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− A Short Note

IMAGE FUSION TECHNIQUES

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ABSTRACT

Image Fusion is the process of combining information from two or more images of the same scene taken at the same instant or at different instants to provide more detailed images than the individual images separately. Image fusion has applications in different areas like commercial, military, medical, remote sensing, urban development, agricultural, etc. We present here the different image fusion techniques and algorithms including PCA, Wavelets, Shearlets and Noiselets.

Key words: Image fusion, PCA, IHS, DWT, Shearlets, Curvelets, Noiselets.

INTRODUCTION

Image Fusion is the process of combining information from two or more images of the same scene taken at the same instant or at different instants to provide more detailed images than the individual images separately. The image fusion techniques involve pixel based methods, decision based methods and feature based methods. The advantages and applications of image fusion have been discussed in literature. In the following sections different image fusion techniques are discussed. The image fusion started with the IHS and PCA methods. With the advent of multiresolution analysis techniques like wavelets came into force. Techniques like curvelets, shearlets were developed to overcome the disadvantages faced by the wavelets. Techniques including Artificial Neural networks, Fuzzy logic, soft computing were also introduced in the decision making. Image fusion can be multimodal, multiview, multifocus or multitemporal. In multimodal fusion the input images are of different sensors like MRI and PET, MS and Panchromatic. Multiview fusion involves fusion of images of the same modality taken by the same sensor but at different angles. Multitemporal fusion involves fusion of images obtained from same sensor obtained at different times. Image fusion techniques can also be classified as spatial domain

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techniques and frequency domain techniques depending on the domain in which the fusion is carried out.

Traditional methods

The traditional methods like averaging, maximum or minimum are simple to implement and were the first to be considered. Here the pixel values of the individual images are considered and the values of corresponding output pixels were taken as per the method. The averaging method involves taking the average of the corresponding pixels of the input images to obtain the value of the output pixels. Weighted superposition of pixel values has also been applied. The maxima method involves finding the maximum value of the corresponding input pixels. The minima method involves finding the minimum of the corresponding input pixels. In Principal Component Analysis[1] the intercorrelated data is converted into a set of unrelated components called the principal components[2].

Multiresolution analysis based methods

The advent of multiresolution analysis led to the use of wavelets. The input images are transformed into the frequency domain by wavelet transform. The frequency coefficients are then merged based on different rules like minimum, maximum, average or soft computing techniques like ANN, Fuzzy etc.., Wavelets like DWT, DTCWT have been discussed in the literature. Wavelet based fusion techniques have been found to give better results when compared with the standard fusion techniques considering the spatial and spectral qualities[3-5]. The Fig. 1[1] shows an example of wavelet based fusion of MS and panchromatic images. The wavelets can also be combined with the traditional methods like IHS, PCA to give better results.

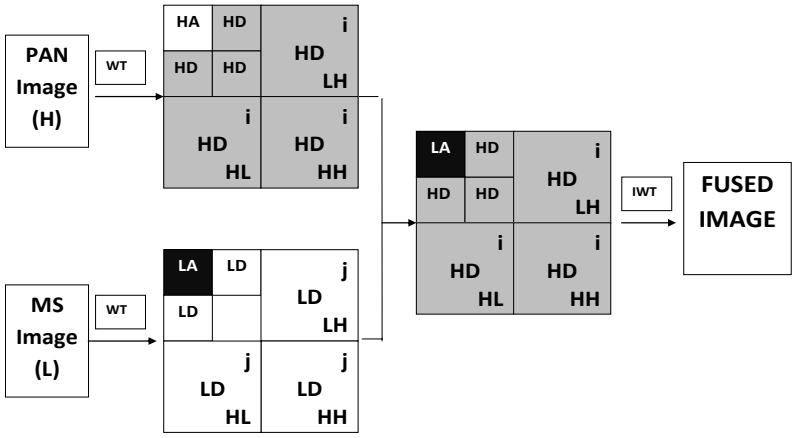

Fig. 1: Wavelet based fusion of multispectral and panchromatic images

Curvelets are transforms that are highly anisotropic. Hence the curvelets are better than wavelets in representing edges and are therefore well suited in the extraction of the detailed spatial information from an image[6]. Wavelets lack directionality and are not good in capturing the geometrical smoothness of the contours[7]. Contourlet is an extension of the wavelet and uses multiscale and directional filter banks[7]. The basis images of the Contourlet transform are oriented at various directions with multiple scales and also have flexible aspect ratios[7]. Contourlets exhibit directionality and anisotropy. Contourlets need fewer coefficients for representing a smooth contour in comparison with wavelets. As explained in by Minh N Do et al.[8] the wavelets have square report only and require more number while the Contourlets can have elongated supports thereby requiring less number of coefficients for efficient representation of a smooth contour, as illustrated in Fig. 2[7-9]. Contourlets are also computationally efficient due to the iterated filter banks. Contourlets have the ability of capturing and linking the point of discontinuities in forming a linear structure i.e. contours.

