Paper ID: E&TC11

EXTRACTION OF FEATURE FROM SATELLITE IMAGES- USING PAN CHROMATIC SHARPENING

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Abstract— Satellite data has been successfully used in various application fields, as it provide a perfect view of a desired region. Satellite images of different resolutions are commercially available. . To obtain more precise and meaning full data from satellite image different preprocessing techniques are available. Panchromatic sharpening is one of the most used technique in remote sensing imaginary. This Sharpened image can be used in various application such as vegetation detection, water bodies detection, highways detection etc. and to extract important features from image data such as area calculation. This will make a description, implementation or understanding of the scene more informative and user friendly by machine.

Index Terms— Satellite Images, Image Processing, Satellite Images, Spectral Resolution, Spatial Resolution, Image Sharpening, Panchromatic Image, Pan-Sharpening Method, Feature Extraction.

I. INTRODUCTION

Remote sensing imaginary can used widely in many field of applications. This includes monitoring of global environmental conditions, for geographical and geological applications, for weather prediction etc. Detail information about earth's surface can be obtained by satellite images, as they cover large area of surface. Satellite Image processing becomes more advantageous as we can frequent re-visits to almost any part of the globe, regardless of its remoteness. To obtain more precise and meaning full data from satellite image different preprocessing techniques are available nowadays. Panchromatic sharpening is one of the most used technique in remote sensing imaginary. Google Maps and mostly nearly every map creating company use this technique to increase image quality. In Pan sharpening process, high-resolution panchromatic and lower resolution multispectral images are merged to create a single high-resolution color image. Further, this Sharpened image can be used in various application and to extract important features from image data such as BW area calculation[13]

II. SYSTEM IMPLEMENTATION

Figure 1 shows, the block diagram of this dissertation work. This is carried out in three different modules.

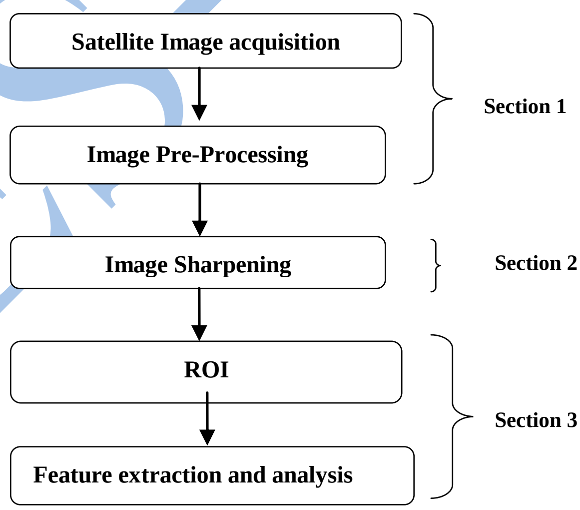


Fig.1: Block Diagram of system to sharpen satellite image and extract the feature.

They are:

MODULE 1:

A. Image Acquisition

This is the first and the fundamental steps of digital image processing. It is the action of retrieving an image from some source. The required multispectral and panchromatic images can be obtained from mentioned data references. [20] and also from internet. The database contains total 30 Images .

Pan sharpening process needs, two images at its input.

a. Multispectral Image
b. Panchromatic Image

A multispectral image is an image captured at different range of frequencies over an electromagnetic spectrum. Panchromatic image is a single band image generally displayed as shades of gray. In contrast to the

Paper ID: E&TC11

multispectral image, a panchromatic image contains only one wideband of reflectance data[23].

Following figure 2 shows one sample image from database:

Figure: 2(a)

Figure: 2(b)

Figure 2: a) Multispectral Image with high spectral resolution and low spatial resolution;

b) Panchromatic Image with low spectral resolution and high spatial resolution.

B. Image Pre-processing

Database available from image acquisition, may be in the different image format such as .jpg, .mat etc. The present system works on .mat image format. In this file format written information of image is present as R, G, B, NIR and PAN content of input image not direct images. So, if source data is available in other format, it is preprocessed to convert it into .mat file format.

MODULE 2:

C. Image Sharpening

Image Sharpening is an efficient process of transformation which brings out more details of image than before. To obtain more precise data from source image, image sharpening operation is performed. In this, image sharpening is carried out by using pan sharpening technique. To perform pan sharpening of image different algorithms are available such as, IHS algorithm, PCX algorithm, Brovery algorithms etc. In this work IHS algorithm is used for sharpening of an image. Now, this sharpened image can be used for further applications.

