

IHS based Pan Sharpening with Geo-Image Processing

Alpesh R. Sankaliya

Electronics & Communication Engineering Department, Government Polytechnic, Dahod, Gujarat, India

ABSTRACT

The image processing methodologies that have been actively studied and developed now play a very significant role in the flourishing Genomic Image Processing research. Spatial data are captured by some remote sensing satellites. These satellites actually capture many bands of images. Now, these captured images are put under different types of processing in order to get the useful image for further usage. The main advantage of doing processing is when a client needs to purchase these images; a provider cannot give the data as it is taken. It has to be converted in the required format for client usage. Moreover, images once captured it may be possible that it cannot be captured again in future, so there will more need to process such data for future usage and work. Using IHS (Intensity-Hue Saturation) based Pan Sharpening we can enhance these images. Pan-sharpening is to fuse a low spatial resolution multispectral image with a higher resolution panchromatic image to obtain an image with high spectral and spatial resolution.

Keywords: Geo-Image Processing, Pan-Sharpener, Grayscale image, CMY, IHS, HSL, HSV, Image Fusion, JAI

I. INTRODUCTION

Geo-Image Processing

Spatial data or Geo Image known as geospatial data or geographic information it is the data or information that identifies the geographic location of features and boundaries on Earth, such as natural or constructed features, oceans, and more. Spatial data is usually stored as coordinates and topology, and is data that can be mapped. Spatial data is often accessed, manipulated or analyzed through Geographic Information Systems.

Spatial data are captured by some remote sensing satellites. These satellites actually capture many bands of images. Now, these captured images are put under different types of processing in order to get the useful image for further usage. This phenomenon is called as Geo – Image Processing.

While doing these satellite imaging generally two types of images are captured on which processing is done:

In this category of images various types of spectral bands generated by satellites are combined to generate

false or true-color images. If the images so created true than no processing required but if the image so created are false image pictures, then processing is must. These images are combination of two or more bands. These images are generally of lower resolution. In this panchromatic images are generate i.e. they are actually Grayscale images. They are made of one band only. These images consist of one band only. These are higher resolution images.

The main advantage of doing processing is when a client needs to purchase these images; a provider cannot give the data as it is taken. It has to be converted in the required format for client usage. Moreover, images once captured it may be possible that it cannot be captured again in future, so there will more need to process such data for future usage and work.

1.1 Types of Geo-Image Processing

There are several categories in which Geo Image Processing can be done. Some of these categories are:

1. Geometric correction

Conversion of data to ground coordinates by removal of distortions from sensor geometry.

2. Image matching

The act of matching defined anatomical structures from one image to another typically during the image review phase to verify patient positioning.

3. Image calibration

The images are calibrated to eliminate as much as possible the unwanted effects produced by a CCD camera and light pollution.

4. Contrast enhancements

Improving the contrast to get a more clear view of data.

5. Hardcopy and digital output in client specific formats

Converting the image in the format as asked by the client.

II. METHODS AND MATERIAL

2. Pan Sharpening

Pan sharpening is an image fusion technique that enhances the spatial resolution of a composite image by combining lower-resolution color images with a higher-resolution panchromatic image.

2.1 Image Types

There are various types of images formats present:

1. RGB Format:



Figure 1: RGB format

These are image comprises of 3 color bands as shown in fig 1:

- Red band
- Green band
- Blue band

The combination of these 3 bands forms various other colors. The color format is also called as additive color format

2. Panchromatic Image

These images comprises of only one band. Grey Scale pictures are generally called as panchromatic Image

3. Other Formats

- CMY format – Cyan – Magenta – Yellow format.
- IHS format – Intensity – Hue – Saturation format
- HSL format – Hue – Saturation – Lightness format
- HSV format – Hue – Saturation – Value format and many more.

2.2 Image Fusion

In computer vision, Multisensor 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 of the input images.

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 multispectral data while merging.

Multisensor data fusion has become a discipline to which more and more general formal solutions to a number of application cases are demanded. Several situations in image processing simultaneously require 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.

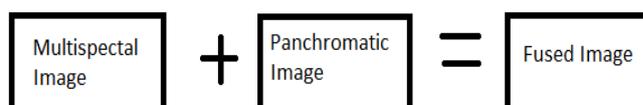


Figure 2: Image Fusion

As shown in the fig 2 multispectral image (low resolution image) are combined with panchromatic image (high resolution) to get a fused image with more better results and more of information.

