Comparison and Evaluation of Fusion Methods to High Resolution Hybrid Products Simulation of the CBERS-2B Satellite

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Abstract. *The widespread methods present in the literature make the fusion process among images with near spatial resolution. What we do not know is if these methods applied to data with a wide resolution difference, resulting hybrid products with the same quality. Therefore, this work proposes to study an image fusion methodology with wide spatial resolution difference. The idea is to test a methodology over images produced by CBERS-2B satellite, that had been launched in September 2007. In such a way, some fusion methods will be compared and evaluated to discover what is the best one to solve the fusion problem.*

1. Introduction

In Remote Sensing, there are several methods to image fusion, for example IHS Method [Haydan et al. 1982], Principal Components Analysis [Chavez and Kwarteng 1989] and Wavelets [Mallat 1989, Otazu et al. 2005]. Some procedures integrate complementary features from two or more methods to have better results [González-Audícana et al. 2004]. The widespread image fusion methods aim to extract the detail information from panchromatic image (PAN) and the spectral information from multispectral images (MULTI) to produce hybrid products with MULTI spectral response and PAN spatial resolution.

However, the methods fuse images with near spatial resolution (the factor between the PAN and MULTI spatial resolution does not exceed 1:4). In this case, the presented results have been satisfactory. What we do not know is if these methods can produce hybrid products with the same quality when we applied to images with wide spatial resolution difference (1:8). This difference can cause some problems in resampling operation that image fusion method makes along their processes.

In this context, this paper proposes to study a image fusion methodology applied to images with wide spatial resolution difference. We intent to introduce this method to produce CBERS-2B multispectral images with high resolution.

2. Methodology

The main object is to study about several fusion methods to detect what is the best one to solve the wide spatial resolution difference problem. Figure 1 shows the methodology schema.

Firstly, a correct co-registration among MULTI and PAN images is required to assure that images are matched. The registration is widely discussed in [Fonseca 1999], and can be done through several applications [Fedorov et al. 2002].

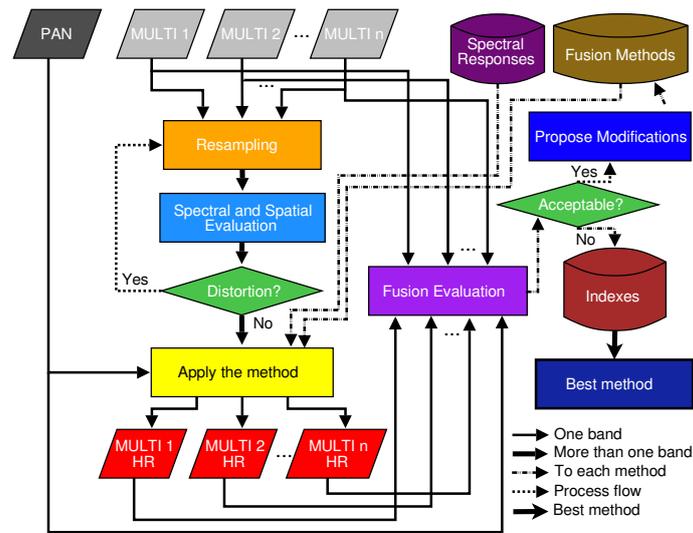All data and processes presented in the schema are discussed as follow:

Figure 1. Methodology diagram.

- **PAN:** High resolution panchromatic image. For the CBERS-2B satellite case, this band have $2.5m$ of spatial resolution, however it will be simulated through SPOT-5 panchromatic band.

- **MULTI** i: Low resolution multispectral images, where $i = 1, 2, \ldots, n$ and n is the number of MULTI bands. In CBERS-2B case, these images will have $20m$ as in CBERS-2 satellite that will be used to the simulations.

- **Resampling:** The resampling aims to reconstruct the image details modifying the edges information. It is necessary because all fusion methods, in this work, require it.

- **Spectral and Spatial Evaluation:** We do not know yet the spectral and spatial effects that the resampling causes. Therefore, they will be evaluated to quantify how much these modifications change the hybrid product.

- **Distortion?:** If the distortion caused by the resampling modify substantially the image, the resampling is changed by another that minimize it.

- **Apply the method:** We choose six fusion methods to make evaluations and comparisons: IHS [Haydan et al. 1982], PCA [Chavez and Kwarteng 1989], Additive Wavelet [Nunez et al. 1999], WiSpeR [Otazu et al. 2005], Improved IHS-Wavelet and Improved PCA-Wavelet [González-Audícana et al. 2004].

- **MULTI** i **HR:** Multispectral images with the same PAN spatial resolution, where $i = 1, 2, \ldots, n$ e n is the number of MULTI bands.

- **Fusion Evaluation:** Through quantitative indexes such as Correlation Coefficient, RMSE, UIQI, ERGAS, Spatial ERGAS and Spatial Standard Deviation, the hybrid products will be compared with the original ones. To make it possible, generally, the MULTI and PAN input images are degraded in order to produce, after the fusion, a hybrid product with the same original MULTI spatial resolution. It is made to have a truth to compare.

- **Acceptable?:** If the evaluation is not good some modifications can be introduced, on the other hand the indexes values are stored.

- **Propose Modifications:** Some methods could not be good for fusions among images with wide spatial resolutions differences. This could be proven by the

indexes values. Therefore, some modifications on these methods will be propose to improve its performance.

- **Fusion Methods:** Knowledge about the methods that will be evaluated and compared.
- **Spectral Responses:** The WiSpeR method needs the information of the sensors spectral response functions. In general, the insertion of this information results in better results.
- **Indexes:** Storage of indexes calculated for each one methods.
- **Best Method:** Choose what is the best method considering input images with wide spatial resolution difference.

3. Conclusions

We intent to choose the best method that insert less distortions in the hybrid product. The computational cost will be also considered since one of the objectives is to become it operational in CBERS station. Besides, the methods and indexes that have been developed will be available at Terralib Library.

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