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# REVIEW ARTICLE

# PERFORMANCE & ANALYSIS OF SATELLITE IMAGE PROCESSING USING PANCHROMATIC AND MULTISPECTRAL IMAGES

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**ABSTRACT**

The field of remote sensing is a continuously growing market with applications like vegetation mapping and observation of the environment. The increase in applications is due to the availability of high quality images for a reasonable price and improved computation power. However, as a result of the demand for higher classification accuracy and the need in enhanced positioning precision (e.g. for geoscience information systems) there is always a need to improve the spectral and spatial resolution of remotely sensed imagery. These requirements can be either fulfilled by building new satellites with a superior resolution power, or by the utilization of image processing techniques. The main advantage of the second alternative is the significantly lower expense. Remote sensing images are distinct in terms of imaging as the images are captured over a wide range of the electromagnetic spectrum such as the thermal infrared and the microwave spectrum. Also, interpreting the satellite images requires a previous experience and understanding of the nature of the Earth's surface and the target areas. Moreover, analysis of remote sensing images aims to extract the information about the land cover and sometimes present it as a graphic format (such as maps).The sensors launched on the satellites provide a variety of images with different specifications. Therefore, it is required to introduce an efficient technique that integrates the output of two or more sensors and produces more accurate images to meet the requirements of remote sensing applications including: environmental change detection agricultural monitoring and urban planning. Therefore, image fusion is a promising research area in the image-based application fields. The aim of the paper is to produce a single image from set of images using Contourlet transform. Considerable progress has been made in the fusion of images from different imaging modalities using software approaches. One goal of fusion software is to align anatomical and functional images and allow improved spatial localization of abnormalities. The software part is using MATLAB for fusing images.

## INTRODUCTION

The purpose of this paper is to present a novel image fusion technique which could be applied to various domains, but focuses on the fusion of remote sensing images. The goal of this technique is to fuse the PAN image and MS image with RGB band separation. The second objective is to perform HIS transformation of MS image and fused with the PAN image to obtain high resolution image. The third objective is to calculate the entropy for both MS image and fused image and to obtain the standard deviation for both MS image and fused image. Finally, comparing all the parameters and to improve the remote sensing image resolution. First goal is to perform RGB transformation for the given MS image and applying it to Contourlet transform. Histogram matching is performed for the PAN image in order to obtain stretched PAN image. Fusing both the stretched PAN and MS image and applying inverse Contourlet transform to obtain high resolution fused image. Corresponding Entropy value for MS image and fused image is Obtained for performance measure [Joshi and Sanderson, 1999; Kwon et al., 2002; Melkamu et al., 2010; Miao Qiguang and Wang Baoshul, 2005]. In similar way the standard deviation for both the MS image and fused image is calculated by calling the corresponding function in MATLAB to perform the manipulation. Second objective is to perform RGB to HIS transformation and fusing the stretched PAN image with the HIS transformed image applying through the Contourlet transform, Contourlet decomposition and taking inverse Contourlet transform to obtain the fused high resolution image. Entropy value for MS image and fused image is obtained for performance measure. In similar way the standard deviation for both the MS image and fused image is calculated by calling corresponding function in MATLAB to perform the manipulation. Finally comparing the image obtained from the two algorithms is compared to evaluate the resolution of the given image and the corresponding entropy and standard deviation values should compare [Anto Bennet et al., 2015; Anto Bennet et al., 2015].

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### EXPERIMENTAL SECTION

Image fusion is a technique that integrates complementary information from multiple image sensor data such that the new images are more suitable for processing tasks. An image pyramid can be described as collection of low-or-band pass copies of an original image in which both the band limit and sample density are reduced in regular steps. The basic strategy of image fusion based on pyramids is to use a feature selection rule to construct a fused pyramid representation from the pyramid representations of the original data. The composite image is obtained by taking an inverse pyramid transform.In remote sensing applications, the increasing availability of space borne sensors gives a motivation for different image fusion algorithms. 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. The image fusion techniques allow the integration of different information sources. The fused image can have complementary spatial and spectral resolution characteristics. However, the standard image fusion techniques can distort the spectral information of the multi spectral data while merging [Anto Bennet and Raglend, 2012; Anto Bennet et al., 2015].

