Pan-sharpening of a multispectral images

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What Are we Upto?

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Aim of The Assignment

To combine the high spatial resolution of panchromatic band imagery and the wide spectral range of multispectral (color) imagery, producing a final color image with sharper quality

For this we use various transformation techniques namely Brovey transformations, mean Pan sharpening and IHS mode of pan-sharpening

How is Pan-Sharpening Useful?

1. **Increased detail**: By combining the high spatial resolution of PAN imagery with the spectral information of MS imagery, pansharpening produces an output with both high spectral and spatial resolution. This allows for a more detailed analysis than either imagery type could provide on its own.
2. **Improved visualization**: With the increased detail of the pan sharpened image, users can more easily identify objects and features within the image. This can be useful for tasks such as mapping, where it is important to distinguish individual objects within the image.
3. **Easier classification**: The greater detail and color information of the pan sharpened image allows for more accurate identification of objects and features within the image, making it easier to assign them to specific classes.
4. **Inconsistent spectral values**: A disadvantage of pansharpening is that it is difficult to maintain the spectral integrity of the data.

Procedure

1. *Upsample the MS image to the size of the PAN image.*
2. *Forward transform the MS image to the desired components.*
3. *Match the histogram of the PAN image with the C_1 component to be substituted.*
4. *Replace the C_1 component with the histogram-matched PAN image.*
5. *Backward transform the components to obtain the pansharpened image.*