The merging of these images is “**Pan Sharpening**“ also called as “**Panchromatic Sharpening**”. There are many algorithms proposed to show these merging.

2.3 Types of Pan Sharpening

2.3.1. High Resolution Imagery



Figure 3: High Resolution Imagery

Left	High-resolution panchromatic images (spatial resolution 0.6 m)
Middle	Low-resolution natural color images made of blue band (band 1), green band (band 2), and red band (band 3) (spatial resolution 2.4 m)
Right	Pan-sharpened, high-resolution color composites (spatial resolution 0.6 m)

Pan Sharpening with False Colour Images

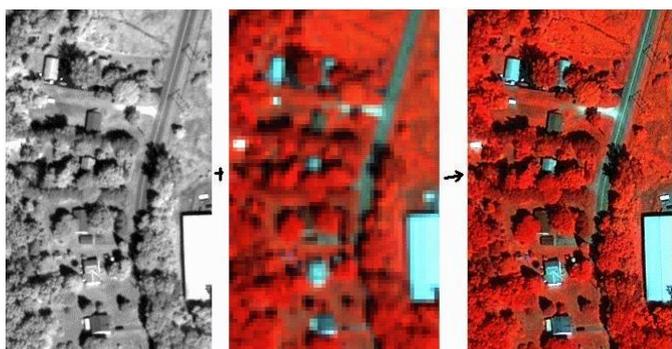


Figure 4: Pan Sharpening with False Colour Images

Left	High-resolution panchromatic band (spatial resolution 0.6 m)
Middle	Low-resolution false colour composite made of QuickBird's blue band (band 1), green band (band 2), and near-infrared band (band 4) (spatial resolution 2.4 m)
Right	Pan-sharpened, high-resolution false colour composite (spatial resolution 0.6 m)

3. IHS Based Pan Sharpening – Algorithm

3.1 Select the image bands that will be used to create a RGB image

Step 1: There are two inputs in this step. They are

- Three image of different bands
- Panchromatic image

Input is done by getting the image from the path.

Step 2: The bands are merged to form a RGB image

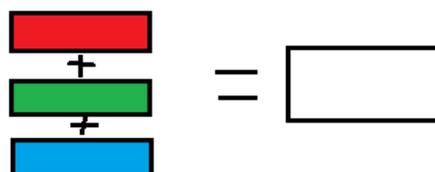


Figure 5: Red green and blue band are merge to form RGB image which is of white color

As shown an example Red Green and blue band are merged to form white color image of 3 bands

How the merging takes place as explained??

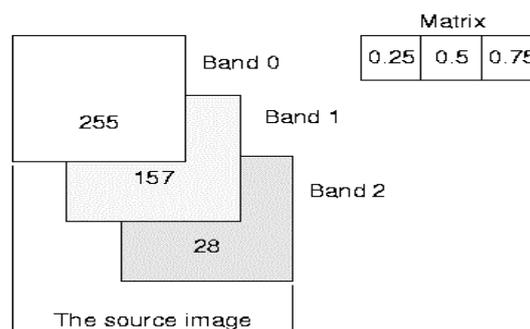


Figure 6: Sample Band Merge

Here as shown in the figure 6, three images are taken of band 0, band 1 and band 2. One pixel value of each image are taken.

Here for band 0, pixel value is 255

Band 1, pixel value is 157

Band 2, pixel value is 28

A matrix is also taken which is formed by (# of source band + 1) / (# of destination band)

Now, finally destination pixel is calculated as:

$$\text{Dst} = (255 * 0.25) + (157 * 0.5) + (28 * 0.75)$$

So the destination pixel is the combination of 3 bands so 3 band image is produced.

This is done by “bandmerge” operator of JAI.

3.2 Rescale the RGB Image Equal to Panchromatic Image

In this step RGB images resized so that it gets equal to panchromatic image size. Here resizing scaling factors are calculated for X and Y axis both. It is done by
 $ScaleX = 1f * width(rgbimage) / width(panimage)$
 $ScaleY = 1f * height(rgbimage) / height(panimage)$

Now these ScaleX and ScaleY passed as parameter and then scaling is done. The scaling is done by
 $x'(dstwidth \text{ of RGB image}) = x(srcwidth) * scaleX$
 $y'(dstheight \text{ of RGB image}) = y(srcheight) * scaleY$

This is done by “scale” operator of JAI.