## TYPES OF IMAGES

In satellite imaging, two types of images are available

- Panchromatic images
- Multi Spectral images

The panchromatic image acquired by satellites is transmitted with the maximum resolution available and the Multi Spectral 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 multi spectral data to convey more information.

## PANCHROMATIC IMAGES

A panchromatic image consists of only one band. It is usually displayed as a grey scale image, i.e. the displayed brightness of a particular pixel is proportional to the pixel digital number which is related to the intensity of solar radiation reflected by the targets in the pixel and detected by the detector. Thus, a panchromatic image may be similarly interpreted as a black-and-white aerial photograph of the area. The Radiometric Information is the main information type utilized in the interpretation.

**Figure 1. Panchromatic Image**

Figure 1 show a panchromatic image extracted from a **SPOT** panchromatic scene at a ground resolution of 10 m. The ground coverage is about 6.5 km (width) by 5.5 km (height). The urban area at the bottom left and a clearing near the top of the image have high reflected intensity, while the vegetated areas on the right part of the image are generally dark. Roads and blocks of buildings in the urban area are visible. A river flowing through the vegetated area, cutting across the top right corner of the image can be seen. The river appears bright due to sediments while the sea at the bottom edge of the image appears dark.

## MULTISPECTRAL IMAGES

A Multispectral image consists of several bands of data. For visual display, each band of the image may be displayed one band at a time as a grey scale image, or in combination of three bands at a time as a colour composite image. Interpretation of a multispectral colour composite image will require the knowledge of the spectral reflectance signature of the targets in the scene. In this case, the spectral information content of the image is utilized in the interpretation. The following three images show the three bands of a multispectral image extracted from a SPOT multispectral scene at a ground resolution of 20 m. The area covered is the same as that shown in the above panchromatic image. Note that both the XS1 (green band) XS2 (red band) bands look almost identical to the panchromatic image shown above. In contrast, the vegetated areas now appear bright in the XS3 (near infra-red) band due to high reflectance of leaves in the near infrared wavelength region. Several shades of grey can be identified for the vegetated areas, corresponding to different types of vegetation. Water mass (both the river and the sea) appear dark in the XS3 (near IR) band Shown in Fig 2.

**Figure 2 (a). SPOT XS1 (green band)**

**Figure 2(b). SPOT XS2 (red band)**

**Figure 2(c) SPOT XS3 (Near IR band)**

## PANSHARPENING

Pan sharpening is a process of merging high-resolution panchromatic and lower resolution multispectral imagery to create a single high-resolution color image. Google-maps and nearly every map creating company use this technique to increase image quality. Pan sharpening produces a high-resolution color image from three, four or more low-resolution multispectral satellite bands plus corresponding high-resolution panchromatic bands:

Low-res color bands + High-res grayscale band = Hi-res color image

Pan sharpening uses spatial information in the high-resolution grayscale band and color information in the multispectral bands to create a high-resolution color image, essentially increasing the resolution of the color information in the data set to match that of the panchromatic band.

One common class of algorithms for pan sharpening is called “component substitution,”which usually involves the following steps:

- Up-sampling: the color bands are up-sampled to the same resolution as the panchromatic band;
- Alignment: the up-sampled color bands and the panchromatic band are aligned to reduce artifacts due to mass-registration (generally, when the data comes from the same sensor, this step is usually not necessary);
- Forward transform: the up-sampled color bands are transformed to an alternate color space (where intensity is orthogonal to the color information);
- Intensity matching: the intensity of the color bands is matched to the pan band intensity in the transformed space;
- Component substitution: the pan band is then directly substituted for the transformed intensity component;
- Reverse transform: the reverse transformation is performed using the substituted intensity component to transform back to the original color space.