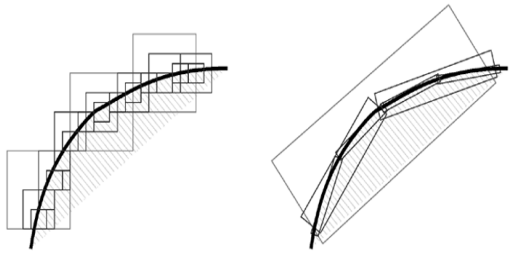

Fig. 2: Wavelets and contourlets in representing a smooth contour

Noiselet basis functions are constructed by twisting the translates and dilates of the mother function[10]. The signal is totally spread out in scale and in time by the noiselet transforms coefficients. Hence information pertaining to the original signal is available in each subset of the noiselet transformation at all the scales and times[10]. Shearlet transform has a single or finite set of generating functions and provides almost optimal representations for a large class of multidimensional data[11]. Shearlet also allows the continuum and digital realms to be treated as unified and has fast algorithmic implementations[11].

Soft computing methods in image fusion

All fusion techniques involve a step wherein the characteristics are to be merged. In spatial domain pixel values are merged. In frequency domain the frequency coefficients are merged. The merging principle is to be based on an algorithm or rule. This can be simple rules like minima, maxima, average, weighted average etc. or advanced algorithms like fuzzy logic, artificial neural networks, genetic algorithms, particle swarm optimization etc.,

CONCLUSION

Image fusion applications have increased manifold with the advent of large number of images being captured by different types of sensors. We have discussed a few techniques that are available in the literature including the traditional IHS, Brovey, PCA, Wavelets and advanced techniques like DTCWT, Curvelets, Noiselets and Shearlets.

REFERENCES

1. D. Jiang, D. Zhuang, Y. Huang and J. Fu, Survey of Multispectral Image Fusion Techniques in Remote Sensing Applications, Image Fusion and Its Applications, Dr. Yufeng Zheng (Ed.), ISBN:978-953-307-182-4 (2011).
2. M. Strait, S. Rahmani and D. Merkurev, Evaluation of Pan-Sharpening Methods (2008).
3. M. Gonzáles Audícana and A. Seco, Fusion of Multispectral and Panchromatic Images Using Wavelet Transform- Evaluation of Crop Classification Accuracy, in Proc. 22nd EARSeL Annu. Symp. Geoinformation Eur.-Wide Integr., Prague, Czech Republic, T. Benes, Ed. (2003) pp. 265-272.
4. K. Amolins, Y. Zhang and P. Dare, Wavelet Based Image Fusion Techniques—An Introduction, Review and Comparison, ISPRS J. Photogrammetric and Remote Sensing, **62**, 249-263 (2007).
5. J. Nunez, X. Otazu, O. Fors, A. Prades, V. Pala and R. Arbiol, Multiresolution-Based Image Fusion with Additive Wavelet Decomposition, Geoscience and Remote Sensing, IEEE Transactions on, **37(3)**, 1204-1211 (1999).
6. M. Choi et al., Fusion of Multispectral and Panchromatic Satellite Images Using the Curvelet Transform, IEEE Geoscience and Remote Sensing Lett., **2(2)** (2005).
7. D. D.-Y. Po and M. N. Do, Directional Multiscale Modeling of Images Using the Contourlet Transform, Image Processing, IEEE Transactions on, **15(6)**, 1610-620 (2006).
8. M. N.Do and M. Vetterli, The Contourlet Transform: An Efficient Directional Multiresolution Image Representation, Image Processing, IEEE Transactions, **14(12)**, 2091, 2106 (2005).
9. M. N. Do and M. Vetterli, The Contourlet Transform: An Efficient Directional Multiresolution Image Representation, Image Processing, IEEE Transactions, **14(12)**, 2091-2106 (2005).

10. K. Pawar et al., Multichannel Compressive Sensing MRI Using Noiselet Encoding, arXiv:1407.5536v2 [physics.med-ph] (2014).

11. C. Duan, Q. Huang, X. Wang, S. Wang and H. Wang, Remote Sensing Image Fusion Based On IHS and Dual Tree Compactly Supported Shearlet Transform, Int. J. Signal Process., Image Processing and Pattern Recognition, **7(5)** (2014).

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