ijecs open access www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 3 Issue 7 July, 2014 Page No. 7350-7353

A Comparative Study of Classification of Image Fusion Techniques

Sukhpreet Singh[1], Rachna Rajput[2]

[1] M.Tech, Department of CSE, Guru Kashi University, Talwandi Sabo, Punjab, India
Bath.sukhpreet@yahoo.com

[2] Assistant Professor, Dept. of CSE, Guru Kashi University, Talwandi Sabo, Punjab, India
Rachna12CSE@gmail.com

Abstract: ***Image fusion is a process by which complimentary details from multiple input images are integrated into a single image, where the output fused image provide more information and more suitable for the purpose of human visual perception. Several situations in image processing require high spatial and high spectral resolution in a single image, to achieve this one solution is image fusion. There are several image fusion techniques are present those can improve the quality of image and provide more extended depth detail. This paper presents classification of some of the image fusion techniques such as Spatial Domain Fusion(Averaging method, Brovey Method, Principal Component Analysis, IHS) and transform domain fusion(multiresolution, Laplacian pyramid, Curvlet transform based, Discrete Wavelet transform). Comparison of all the techniques concludes the better approach for its future research.***

Keywords: Image Fusion, Curvelet transform, Image quality assessment parameter, Pyramid Methods, Principal Component analysis(PCA)

1. Introduction

Image fusion is the process by which two or more images are combined into a single image retaining the important features from each of the original images [1]. Image fusion combines perfectly registered images from multiple sources to produce a high quality fused image with spatial and spectral information.

The output fused image provides the more information without the introduction of distortion. Image fusion has many applications in different areas like medical imaging, microscopic imaging, satellite imaging for remote sensing, computer vision and robotics etc. One of the important pre-processing steps for the fusion process is image registration, i.e., coordinate transformation one image with respect to other image [2]. Several approaches to image fusion can be distinguished depending on whether the images are fused in spatial domain or they are transformed into another domain, and their transforms fused. Recently Transform domain fusion methods are much popular than the spatial methods (select minimum, select maximum, simple averaging).

2. Image Fusion Techniques

Image fusion is process in which a better enhanced quality image is produced by combining two or more images of same scene [2] [5]. The enhancement methods are broadly classified into two categories –

1) Spatial domain fusion methods
2) Transform domain fusion methods

In spatial domain fusion methods we deal with pixels, the pixel values are manipulated to achieve desired enhancement. These methods improve the spatial information and provide fused image with much quality than any input image. The averaging method, Brovey method, Principal component analysis, IHS all comes under this category. While in the case of Frequency Transform domain methods the image is transferred into frequency domain. First Fourier transform of the image is computed and all operation are performed on the Fourier transform and after that inverse Fourier transform is applied to get resultant image. The wavelet transform, Curvelet transform, Laplacian pyramid based methods comes under transform domain category. The frequency domain methods enhance the properties of image like its brightness, its contrast or distribution of gray levels. These methods improve spectral information in output fused image. The different fusion algorithm can be selected according to the requirement of our work. Today image fusion is very much popular in the different fields because due to limited focus of depth of the optical lens it is often not possible to get an image that contains all the relevant objects in focus.

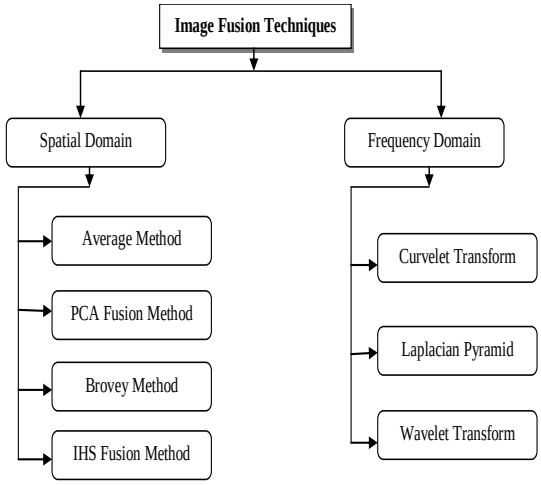

Fig 1. Categorization of Image Fusion Techniques

2.1 Spatial Domain Fusion Methods

2.1.1 Simple Averaging Method

This technique is very basic and straightforward technique in which Pixel Value P(i, j) of each input image are taken and added, after adding result is divided by 2 to get average value. This average value is added to corresponding Pixel of output image as given in equation given below :

$$F(i, j) = \{ A(i, j) + B(i, j)\}/2 \ldots\ldots (1)$$

A(i, j) and B(i, j) are input images and F(i, j) is output fused image.

2.1.2 Principal Component Analysis

Principal Component Analysis is a mathematical tool which reduces the multidimensional data sets into lower dimensions for analysis [8]. This method determines the weight factor and adds this to each pixel location in input image and takes average of weighted pixel values to produce result at same pixel location. This method works on pixel so it may produce some time spectral degradation in fused output image.