## NEED FOR IMAGE FUSION

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 TECHNIQUES

Image fusion is important in remote sensing where the instruments are not capable of providing such information either by design or because of observational constraints. There are many fusion techniques have been proposed so far. Figure 3 represents the evolution of fusion techniques.

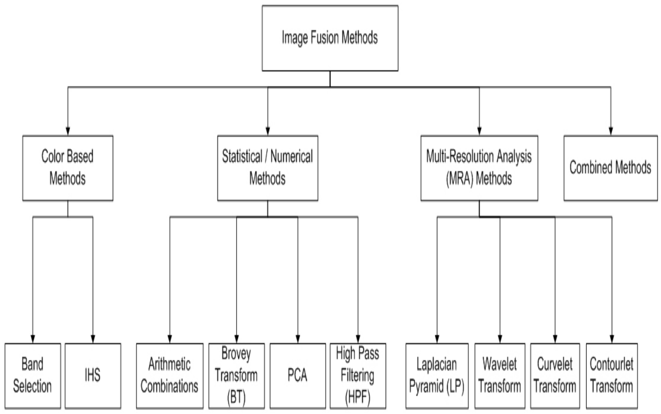



**Figure 3. Evolutions of Fusion Techniques**

Fusing information contained in multiple images plays an increasingly important role for quality inspection in industrial processes as well as in situation assessment for autonomous systems and assistance systems. The aim of image fusion in general is to use images as redundant or complementary sources to extract information from them with higher accuracy or reliability.

The most interesting scenario is to use complementary image information obtained by varying one or several imaging parameters, such as the camera spectral response, polarization filters, dynamic range or aperture setting. However, the challenges of image fusion are still numerous for an inspection task, specific imaging constellations yielding the desired information must be found. Furthermore, fusion techniques are required to produce a result that offers the desired accuracy and reliability. In addition, the algorithms must meet the requirements of affordable calculation time in real-time systems.

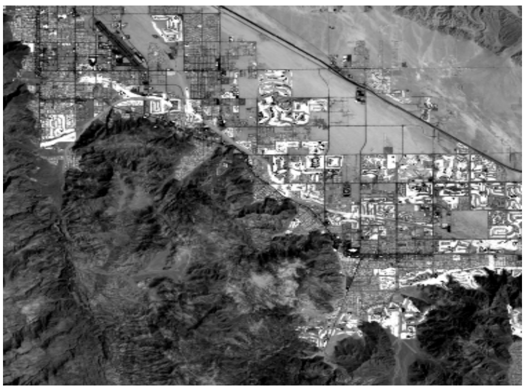
Feature detection/extraction was done with a variety of methods, such as Laplacian operators, gradient operators, the Laplacian of Gaussians, difference of Gaussians, Canny detectors or anisotropic diffusion. However, wavelet transforms have come into light as a means of feature detection. Typically, feature detection/extraction is a preliminary step in machine learning and machine vision applications. However, there is no perfect edge detector or feature extraction algorithm. One edge detector may work very well in one application, while the exact same algorithm may fail in other applications. Therefore, it is useful to have as many types of algorithms available for evaluation shown in Fig 4.

**(a)**

**(b)**

**The figure 4 (a)-(f) images are courtesy of NASA. Details in all images are fused into one image as shown in Figure 4(g). The given images are already registered in image fusion technique.**

