion and segmentation". 1st International Conference on Object-based Image Analysis. Salzburg University, Austria , 2006 | 5. Ling, Y., M. Ehlers, L. Usery, and M. Madden,. "FFTenhanced IHS transform method for fusing high-resolution satellite images". ISPRS Journal of Photogrammetry and Remote Sensing, 2007, 61, 6, pp. 381–392. | 6. Sascha Klonus and Manfred Ehlers, " Performance of evaluation methods in image fusion", 12th International Conference on Information Fusion Seattle, WA, USA, July 6-9, 2009. |