CATALYST
PROFESSIONAL

Pan Sharpening Module: Description

The Pan Sharpening module is an add-on module to CATALYST Professional Essentials.

Pan sharpening is the process of automatic image fusion that increases the spatial detail in a lower resolution multispectral (color) image by using a higher resolution panchromatic (black and white) image to produce a high-resolution multispectral image.

Many satellites provide multispectral images at a lower spatial resolution and panchromatic images at a higher spatial resolution. This sharpening process allows you to easily fuse images acquired simultaneously by the same sensor. Alternatively, you can fuse images from different sensors.

Pan sharpening works with 8-bit, 16-bit, and 32-bit real data types.

CATALYST is a PCI Geomatics Enterprises Inc. brand, which has been introduced to put our leading-edge technology into the hands of decision makers. CATALYST provides proven algorithms rooted in photogrammetry and remote sensing to offer engineers, environmental management, and geospatial professionals access to leading edge and scalable software solutions and platforms.

Table of Contents

Module Prerequisites

Pan Sharpening is an add-on module to the CATALYST Professional Essentials bundle and comes included with any of the following bundles: Satellite bundle, Airphoto bundle, SAR bundle, Complete bundle, Developer bundle.

Algorithms

The Pan Sharpening package includes two unique fusion algorithms:

- PANSHARP
- MRAFUSION

Input Images

In both cases the functions require the following input images:

- Multispectral Image Layers:
  - Color layers that will be fused with a high-resolution panchromatic image layer
- Reference Multispectral Image Layers:
  - Aid in the pan-sharpening process
  - Span the same frequency range as the panchromatic image layer
  - Varies from sensor to sensor
- Panchromatic Image Layer:
  - The high-resolution grayscale layer used to pan sharpen the multispectral image layers

PANSHARP

The PANSHARP algorithm is based on the least number of squares to an approximate gray-value relationship between the original multispectral image, panchromatic image, and fused image. Using the PANSHARP algorithm, you can:

- Solve color-distortion and operator- or data-dependency problems
- Achieve the best color representation
- Preserve the mean, standard deviation, and histogram shape for each channel
- Fuse all spectral bands of a satellite image with the corresponding panchromatic band at once
- Minimize color distortion, maximize feature detail, and naturally integrate spatial and spectral features of the scene.
- PANSHARP is OpenMP-enabled, which improved the performance of the function

Options

Enhanced pan sharpening generates a refined pan-sharpened output image:

- "Yes" option generates a refined pan-sharpened output image (more suitable for visualization or visual interpretation purposes)
- "No" option generates a standard pan-sharpened output image (more suitable for digital classification purposes)

- No-data image value:
  - Specifies a background value for all layers
- Resampling
  - Specifies the resampling method to use to determine the output pixel values when resampling the input low-resolution data to the higher resolution panchromatic data. (cubic convolution or bilinear interpolation)
- Pyramid options:
  - Specifies the type of resampling to use when computing overview levels (nearest neighbor, average, or model)

NOTE: The Pan Sharpening technique was originally developed by Professor Yun Zhang, from the University of New Brunswick.

MRAFUSION

MRAFUSION, uses advanced wavelet analysis to perform high-quality image pan sharpening while maintaining multispectral consistency.
The A Trous nonorthogonal wavelet transformation is used as the basis for pan sharpening images. The advantage of this type of transformation is that the reconstruction can perfectly recover the original image from decomposed ones regardless of how many decomposition levels have been performed. The transformation can also increase the spatial resolution of the multispectral image to that of the panchromatic while preserving the quality of the spectral information. Because of the multiple levels of decomposition, the transformation tends to provide pansharpened products that have less noise.

Extensive research and analysis has proven that MRAFUSION maintains high spectral fidelity of the multispectral bands. Statistical analysis has been conducted on multiple images, of varying land cover, and of various multispectral bands to verify the algorithm and its ability to preserve radiometric content.

Options
MRAFUSION offers:

- No-data image value:
  - Specifies a background value for all layers or utilizes the values from the source imagery automatically
- Decomposition levels
  - Specify the number of levels to be used for decomposing the image when applying wavelets.
- Output radiometry adaptation
  - User can choose whether to adapt the output radiometry values to those of the input multispectral images.
  - If chosen, the function will try to bring the fused product spectrally closer to the input multispectral data

NOTE: The following paper was used in the development of this functionality: M. Gonzalez-Audicanna, X. Otazy, O. Fors and A. Seco. (2005). "Comparison between Mallat's and the A Trous discrete wavelet transform based algorithm for the fusion of multispectral and panchromatic images". In International Journal of Remote Sensing, Vol. 26, No. 3, pp 595-614.

For Best Results

When using the pan sharpening algorithms, it is recommended that you:

- Use multispectral-image channels whose wavelengths lie within the frequency range of the panchromatic image channels
- Do not exceed a resolutions ration of 5:1 (e.g. 5m color, 1m panchromatic)