2.1.3 Brovey Method

Brovey,[3] is also called the color normalization transform because it involves a red-green-blue (RGB) color transform method. The Brovey transformation was developed to avoid the disadvantages of the multiplicative method. It is a simple method for combining data from different sensors. It is a combination of arithmetic operations and normalizes the spectral bands before they are multiplied with the panchromatic image. It retains the corresponding spectral feature of each pixel, and transforms all the luminance information into a panchromatic image of high resolution.

The formula used for the Brovey transform can be described as follows

Red = (band1/Σ band n)∗ High Resolution Band

Green = (band2/Σ band n)∗ High Resolution Band

Blue = (band3/Σ band n)∗ High Resolution Band

High resolution band = PAN

2.1.3 IHS (Intensity-Hue-Saturation)

IHS Fusion technique is used for sharpening [4]. This technique works best in image analysis for color enhancement, feature enhancement, improvement of spatial resolution and the fusion of disparate data sets. The IHS fusion technique converts a color image from the red, green, and blue (RGB) space into the IHS color space. The intensity band (I) in the IHS space is replaced by a high-resolution Pan image and then transformed back into the original RGB space together with the previous hue band (H) and the saturation band (S), resulting in an IHS fused image.

2.2 Transform Domain methods

2.2.1Curvelet Transform

This technique represents edges clear than wavelet technique since edges play fundamental role in image representation and same color as the original multispectral image [9]. This fusion method is very useful for fusion of high-spectral/low-spatial resolution multispectral and low-spectral/high-spatial resolution panchromatic satellite images. It provides more information in spatial and spectral domain both in the output fused images.

2.2.2Laplacian Pyramid

In this technique pyramid decomposition is done on each input image and after that fused image is reconstructed by performing inverse pyramid transform. Image pyramid are basically the collection of low or band pass copies of an input image in which both the band limit and sample density are reduced at each step of decomposition [10]. Fused image produced by this technique can further be used for more tasks like segmentation, object detection.

2.2.3Discrete Wavelet Transform

Discrete Wavelet transform technique is a signal analyzing technique in which input image is firstly transferred into frequency domain. The wavelet transform decomposes the input image into low-high, high-low, high-high bands at different scales and the low-low band at coarsest scale [1]. More formally can be defined by considering the wavelet transforms ω of two registered input images I_1 (x, y) and I_2 (x, y) together with the fusion rule φ, then inverse wavelet transform ω^{-1} is computed and I(x, y) fused image is reconstructed

$$I(x, y) = \omega^{-1}(\varphi(\omega(I_1(x, y)), \omega(I_2(x, y)))) \ldots\ldots (2)$$

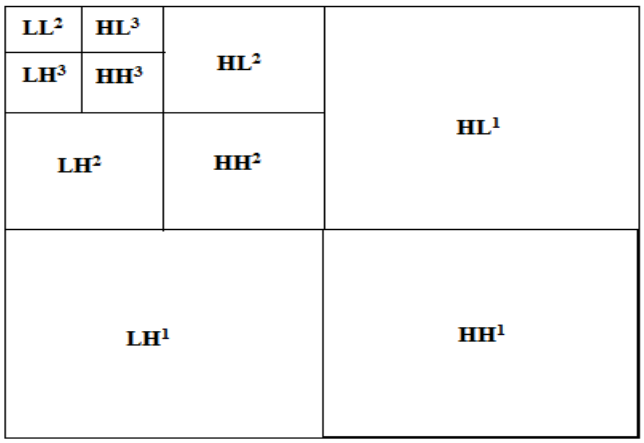

Fig 2. Wavelet Decomposition

3. Performance Measures

For the evaluation of the output fused image there are so many methods. The main function of these methods is to check the output fused image that whether it provide valid and useful information from the source image without introducing the irrelevant and redundant information. Few of schemes are discussed below:

3.1 Peak Signal to Noise Ratio (PSNR)

PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation [5].The PSNR value of better fused image is always high.

$$PSNR=10\ log_{10}\frac{\left(2^{n}-1\right)^{2}}{\sqrt{MSE}} \ldots\ldots(3)$$

3.2 ENTROPY

For the evaluation of information quantity contained in an image entropy index is calculated, if its value comes high it means information in fused image is high and improved image is produced after fusion.

$$E = -\sum_{i=0}^{L-1} pi\ log2\ pi \ldots\ldots\ldots(4)$$

Where L is total of grey levels and p is probability distribution of each level.

