Pixel based image fusion for remote sensing

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Abstract—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 several situations in image processing require high spatial and high spectral resolution in a single image. Most of the available equipment is not capable of providing such data convincingly. Image fusion techniques allow the integration of different information sources. This paper is related to the image fusion of satellite images where image are having high or low resolutions. The fused image can have complementary spatial and spectral resolution characteristics. However, the standard image fusion techniques can distort the spectral information of the multispectral data while merging of the input images.

Keywords- *spatial, spectral, and panchromatic*

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I. INTRODUCTION

Image fusion means the combining of two images into a single image that has the maximum information content without producing details that are non-existent in the given images. Image fusion is a process of combining images, obtained by sensors of different wavelengths simultaneously viewing of the same scene, to form a composite image. The composite image is formed to improve image content and to make it easier for the user to detect, recognize, and identify targets and increase his situational awareness.

In satellite imaging, two types of images are available. The panchromatic image acquired by satellites is transmitted with the maximum resolution available and the multispectral data are transmitted with coarser resolution. This will usually be two or four times lower. At the receiver station, the panchromatic image is merged with the multispectral data to convey more information.

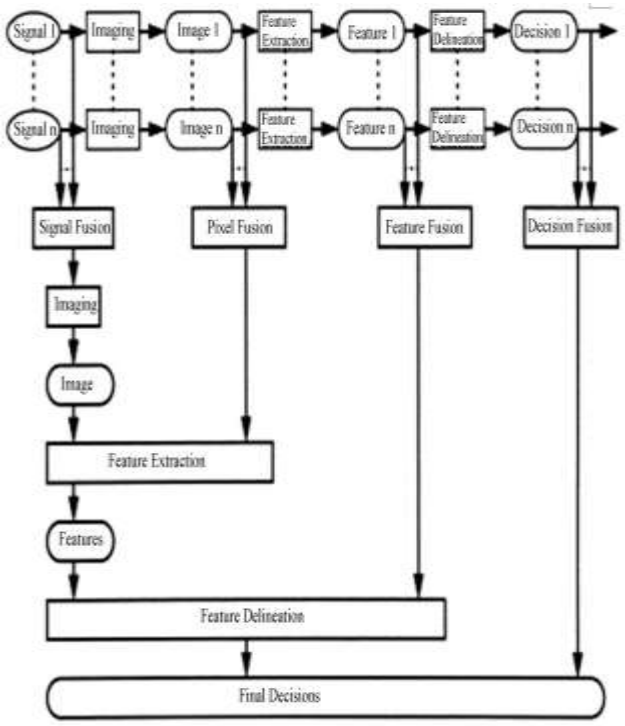
Image fusion in remote sensing has several application domains. An important domain is the multi-resolution image fusion (commonly referred to pan-sharpening). In satellite imagery we can have two types of images

Panchromatic images - An image collected in the broad visual wavelength range but rendered in black and white.

Multispectral images - Images optically acquired in more than one spectral or wavelength interval. Each individual image is usually of the same physical area and scale but of a different spectral band.

The SPOT PAN satellite provides high resolution (10m pixel) panchromatic data. While the LANDSAT TM satellite provides low resolution (30m pixel) multispectral images. Image fusion attempts to merge these images and produce a single high resolution multispectral image.

Image fusion can be performed roughly at four different stages: signal level, pixel level, feature level, and decision level. Fig illustrates of the concept of the four different fusion levels .



A]Signal level fusion.

In signal-based fusion, signals from different sensors are combined to create a new signal with a better signal-to noise ratio than the original signals.

B]Pixel level fusion.

Pixel-based fusion is performed on a pixel-by-pixel basis. It generates a fused image in which information associated with each pixel is determined from a set of pixels in source images to improve the performance of image processing tasks such as segmentation

C]Feature level fusion.

Feature-based fusion at feature level requires an extraction of objects recognized in the various data sources. It requires

the extraction of salient features which are depending on their environment such as pixel intensities, edges or textures. These similar features from input images are fused.
D]Decision-level fusion consists of merging information at a higher level of abstraction, combines the results from multiple algorithms to yield a final fused decision. Input images are processed individually for information extraction. The obtained information is then combined applying decision rules to reinforce common interpretation.
The usual steps involved in satellite image fusion are as follows:

1]Resize the low resolution multispectral images to the same size as the panchromatic image.

2]Transform the R, G and B bands of the multispectral image into IHS components.

3]Modify the panchromatic image with respect to the multispectral image. This is usually performed by histogram matching of the panchromatic image with Intensity component of the multispectral images as reference.