Following figure 3 shows one sample image from database:

Figure 3: Pan sharpened Image with high spectral resolution and high spatial resolution

MODULE 2:

D. Region of Interest (ROI)

Image obtained from satellite covers maximum region of earth's surface. Numerous applications are present in satellite image processing. Depending upon the particular application required data from the obtained image has to be considered. In this work, green content and blue content of an image are considered. This will extract vegetation area and water body content from image respectively.

E. Feature Extraction

From selected ROI, the different features can be extracted depending upon particular application. Here BW area of ROI is calculated.

Following figure 4 and figure 5 shows Green and Blue BW area from pan sharpened image respectively:

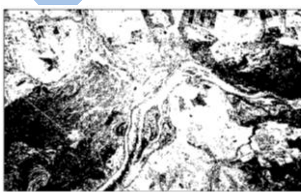


Figure 4(a)

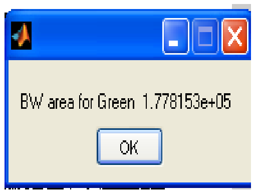


Figure 4(b)

Figure4:(a)Green region from Image (b) BW area of Green Region

Figure5(a)

Figure5(b)

Figure5:(a)Blue region from Image (b) BW area of blue Region

IHS –PANSHARPENING ALGORITHM

Paper ID: E&TC11

In remote sensing imaginary, image fusion has wide range of application areas. An important domain is the multi-resolution image fusion, commonly referred to pan-sharpening. In satellite imagery two types of images are considered:

a. Panchromatic images –It is an image captured in the broad visual wavelength range but appeared in black and white.
b. Multispectral images - It is an image captured 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.

In the Image fusion, these two images are merged to produce a single high resolution multispectral image. The standard merging methods of image fusion are based on Red-Green-Blue (RGB) to Intensity-Hue-Saturation (IHS) transformation. [12]

The usual steps involved in satellite image fusion are as follows:

i) Step-I: Resize the low resolution multispectral images to the same size as the panchromatic image.

ii) Step-II: Transform the R, G and B bands of the multispectral image into IHS components, using following linear transformation.

$$\begin{pmatrix} I_v \\ v_1 \\ v_2 \end{pmatrix} = \begin{pmatrix} \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\ -\frac{\sqrt{2}}{6} & -\frac{\sqrt{2}}{6} & \frac{2\sqrt{2}}{6} \\ \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} & 0 \end{pmatrix} \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

Where, I_v =Intensity of visual image

R, G, B =color information of visual image respectively.

v_1 And v_2 = components to calculate hue H and saturation S as,

$$H = \tan^{-1}\left(\frac{v_2}{v_1}\right) \text{ and,}$$

$$S = \sqrt{v_1^2 + v_2^2} \qquad \text{. . . . . Eq(1)}$$

iii)Step-III: 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.

iv)Step-IV: Replace the intensity component by the panchromatic image and perform inverse transformation to obtain a high resolution multispectral image.

$$\begin{pmatrix} F(R) \\ F(G) \\ F(B) \end{pmatrix} = \begin{pmatrix} 1 & -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ 1 & -\frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \\ 1 & \sqrt{2} & 0 \end{pmatrix} \begin{pmatrix} Pan \\ v_1 \\ v_2 \end{pmatrix} \qquad \text{. . . . . Eq(2)}$$

This process is equivalent to,

$$\begin{pmatrix} F(R) \\ F(G) \\ F(B) \end{pmatrix} = \begin{pmatrix} R + Pan - I \\ G + Pan - I \\ B + Pan - I \end{pmatrix} \qquad \text{. . . . . Eq(3)}$$

Implementing the IHS fusion method in this manner is very efficient and is called the fast IHS technique (FIHS), making IHS ideal for the large volumes of data produced by satellites.

Ideally the fused image would have a higher resolution and sharper edges than the original color image without additional changes to the spectral data.[6],[8] &[12]

III. METRICS PERFORMANCE EVALUATION

METRICS PERFORMANCE EVALUATION

The results of pan-sharpened can be analyzed with different Methods. In this analysis main focus is on spatial and spectral quality of final image. By visualizing sharpness of edges in an image its spatial quality can be judged. But spectral quality of test image cannot be monitored by visual inspection.