3.3 Convert the RGB image to IHS based color model.

After rescaling next step is to convert RGB image into HIS model. IHS model is Intensity Hue Saturation based model.

JAI (Java Library) has already provided IHS class for IHSColorModel and conversion of RGB image is done by following equations:

$$I = (R+G+B)/3$$

$$S = 1 - \min(R, G, B)/I$$

$$H = G > B ? h : 2 * \pi - h,$$

where

$$h = \cos^{-1} \{ [(R-G) + (R-B)] / [2 \sqrt{(R-G)^2 + (R-G)(G-B)}] \}$$

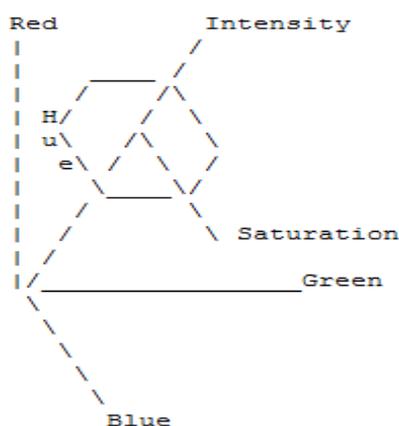


Figure 7: Relation between all 6 components

Here as shown in figure 7 Red band forms Y axis, Blue band forms Z axis and Green band forms X axis. Intensity is defined by axis perpendicular to all 3 axis above. Hue is an angle on a circle that is centred and perpendicular to the intensity axis and Saturation is defined by the radius of the circle defined by hue.

3.4 Split the IHS Image Into its Three Components

Now once the image is converted to IHS model the next task is split it into all its three bands. They are :

- Intensity band(band 0)
- Hue band(band 1)
- Saturation(band 2)

This done by “bandselect” operator of JAI. JAI has also defined

a bandIndices parameter which gives band index to each bands. So the destination pixel values will be:

$$dst[x][y][b] = src[x][y][bandIndices[b]];$$

3.5 Substitute I band in the image by the panchromatic image.

Now once all the three bands are separated Intensity band (band 0) is replaced with the one band panchromatic image. Now main advantage of doing so is that panchromatic image is correct resolution image so by replacing Intensity band with this band, the correct resolution image is obtained or formed.

Replacing Hue or Saturation band will not correct picture because they are related to color.

3.6 Merge the three bands to a single IHS image.

Once the Intensity band is corrected, the 3 bands which will be combined again are panimage band hue band saturation band Here again “bandmerge” operator is used to merge the 3 bands.

3.7 Convert the IHS to the RGB color model

Now one new IHS image is formed reverse conversion of IHS model to RGB model will take place.

The conversion of HIS to RGB is as shown below:

When H is in $[2\pi/3, 4\pi/3]$, R should be the smallest.

Then,

$$R = (1-S)I \text{ and}$$

$$G = (c1 + c2)/2$$

$$B = (c1 - c2)/2$$

where $c1 = 3I - R$ and $c2 = \sqrt{3}(R - I)\tan(H)$

When H is in $[4\pi/3, 2\pi]$,

$$G = (1-S)I \text{ and}$$

$$B = (c1 + c2)/2$$

$$R = (c1 - c2)/2$$

$$\text{where } c1 = 3I-G \text{ and } c2 = \sqrt{3}(G-I)\text{tg}(H-2\text{PI}/3)$$

When H is in $[0, 2\text{PI}/3]$,

$$B = (1-S)I \text{ and}$$

$$R = (c1 + c2)/2$$

$$G = (c1 - c2)/2$$

$$\text{where } c1 = 3I-B \text{ and } c2 = \sqrt{3}(B-I)\text{tg}(H-4\text{PI}/3)$$

Hence finally at the end of 7 step the intensity of the model is corrected and the image resolution will be increased.