4]Replace the intensity component by the panchromatic image and perform inverse transformation to obtain a high resolution multispectral image.
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The PCA transform converts inter-correlated multi-spectral (MS) bands into a new set of uncorrelated components. To do this approach first we must get the principle components of the MS image bands. After that, the first principle component which contains the most information of the image is substituted by the panchromatic image. Finally the inverse principal component transform is done to get the new RGB (Red, Green, and Blue) bands of multi-spectral image from the principle components.
The standard merging methods of image fusion are based on Red-Green-Blue (RGB) to Intensity-Hue-Saturation (IHS) transformation
The intensity-hue-saturation (HIS) fusion converts a color MS image from the RGB space into the IHS color space. The HIS components can be defined as follows:

$$I=(R+G+B)/3 \quad [1]$$

$$H=(B-R)/3(I-R),S=1-R/I \quad [2]$$
when=Minimum(R,G,B)

$$H=(R-G)/3(I-G),S=1-G/I \quad [3]$$
when=Minimum(R,G,B)

$$H=(G-B)/3(I-B),S=1-B/I \quad [4]$$
when=Minimum(R,G,B)

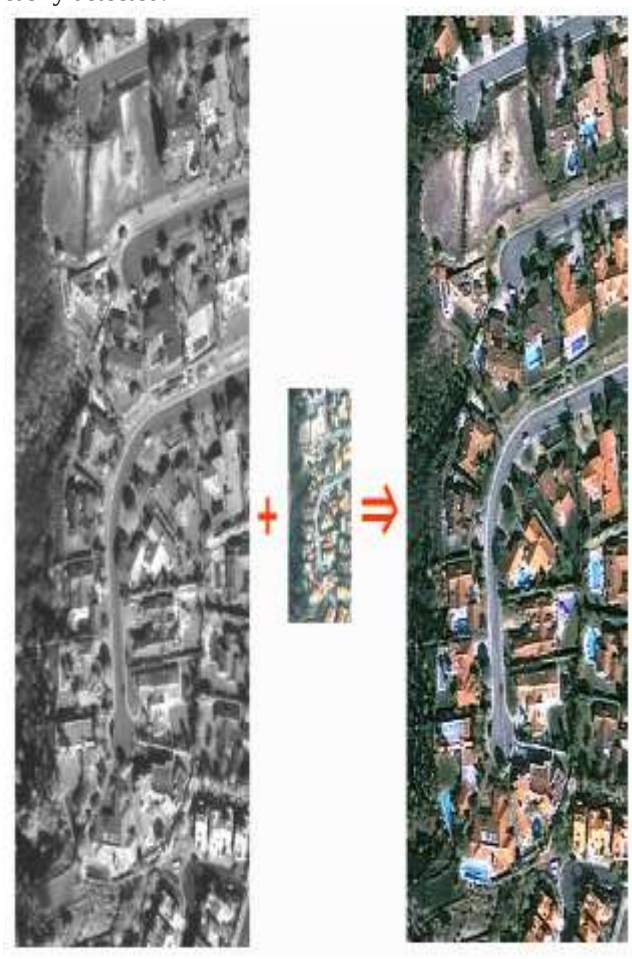
Were I,H,S stand for intensity, hue and saturation components respectively; R, G, B mean Red, Green, and Blue bands of multi-spectral image.
Because the intensity (I) band resembles a panchromatic (PAN) image, it is replaced by a high-resolution PAN image in the fusion. A reverse IHS transform is then performed on the PAN together with the hue (H) and saturation (S) bands, resulting in an IHS fused image.

Different arithmetic combinations have been developed for image fusion.
The Bovey transform, Synthetic Variable Ratio (SVR), and Ratio Enhancement (RE) techniques are some successful examples. The basic procedure of the Brovey transform first multiplies each MS band by the high resolution PAN band, and then divides each product by the sum of the MS bands. The algorithm is shown in equation

$$DNfused=DNpan\times DNb1/(DNb1+DNb2+DNb3)$$

Where DN_{fused} means the digital number (DN) of the resulting fused image; DN_{b1}, DN_{b2} and DN_{b3}stand for pixel values of three bands of multiple spectral image; DN_{pan} stand for pixel values of high resolution Pan band.

The SVR and RE techniques are similar, but involve more sophisticated calculations for the MS sum for better fusion quality. For example Spot 5 Pan band data with spatial resolution of 2.5m of Yanking city, Beijing China, in 2005 was fused with multiple spectral bands of Land sat TM data (spatial resolution:30m) in 2007. A simple Bovey transformation fusion method was used and the 3rd, 4th, 7th bands of TM were selected for calculation. The building areas remained unchanged from 2005-2007 were grey-purple, meanwhile, the newly established buildings were highlighted (lime color) in the composed image and could easily detected.



The left and middle input images are obtained from Space Imaging, and the right-hand image is the fused result from High View.

The past few decades have seen quite a few image fusion and pan-sharpening methods in the public domain, including those based on multi-resolution wavelet transforms, PCA (Principal Component Analysis) transforms, and IHS (Intensity-Hue-Saturation) transforms. These methods, however, largely disregard important spectral characteristics of specific satellite sensors, therefore no consistent, color-preserving results can be achieved.

II. CONCLUSION

This paper has been presented for Pixel level fusion of satellite images . A simple data-driven approach without REFERRING TO SPECTRAL EVIDENCE CAN HARDLY PRODUCE satisfactory outcomes. This becomes more apparent when the recent generation of high- and medium-resolution satellite images is available, where there are marked spectral disparities between color bands and the panchromatic band.

REFERENCES

[1] Dr. –Ing Michael Heisman, "Image fusion tutorial," in IEEE international conference on multisensory fusion and integration for intelligent systems, Heidelberg,2006.
[2] Fang Liu, Senior Member, IEEE, Junying Liu and Yi Gao "IMAGE FUSION BASED ON WEDGELET AND WAVELET".
[3] Wavelet Transform By Raghuveer M. Rao & Ajit S. Borardikar.
[4] Wikipedia. "Wavelets," http://www.wikipedia .com/waelets/
[5] www.ijert.org.