3.3 Normalized Cross Correlation (NCC)

Normalized Cross Correlation method is used for finding the similarities between fused image and registered image. The equation is given by

$$NCC= \sum_{i=1} m \sum_{j=1} n (A_{ij} * B_{ij})/ \sum_{i=1} m \sum_{j=1} n (Aij)^2 \ldots(5)$$

3.4 Mean Squared Error(MSE)

The mathematical equation of MSE is given by the equation [5]

$$MSE=\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(x(i,j)-y(i,j))^{2} \ldots\ldots..(6)$$

Where *i*- pixel row index, *j*- pixel column index, *M*, *N* – No. of row and column.

4.Comparison between Spatial and Transform Techniques/algorithm

S. No	Type of Fusion Technique/Algorithm	Advantages	Disadvantages
1.	Spatial Domain Fusion Methods	These methods are very simple to use and provide highly focused output images with more spatial information.	In Pixel level methods blurring problem affects the contrast of output fused image, provides low spectral information.
2.	Transform Domain Fusion Methods	These methods provide better results as compare to Pixel level methods. These methods enhance the Spectral Information. Combination of these methods with spatial methods provides both high spatial and high spectral details.	These methods are complex methods as compare to spatial methods and provide low spatial detail in output fused image.

5. Conclusion

This paper present comparative study of different image fusion techniques. The main aim of each image fusion techniques is to combine input images and enhance the quality of fused image. Although selection of fusion algorithm is problem dependent, but on the basis of the study we find out the spatial domain provide high spatial fused detail in output image but there is an blurring problem. On the other hand frequency domain fusion technique provides high spectral information. By the combination of these two, frequency domain and spatial domain methods, for example (DWT and PCA), image fusion quality will more improved and may be future trend of research regarding image fusion.

References

[1] Miss. Yogita Jawale, Mrs.A.G. Andurkar, "Implementation of Image Fusion Technique Using Wavelet Transform," International Journal of science, Engineering and Technology Research, Volume 2, Issue 3, March 2013.

[2] S.S. Bedi , RatinKhandewal, "Comprehensive and Comparative Study of Image Fusion Techniques," International Journal of Soft Computing and Engineering, Vol.3, Issue 1, March 2013.

[3] Rohan Ashok Mandhare, Sudha Gupta, "Pixel Level Image Fusion Using Brovey Transforme And Wavelet Transform," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 2, Issue 6, June 2013.

[4] Myungjin Choi, " A New Intensity-Hue-saturation Fusion Approach to Image Fusion with a Tradeoff Parameter", IEEE Transactions On Geoscience And Remote Sensing Volume 44, No.6, June 2006.
[5] Deepak Kumar Sahu, M.P.Parsai, "Different Image Fusion Techniques-A Critical Review," International Journal of Modern Engineering Research, Vol.2, Issue.5, Sep-2012.
[6] Peter J. Burt , "The Laplacian Pyramid as a Compact Image Code," IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. COM-3l, NO. 4, APRIL 1983
[7] Dr.S.S. Bedi, Mrs.Jyoti Agarwal, "Image fusión Techniques and Quality Assessment Parameters for Clinical Diagosis :A review," International Journal Of Advanced Research in Computer and Communication Engineering, Vol.2, Issue.2, Feb 2013.
[8] Kusum Rani, Reecha Sharma, "Study of Different Image Fusión Algoritms", International Journal Of Emerging Technology and Advanced Engineering, Vol. 3, Issue 5, 2013.
[9] Vishal P. Tank, Divyang D. Shah, "Image Fusion Based On wavelet And Curvelet Transform", IOSR Journal of VLSI and Signal Processing, Vol.1, Issue 5, Jan-2013.
[10] M. Pradeep, "Implementation of Image Fusion algorithm using MATLAB", IEEE 2013
[11] N. Indhumadhi, G. Padmavathi, "Enhanced Image fusión algorithm Using Laplacian Pyramid and Spatial Frequency Based Wavelet algorithm", International Journal of Soft Computing And Engineering, Vol.1,Issue 5, Nov 2011.
[12] Ravi Kumar, Munish Rattan, "Analysis Of Various Quality Metrics for Medical Iamge Processing", International Journal of Advanced Research in Computer science and Software Engineering, Vol.2, Issue 11, November 2012.
[13] Minh N. Do, Martin Vetterli, "Frame Reconstruction Of The Laplacian Pyramid", Proc. Of IEEE Intl. Conf. On Acoustics, Speech and Signal Processing, Salt Lake City, 2001.
[14] Wencheng Wang, Faliang Chang, "A Multi-focus Image Fusion Method Based On Laplacian Pyramid", Journal of Computers, Vol.6, No. 12, Dec-2011.

Author Profile

Sukhpreet Singh received the B.Tech degrees in Information Technology from Baba Farid College of Engineering & Technology in 2012. Currently he is pursuing M.Tech degree in Computer Science Engineering from Guru Kashi University, Talwandi Sabo, Bathinda (Punjab). His research interests include Image processing and Data mining.Mob.9779574120