A Review on an approach for Multifocus Digital Image Fusion using Multiscale Image Decomposition

Pranita. J. Pakhale[1], R. D. Sushir[2]

[1]Electronics and Telecommunication Engineering, P.R. Pote (Patil) College of Engineering and Management, Amravati

[2]Professor, Electronics and Telecommunication Engineering, P.R. Pote (Patil) College of Engineering and Management, Amravati

Abstract: ***Image fusion aims at improving spectral information in a fused image as well as adding spatial details to it. Among the existing fusion algorithms, filter-based fusion methods are the most frequently discussed cases in recent publications due to their ability to improve spatial and spectral information of images. Filter-based approaches extract spatial information from the original image and inject it into another images. Designing an optimal filter that is able to extract relevant and non-redundant information from the original image is presented in this letter. The optimal filter coefficients extracted from statistical properties of the images are more consistent with type and texture of the remotely sensed images compared with other kernels such as wavelets. Visual and statistical assessments show that the proposed algorithm clearly improves the fusion quality in terms of correlation coefficient, relative dimensionless global error in synthesis, spectral angle mapper, universal image quality index, and quality without reference. The visual assessment will show that the proposed method provides more spectral and spatial information. In addition to the visual inspection, the efficiency of each method will quantitatively analyze in both the original and inferior levels. This paper presents a method of image fusion based on wavelet transform. The designed method improves the definition and the special quality of image and is more suitable for multiscale properties of human vision system.***

Keywords: Image fusion, Wavelet, multiscale, Spatial, Spectral

1. Introduction

Image fusion is the process of detecting salient features in the source images and fusing these details to a synthetic image. It Produce a single image from a set of input images. The fused image should have more complete information which is more useful for human or machine perception. Through image fusion, extended or enhanced information content can be obtained in the composite image, which has many application fields, such as digital imaging, medical imaging, remote sensing, military, astronomy and machine vision. In satellite imaging system different sensor provide distinct data with distinct spatial and spectral resolution. Multispectral imaging sensor provides well spectral resolution but provide poor spatial resolution and panchromatic imaging sensor provides good spatial resolution but provide poor spectral resolution. Image fusion techniques can combine information from different sensors. Image processing results used in many image processing tasks like, image segmentation, extracting the image feature, identification of image feature, object detection, and target recognition from two or more images into a single image. Image fusion is a process of combining two or more images to enhance the information content. Image fusion techniques are important as it improves the performance of object recognition systems by integrating many sources of satellite, airborne and ground based imaging systems with other related data sets. It combines the significant information from two or more source images into a single resultant image that describes the scene better and retains useful information from the input images.

Image fusion is the technology that can take advantage of complementary information and redundancy information from different image sensors at the same time or at different times for the same scene by using some certain fusion rules, and then the fused images are more accurate and more complete than the single image and more suitable for human visual perception and processing. It also helps in sharpening the images, improve geometric corrections. To obtain an image with every object in focus, we always need to fuse images taken from the same view point with different focal settings. Multiresolution transforms, such as pyramid decomposition and wavelet, are usually used to solve this problem. Image fusion extracts the information from several images of a given scene to obtain a final image which has more information for human visual perception and become more useful for additional vision processing. It also intends to review quality assessment metrics for image fusion algorithms.

2. Literature Survey

Image Fusion is used extensively in image processing systems. Various Image Fusion methods have been proposed in the literature to reduce blurring effects. Many of these methods are based on the post-processing idea. In other words, Image fusion enhances the quality of image by removing the noise and the blurriness of the image. Image fusion takes place at three different levels i.e. pixel, feature and decision.

Shashidhar Sonnad [1] , presented different methods used to fuse the high spatial panchromatic image and low resolution multispectral images. Summarize the different satellite images used to test the particular methods and different quantitative performance measurement techniques. One should understand while applying image fusion technique is that, no specific image fusion technique is superior compared to others, the best technique is chosen depending upon the application

Sruthy, S et al.[4] has discussed that the Image Fusion is the process of combining information of two or more images into a single image which can retain all important features of the all original images. Here the input to fusion involves set of images taken from different modalities of the same scene. Output is a better quality image; which depends on a particular application. The objective of fusion is to generate an image which describes a scene better or even higher than any single image with respect to some relevant properties providing an informative image. These fusion techniques are important in diagnosing and treating cancer in medical fields. This paper focuses on the development of an image fusion method using Dual Tree Complex Wavelet Transform. The results show the proposed algorithm has a better visual quality than the base methods. Also the quality of the fused image has been evaluated using a set of quality metrics.