**(c)**



**(d)**

**(e)**

**(f)**

**(g)**

**Figure 4 (a)-(f) Bands 1, 2, 3, 4, 5, and 7 of a Landsat TM image**

## EXPERIMENTAL RESULTS

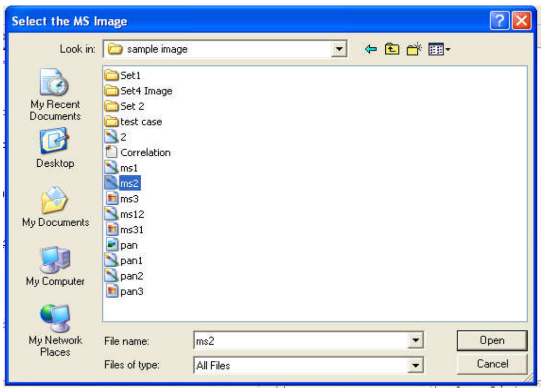



**Figure 5 (a). Selection of MS Image**

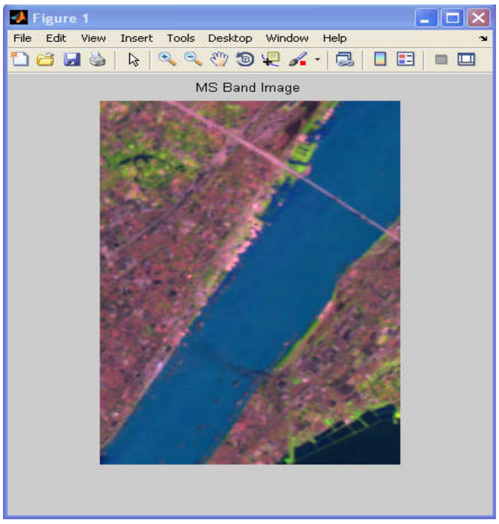



**Figure 5 (b). Selected Ms Image**

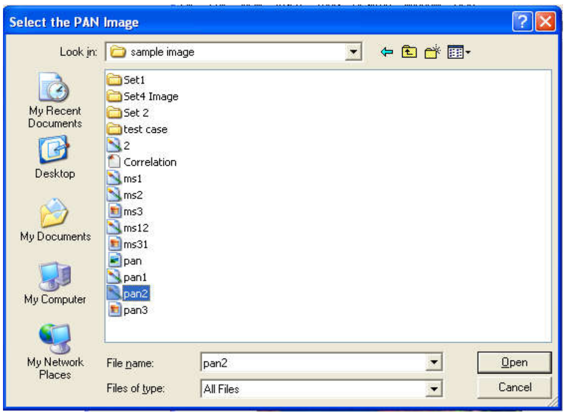



**Figure 6 (a). Selection of PAN Image**

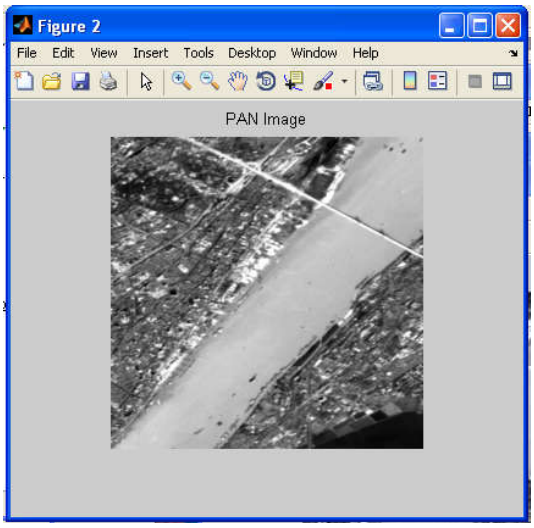



**Figure 6 (b). Selected PAN Image**

**Step 1:** Open the main program for fusion algorithm I.
**Step 2:** Select the multispectral image as shown below in figure 5(a) & (b)
**Step3:** Select the corresponding pan image as shown in figure 6(a) & (b) and 7(a),(b), & (c).
**Step4:** The following snapshot illustrates the result for the proposed system as shown in Fig 8 (a) through Fig 8(g)
**Step5:** The displayed values in command window is shown in Figure 9.