III. RESULTS AND DISCUSSION

An Experimental Program on Java Advance Imaging

An imaging operation within JAI is summarized in the following four steps:

1. Obtain the source image or images. Images may be obtained in one of three ways
 - a. Load from an image file such as GIF, TIFF, or JPEG
 - b. Fetch the image from another data source, such as a remote server
 - c. Generate the image internally
2. Define the imaging graph. This is a two part process:
 - a. Define the image operators
 - b. Define the parent/child relationship between sources and sinks
3. Evaluate the graph using one of three execution models:
 - a. Rendered execution model
 - b. Renderable execution model
 - c. Remote execution model
4. Process the result. There are four possible destinations:
 - a. Save the image in a file
 - b. Display the image on the screen
 - c. Print the image on a printer or other output device
 - d. Send the image to another API, such as Swing

Output Image 1

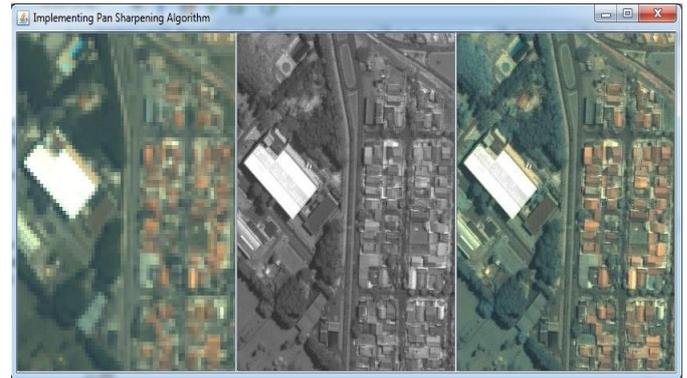


Figure 8: Implementation of Pan Sharpening Algorithm

Here as shown in the figure:

Panel 1 of Grid is RGB input low resolution image

Panel 2 of Grid is the panchromatic high resolution Image

Panel 3 of Grid is the Pan Sharpened High Resolution Image

Output Image 2

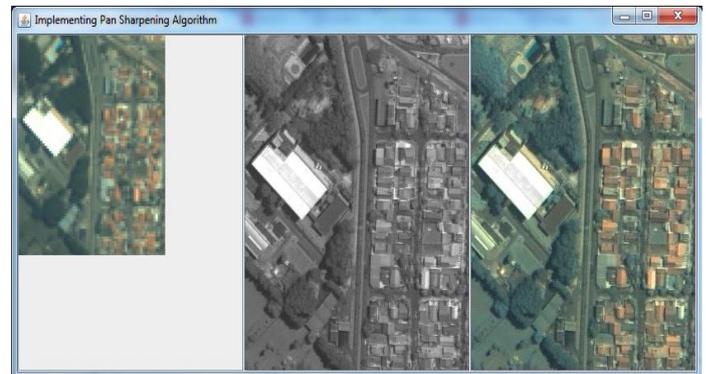


Figure 9: Implementation of Pan Sharpening Algorithm

Here as shown in the figure:

Panel 1 of Grid is RGB input low resolution image

Panel 2 of Grid is the panchromatic high resolution Image

Panel 3 of Grid is the Pan Sharpened High Resolution Image

IV. CONCLUSION

The IHS pan-sharpening method gives good spatial quality and is a commonly used algorithm for its speed and simplicity. To improve its spectral quality we proposed IHS Based Pan Sharpening algorithm. Pan-sharpening is to fuse a low spatial resolution multispectral image with a higher resolution panchromatic image to obtain an image with high spectral and spatial resolution. Most remote sensing satellites have several spectral bands which can be used to generate false or true-color images, and a panchromatic image of higher resolution.

