COMPARATIVE STUDY OF WAVELETS AND CONTOURLETS TECHNIQUES APPLIED TO ALSAT-2 ALGERIAN SATELLITE IMAGE FUSION

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Abstract:

In many remote sensing and mapping applications, the fusion of panchromatic and multispectral images is an important issue. Several techniques and software tools for fusing images have been developed. The well-known methods include the Brovey method, the intensity–hue–saturation (IHS) color model, and principal component analysis (PCA). However, a limitation of these methods is that some distortion occurs in the spectral characteristics of the original multispectral images. Intensity-Hue-Saturation(IHS) transform which always distorts the spectral features, High Pass Filter (HPF) method and Principle Component Analysis (PCA) which lose the physical features of the source images. Some approaches are based on multiresolution decomposition, such as Laplacian pyramid and wavelet transform. But Laplacian pyramid increase the amount of the data. Recently, developments in wavelet analysis have provided a potential solution to this problem. Wavelet-based image fusion method provides high spectral quality of the fused satellite images. However, the fused image by Wavelets have much less spatial information than those by the Brovey, IHS, and PCA methods.

In this communication, we describe and study another digital implementation, namely, the contourlet transform. The contourlet transform is a new image decomposition scheme that provides sparse representation of the data, constructed by combining two successive stages, applying in first a Laplacian pyramidal decomposition followed by a directional filter bank. This non-linear approach is designed to give a good representation of the geometrical content of the image. Recently, the Stationary version of the Contourlet Transform (SCT) has been proposed because of its ability to give an asymptotic optimal representation of edges and contours in image by virtue of its property of good multiresolution, shift-invariance, and high directionality.

In this paper, we propose a comparative study between fusion methods implemented in our laboratory :
- Transformations in colorimetric field: the IHS transform (Intensity, Hue and saturation) and the INR transform (Intensity Normalized Report),
- Combination between the SCT and the IHS transform in his variant technique to present the intensity ,
- Combination between the wavelet transform and the IHS transform in one hand and the stationary wavelet transform (SCT) using the "A trous" algorithm, with the INR transform in the other hand.

To obtain results with spatial improvement and minimum loss of spectral characteristics, the studied methods have been tested on images getting by ALSAT 2A Algerian satellite and covering an area of Algiers town (Algeria).

In our study, we adopt the following statistic indexes to performance, to evaluate the spatial and spectral quality of the synthetic images such as: the mean value, the standard deviation, the entropy, the average gradient, the correlation coefficient, the spectrum distortion, the weighted fusion quality index, and the edge-dependent fusion quality index.

Based on the experimental results obtained from these methods, we noticed that the propose methods based on the SCT preserve well the spectral information of the original multispectral image and gives more spatial characteristics to the synthetic image because of her ability to detect edges and contours in the Pan component, and by the use of the fusion rule, that allows us to see the injection of structures by the increasing clarity of the synthetic fused image.

Key words: image fusion, spectral resolution, spatial resolution, wavelets, stationary contourlet transform.