1	2
3	4

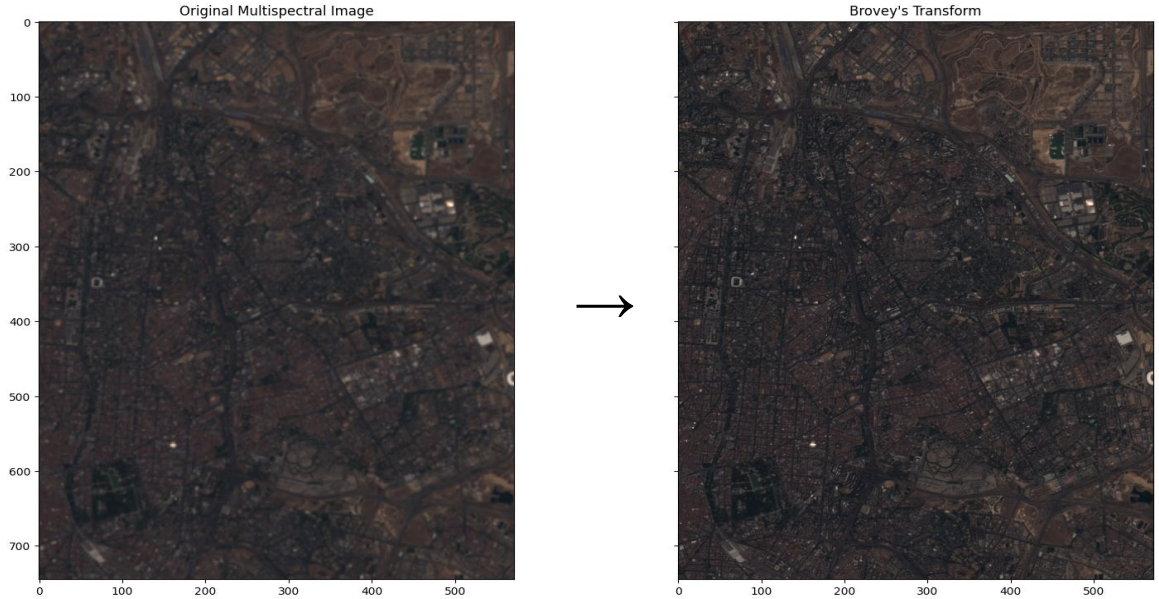
Down sampling

1	0	2	0
0	0	0	0
3	0	4	0
0	0	0	0

Our Code

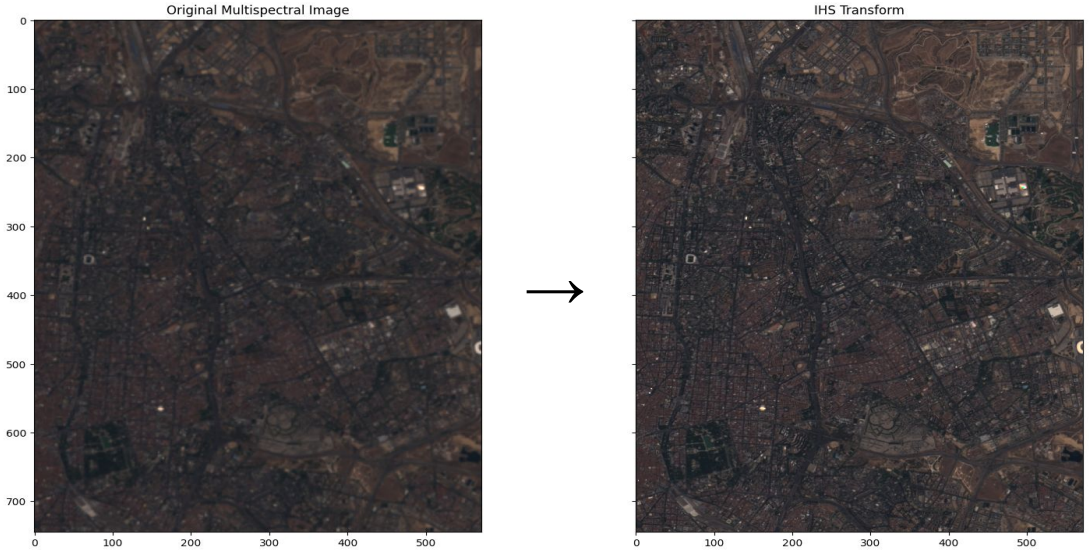
Brovey Transformations

The Brovey transformation is a sharpening method that uses a mathematical combination of the color image and high resolution data. Each resampled, multispectral pixel is multiplied by the ratio of the corresponding panchromatic pixel intensity to the sum of all the multispectral intensities.



IHS Transformations

Pan-sharpened MS images are obtained by performing an inverse spectral transform. The second group (MRA-based methods) usually applies digital filters, covering wavelet transform, contourlet and curvelet transform, Laplacian pyramids and ripplet transform to obtain the multi-scale representation of the MS images. The MRA-based approaches firstly employ MRA transforms to decompose PAN images into multi-scale components. Then, the equivalent spatial information contained in the high-frequency component is injected into an up-sampled MS image. IHS-based algorithms utilize MRA transforms to improve spectral fidelity without the aid of a compressed sensing techniques.