Aribi, W et al.[8] explained that the quality of the medical image can be evaluated by several subjective techniques. However, the objective technical assessments of the quality of medical imaging have been recently proposed. The fusion of information from different imaging modalities allows a more accurate analysis. We have developed new techniques based on the multi resolution fusion. MRI and PET images have been fused with eight multi resolution techniques. For the evaluation of fusion images obtained, authors opted by objective techniques. The results proved that the fusion with RATIO and contrast techniques to offer the best results. Evaluation by objective technical quality of medical images fused is feasible and successful.

Bin Yang and Shutao Li [9], proposed a sparse representation-based multifocus image fusion method. In the method, first, the source image is represented with sparse coefficients using an overcomplete dictionary. Second, the coefficients are combined with the choose-max fusion rule. Finally, the fused image is reconstructed from the combined sparse coefficients and the dictionary**.**

Filippo Nencini, Andrea Garzelli, Stefano Baronti, Luciano Alparone [10] , presented an image fusion method suitable for pan-sharpening of multispectral (MS) bands, based on nonseparable multiresolution analysis (MRA). The low-resolution MS bands are resample to the fine scale of the panchromatic (Pan) image and sharpened by injecting high pass directional details extracted from the high-resolution Pan image by means of the curvelet transform (CT). CT is a nonseparable MRA, whose basis functions are directional edges with progressively increasing resolution. They carried out experiment on very-high-resolution MS + Pan images acquired by the QuickBird and Ikonos satellite systems.

3. Proposed Work

Image fusion using wavelet transform:

The wavelet transform is similar to the Fourier transform (or much more to the windowed Fourier Transform) with a completely different merit function. The main difference is this: Fourier transform decomposes the signal into sines and cosines, i.e. the functions localized in Fourier space; In contrary the wavelet transform uses functions that are localized in both the real and Fourier space. Generally, the wavelet transform can beexpressed by the following equation:

$$F(a,b) = \int_{-\infty}^{\infty} f(x)\, \psi^*_{(a,b)}(x)\, \mathrm{d}x$$

where the * is the complex conjugate symbol and function ψ is some function. This function can be chosen arbitrarily provided that obeys certain rules. the Wavelet transform is in fact an infinite set of various transforms, depending on the merit function used for its computation. This is the main reason, why we can hear the term “wavelet transform” in very different situations and applications. Nowadays, wavelet transformation is one of the most popular candidates of the time frequency transformations. the basis function Ψ can be regarded as an impulse response of a system with which the function x(t) has been filtered. The transformed signal provides information about the time and the frequency. Therefore, wavelet transformation contains information similar to the short time Fourier transformation, but with additional special properties of the wavelets, which show up at the resolution in time at higher analysis frequencies of the basis function. Wavelet transforms are broadly divided into three classes: continuous, discrete wavelet transform.

The discrete wavelet transform returns a data vector of the same length as the input is. Usually, even in this vector many data are almost zero. This corresponds to the fact that it decomposes into a set of wavelets (functions) that are orthogonal to its translations and scaling. Therefore we decompose such a signal to a same or lower number of the wavelet coefficient spectrum as is the number of signal data points. Such a wavelet spectrum is very good for signal processing and compression, for example, as we get no redundant information here.

The continuous wavelet transform in contrary returns an array one dimension larger than the input data. For a 1D data we obtain an image of the time frequency plane. We can easily see the signal frequencies evolution during the duration of the signal and compare the spectrum with other signals spectra. As here is used the non orthogonal set of wavelets, data are correlated highly, so big redundancy is seen here.

The block diagram of a generic wavelet based image fusion scheme is shown in the following figure:

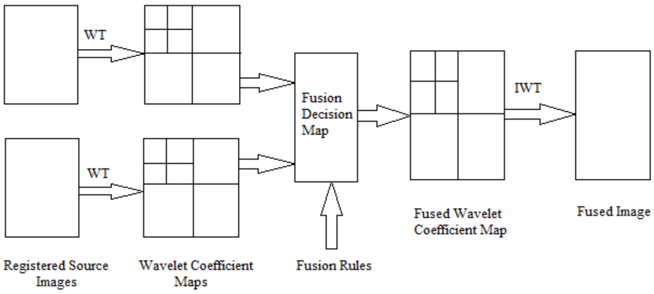

Figure 1 Generic wavelet based image fusion scheme

Wavelet transform is first performed on each source images, then a fusion decision map is generated based on a set of fusion rules. The fused wavelet coefficient map can be constructed from the wavelet coefficients of the source images according to the fusion decision map. Finally the fused image is obtained by performing the inverse wavelet transform. From the above diagram, we can see that the fusion rules are playing a very important role during the fusion process. The wavelet transform decomposes the signal into scaled and shifted forms of the mother wavelet or function. In the image fusion using wavelet transform, the input images are decomposed into approximate and informative coefficients using WT at some specific level. A fusion rule is applied to combine these two coefficients and the resultant image is obtained by taking the inverse wavelet transform. Wavelet transform based image fusion process improves only spectral information.