V. REFERENCES

- [1] M. Choi, R. Kim. "Fusion of Multispectral and Panchromatic Satellite Images Using the Curvelet Transforms." *IEEE Geosci. Remote Sens. Lett.* Vol. 2, No. 2, pp. 136-140, Apr. 2005.
- [2] Zhang J., 2010. "Multi-Source Remote Sensing Data Fusion: Status and Trends". *International Journal of Image and Data Fusion*, Vol. 1, No. 1, March 2010, pp.5-24.
- [3] Ehlers M., Klonus S., Johan P., strand Á and Rosso P., 2010. "Multi-Sensor Image Fusion For Pan Sharpening In Remote Sensing". *International Journal of Image and Data Fusion*, Vol. 1, No. 1, March 2010, pp.25-45.
- [4] Ehlers M., Klonus S., Johan P., strand Á and Rosso P., 2010. "Multi-Sensor Image Fusion For Pan Sharpening In Remote Sensing". *International Journal of Image and Data Fusion*, Vol. 1, No. 1, March 2010, pp.25-45.
- [5] Gangkofner U. G., P. S. Pradhan, and D. W. Holcomb, 2008. "Optimizing the High-Pass Filter Addition Technique for Image Fusion". *Photogrammetric Engineering & Remote Sensing*, Vol. 74, No. 9, pp. 1107-1118.
- [6] Q. Du, O. Gungor, and J. Shan. "Performance Evaluation for Pan-sharpening Techniques." Department of Electrical and computer engineering, Mississippi State University. 24. 2008.
- [7] L. Wald. "Quality of High Resolution Synthesized Images: Is There a Simple Criterion?" *Proc. Int. Conf. Fusion Earth Data*. 2000.
- [8] V. P. Shah and N. H. Younan. "An Efficient Pan-Sharpening Method via a Combined Adaptive PCA Approach and Contourlets." *IEEE Trans. on Geosc. and Remote Sens.* 46. 2008.
- [9] X. Otazu and M. Gonzalez-Ausicana. "Introduction of Sensor Spectral Response Into Image Fusion Methods: Application to Wavelet-Based Methods." *IEEE Transactions of Geoscience and Remote Sens.* vol. 43, pp. 2376-2385, 2005.
- [10] A. Eshtehari and H. Ebadi. "Image Fusion of Landsat ETM+ and Spot Satellite Images Using IHS, Brovey and PCA." Toosi University of Technology. 2008.
- [11] C. Ballester, V. Caselles, L. Igual and J. Verdera. "A Variational Model for P+XS Image Fusion." *International Journal of Computer Vision*, pp.43-58, 2006.
- [12] P. Perona and J. Malik. "Scale-space and Edge Detection Using Anisotropic Diffusion," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 12, no. 7, pp. 629-639, Jul. 1990.
- [13] H. Aanaes and J. Sveinsson, "Model-based Satellite Image Fusion," *IEEE Trans. Geosci. Remote Sens.* Vol. 46, no. 5,
- [14] A. Goetz, W. Boardman and R. Yunas. "Discrimination Among Semi-Arid Landscape Endmembers Using the Spectral Angle Mapper(SAM) Algorithm." *Proc. Summeries 3rd Annu. JPL Airborne Geosci Workshop*. pp. 147-149. 1992.
- [15] Y. Zhang. "Understanding Image Fusion." *PCI Geomatics*. 2008.
- [16] M. Choi. "A New Intensity-Hue-Saturation Fusion Approach to Image Fusion with a Tradeoff Parameter." *IEEE Transactions of Geoscience and Remote Sensing*. Vol. 44, No. 6, pp. 1672-1682, Jun. 2006.
- [17] M. Choi, H. Kim, N.I. Cho and H.O. Kim. "An Improved Intensity-Hue-Saturation Method for IKONOS Image Fusion." *International Journal of Remote Sensing*. 2008.
- [18] J. Canny. "A Computational Approach to Edge Detection," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. PAMI-8, no.6, pp.679-698, Nov. 1986.
- [19] C. Chang. "Spectral Information Divergence for Hyperspectral Image Analysis" *Proc. Geosci. Remote Sens. Symp.* Vol. 1. pp. 509-511, 1999.
- [20] A. Bovik and Z. Wang. "A Universal Image Quality Index." *IEEE Signal Processing Letters*. Vol. 9, No. 3, pp. 81-84, Mar. 2002.
- [21] L. Alparone, B. Aiazzi, S. Baronti, A. Garzelli and P. Nencini. "A Global Quality Measurement of Pan-sharpened Multispectral Imagery." *IEEE Geosci. Remote Sens. Lett.* Vol. 1, No. 4, pp. 313-317, Oct. 2004.
- [22] Lu J., Zhang B., Gong Z., Li Z., Liu H., 2008. "The Remote-Sensing Image Fusion Based On GPU". *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*. Vol. XXXVII. Part B7. Beijing pp. 1233-1238.
- [23] Hui Y. X. and Cheng J. L., 2008. "Fusion Algorithm for Remote Sensing Images Based on Nonsampled Contourlet Transform". *ACTA AUTOMATICA SINICA*, Vol. 34, No. 3. pp. 274-281.
- [24] Hsu S. L., Gau P.W., Wu I L., and Jeng J.H., 2009. "Region-Based Image Fusion with Artificial Neural Network". *World Academy of Science, Engineering and Technology*, 53, pp 156 -159.