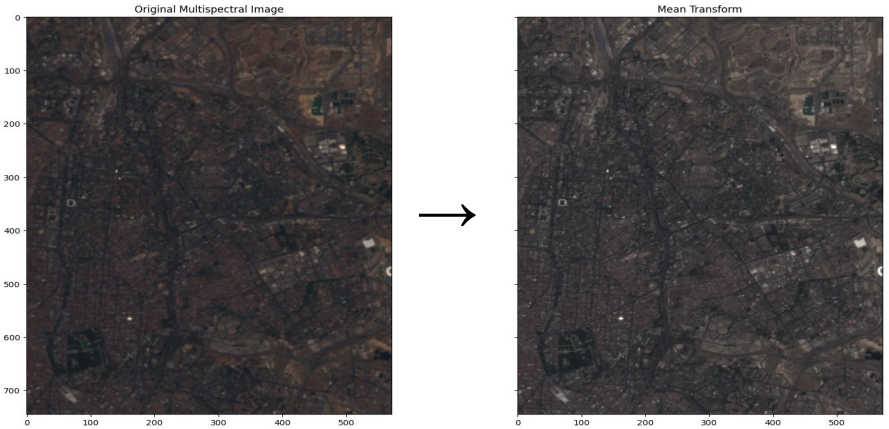


Mean Pan-Sharpening

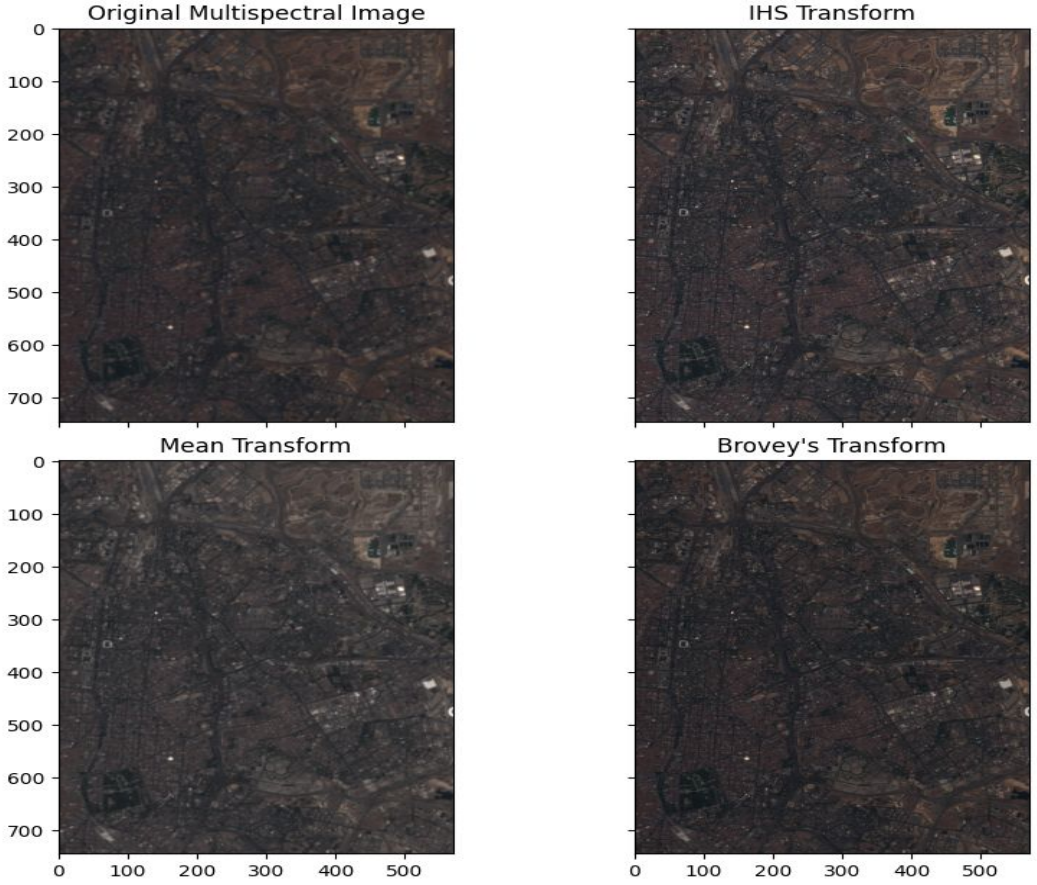
The technique in minimizes the modification of the spectral information of the fused high-resolution multispectral (HRMS) image with respect to the original low-resolution multispectral (LRMS) image. This method modifies the value of the PAN image at each pixel (i, j) as

$$\text{Stretched}_{PAN}\,(i,j) = (PAN\,(i,j) - \mu_{PAN})\,\frac{\sigma_b}{\sigma_{PAN}} + \mu_b,$$

ensures that the mean and standard deviation of PAN image and MS bands are within the same range, thus reducing the chromatic difference between both images.



Finally, we see



Quality-Assessment

(1)Any pan-sharpened image once downsampled to its original spatial resolution should be as similar as possible to the original image.

(2)Any pan-sharpened image should be as similar as possible to the image that a corresponding sensor would observe with the same high spatial resolution.

(3)The MS set of pansharpened images should be as similar as possible to the MS set of images that a corresponding sensor would observe with the same high spatial resolution