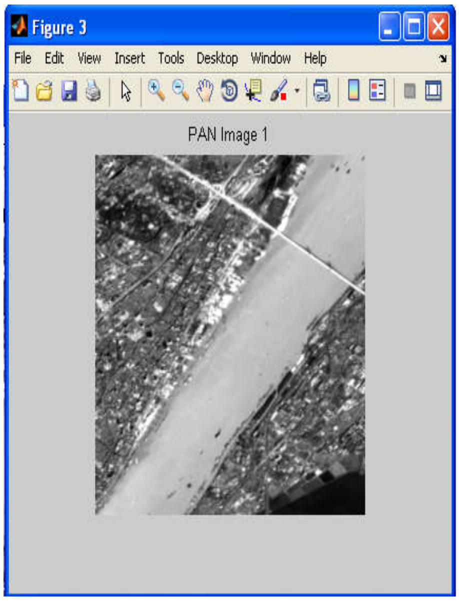



**Fig. 7 (a). PAN Image1**

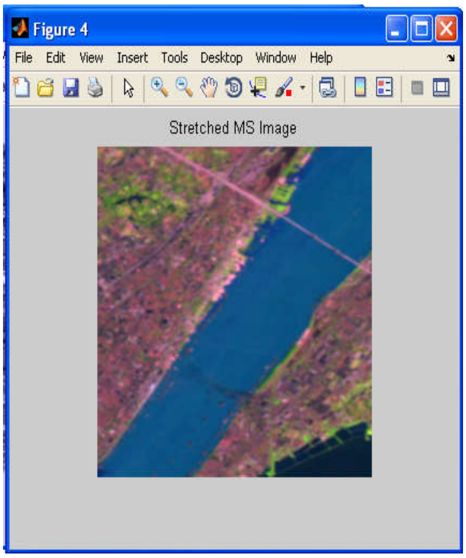



**Fig. 7(b). Stretched MS Image**

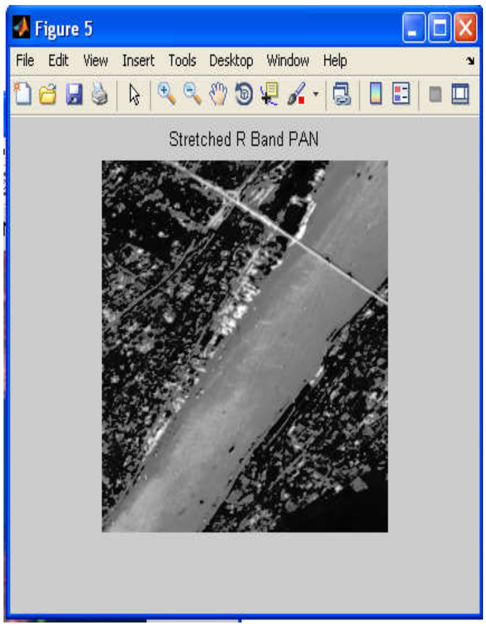



**Fig. 7 (c). Stretched R Band PAN**


**Fig. 8 (d). Stretched G Band PAN**

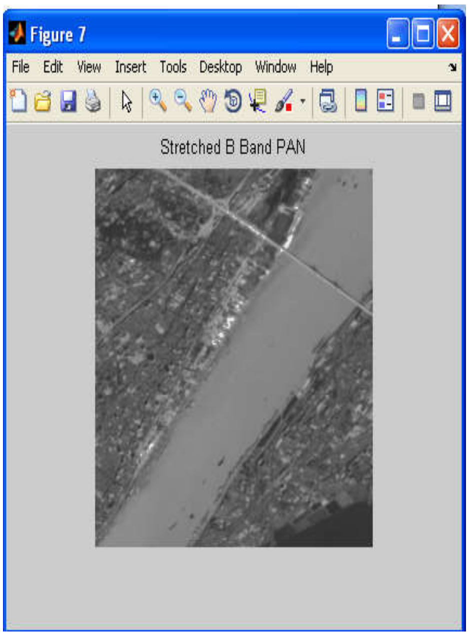



**Fig. 8 (e). Stretched B Band PAN**

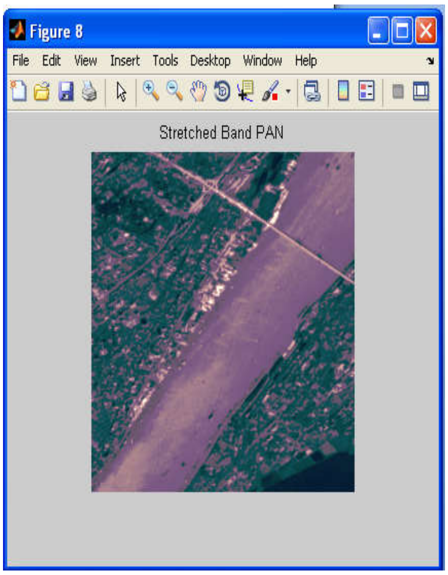



**Fig. 8 (f). Stretched Band PAN**

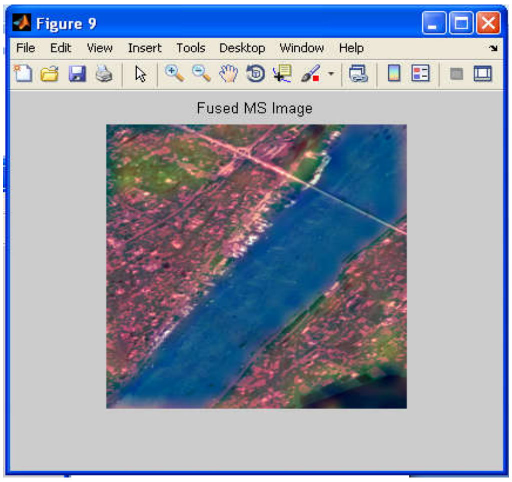



**Fig. 9 (g). Fused MS image**

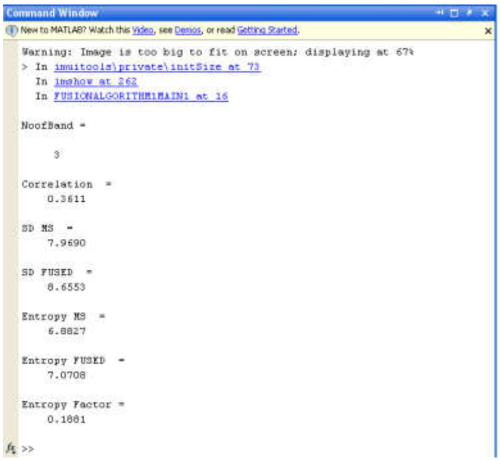



**Fig. 9. Command Window Snapshot**

## Conclusion

The main objective of this paper was to present a reliable and robust image fusion algorithm that dealt with the limitations of traditional image fusion methods. The presented region based fusion technique combined the information presented in the input images and provided more accurate images about the target areas. It also fused the fine lines and details presented in the high resolution panchromatic image with the color information presented in the low resolution colored image. A combination of the contourlet transform and RGB color system was used to build the presented region-based fusion technique.

This combination facilitated capturing fine details and lines due to the high directionality of the contourlet transform. Moreover, this approach preserves the chromaticity information of the input images. The contourlet transform was used to ensure that the directional information is captured efficiently, which is a big advantage when fusing remote sensing images that contain fine roads and contours. The presented contourlet-based fusion technique confirms the advantage of the presented fusion approach over the conventional methods such as PCA, IHS, and Wavelet techniques. First goal is to perform RGB transformation for the given MS image and applying it to Contourlet transform. Histogram matching is performed for the PAN image in order to obtain stretched PAN image. Fusing both the stretched PAN and MS image and applying inverse

Contourlet transform to obtain high resolution fused image. Corresponding Entropy value for MS image and fused image is obtained for performance measure.

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