Image fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images. Multisensor data fusion has become a discipline which demands more general formal solutions to a number of application cases. Several situations in image processing require both high spatial and high spectral information in a single image. This is important in remote sensing. However, the instruments are not capable of providing such information either by design or because of observational constraints. One possible solution for this is data fusion. Image fusion methods can be broadly classified into two groups spatial domain fusion and transform domain fusion.

The fusion methods such as averaging, Brovey method, principal component analysis (PCA) and IHS based methods fall under spatial domain approaches. Another important spatial domain fusion method is the high pass filtering based technique. Here the high frequency details are injected into upsampled version of MS images. The disadvantage of spatial domain approaches is that they produce spatial distortion in the fused image. Spectral distortion becomes a negative factor while we go for further processing, such as classification problem. Spatial distortion can be very well handled by frequency domain approaches on image fusion. The multiresolution analysis has become a very useful tool for analysing remote sensing images. The discrete wavelet transform has become a very useful tool for fusion. Some other fusion methods are also there, such as Laplacian pyramid based, curvelet transform based etc. These methods show a better performance in spatial and spectral quality of the fused image compared to other spatial methods of fusion.

4. Conclusion

In this paper, we have presented a multifocus image fusion method based on wavelet transform theory. Fusion rules are given using multiple operators according to different fusion rules. The process of image fusion combines the input images and extracts useful information giving the resultant image. The main goal of image fusion in multi-focus cameras to integrate the information from several pictures of the identical scene in order to deliver only the multi focused image. To acquire the crucial features or attributes of the images of common features image fusion is widely used technology. The wavelet transform is one of the most efficient approaches to extract the features by the transformation and decomposition process but this method is not efficient to retain the edge information. In this paper literature study of the fusion techniques is described with their shortcoming. In future work, design such algorithm which can efficiently retain the edge information.

References

[1] Shashidhar Sonnad "A Survey on Fusion of Multispectral and Panchromatic Images for High Spatial and Spectral Information" Dept. of Electronics & Communication Engineering APPA Institute of Engineering & Technology Kalaburagi, Karnataka, India IEEE WiSPNET 2016 conference.

[2] Mamta Sharma " A Review : Image Fusion Techniques and Applications"(IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 7 (3) , 2016, 1082-1085.

[3] Shaveta Mahajan, Arpinder Singh, "A Comparative Analysis of Different Image Fusion Techniques", IPASJ International Journal of Computer Science (IIJCS), Volume 2, Issue 1, January 2014

[4] Sruthy, S., Latha Parameswaran, and Ajeesh P. Sasi. "Image Fusion Technique using DT-CWT." In Automation, Computing, Communication, Control and Compressed Sensing (iMac4s), 2013 International Conference on, pp. 160-164. IEEE, 2013.

[5] Kanisetty Venkata Swathi, CH.Hima Bindu "Modified Approach of Multimodal Medical Image Using Daubechies Wavelet Transform" International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 11, November 2013, ISSN (Print): 2319-5940.

[6] J. Srikanth*, C.N Sujatha "Image Fusion Based on Wavelet Transform for Medical Diagnosis", Int. Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 3, Issue 6, Nov-Dec 2013, pp.252-256.

[7] Ch.Bhanusree, P. Aditya Ratna Chowdary "A Novel Approach of image fusion MRI and CT image using Wavelet family", International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 2, Issue 8, August 2013, ISSN 2319 – 4847.

[8] Aribi, Walid, Ali Khalfallah, Med Salim Bouhlel, and Noomene Elkadri. "Evaluation of image fusion

techniques in nuclear medicine." In Sciences of Electronics, Technologies of Information and Telecommunications (SETIT), 2012 6th International Conference on, pp. 875-880. IEEE, 2012.

[9] Bin Yang and Shutao Li, Member, *IEEE,* “Multifocus Image Fusion and Restoration With Sparse Representation” , IEEE transactions on instrumentation and measurement, vol. 59, no. 4, april 2010.

[10] Filippo Nencini, Andrea Garzelli, Stefano Baronti, Luciano Alparone, “Remote sensing image fusion using the curvelet transform”, Department of Information Engineering, University of Siena, Via Roma, 56, 53100 Siena, Italy. *Inf. Fusion*, vol. 8, no. 2, pp. 143–156, Apr. 2007.