To inspect, spectral quality of image many matrices can be used such as correlation coefficient, ERGAS, Q-ave, RASE, RMSE, SAM, SID, Spatial Coefficient &Time for Pan sharpening. These are discussed below:

A. ERGAS:

It is Relative dimensionless global error in synthesis. ERGAS calculates the amount of spectral distortion in the image. The formula for ERGAS is given by:

$$ERGAS = 100\frac{h}{l}\sqrt{\frac{1}{N}\sum_{N=1}^{N}\left(\frac{RMSE(n)}{u(n)}\right)^2} \qquad \text{. . Eq(4)}$$

Where, $\frac{h}{l}$ = ratio between pixel sizes of Pan and MS,

$u(n)$ = the mean of the nth band, and

N=the number of bands.[2][12]

B. SAM:

It is Spectral Angle Mapper (SAM). SAM compares each pixel in the image with every end member for each class and assigns a value between 0 (low resemblance) and 1 (high resemblance).The formula for SAM at a specific pixel is given by

Paper ID: E&TC11

$$\cos\alpha = \frac{\sum_{i=1}^{N} A_i B_i}{\sqrt{\sum_{i=1}^{N} A_i A_i}\sqrt{\sum_{i=1}^{N} B_i B_i}} \quad \text{.......... Eq(5)}$$

Where, N = the number of bands,

α=spectral angle at a specific point,

A=(A1, A2, A3, ……., AN) and B=(B1, B2, B3, ……., BN) are two spectral vectors with the same wavelength from the multispectral image and fused image, respectively.[12][25]

C. SID:

It is Spectral Information Divergence (SID). To compute SID, we have the vector x =(x1 ,…,x N) T, which is taken from the multispectral image and y = (y1 ,…,yN)T which is a vector from the final fused image. The range of xi's and yi's needs to be between [0,1] and we define this by :

$$p_j = \frac{x_j}{\sum_{i=1}^{N} x_i}$$

$$q_j = \frac{y_j}{\sum_{i=1}^{N} y_i}$$

With N being the number of bands.

We define SID by,

SID(x,y)=D(x||y)+D(y||x) .... Eq(6)

where,

$$D(x||y)= \sum_{i=1}^{L} p_i \log(\frac{p_i}{q_i}) \quad \text{and}$$

similarly for D(y x) , which is called the relative entropy.[12]

D. Q-ave:

It is Universal Image Quality Index(Q-average).It models any distortion as a combination of three different factors: loss of correlation, luminance distortion, and contrast distortion

$$Q = \frac{4\sigma_{xy}\overline{xy}}{[\sigma_x^2+\sigma_y^2][(\bar{x})^2+(\bar{y})^2]} \quad \text{........ Eq(7)}$$

For the above formula, let x= {xi| i=1,2,..., N} and y ={yi| i=1,2,..., N}be the original MS and fused image vectors, respectively. [12][17]

Each component of the formula can be defined as follows:

$$\bar{x} = \frac{1}{N}\sum_{i=1}^{N} x_i$$

$$\bar{y} = \frac{1}{N}\sum_{i=1}^{N} y_i$$

$$\sigma_x^2 = \frac{1}{N-1}\sum_{i=1}^{N}(x_i-\bar{x})^2$$

$$\sigma_y^2 = \frac{1}{N-1}\sum_{i=1}^{N}(y_i-\bar{y})^2$$

$$\sigma_{xy}^2 = \frac{1}{N-1}\sum_{i=1}^{N}(x_i-\bar{x})^2(y_i-\bar{y})^2$$

E. RASE:

It is relative average spectral error (RASE).It characterizes the average performance of the method of image fusion in the spectral bands. It is given by,

$$RASE = \frac{100}{M}\sqrt{\frac{1}{N}\sum_{i=1}^{N} RMSE^2(B_i)} \quad \text{... Eq(8)}$$

Where, M=the mean radiance of the N spectral bands (Bi) of the original MS bands[12]

F. RMSE and Correlation coefficient:

Root mean squared error (RMSE) and correlation coefficient (CC) to analyze and compare the spectral quality. The CC between the original MS image and the final fused image is defined as[12]:

$$CC(A,B) = \frac{\sum_{mn}(A_{mn}-\bar{A})(B_{mn}-\bar{B})}{\sqrt{\sum_{mn}(A_{mn}-\bar{A})^2(\sum_{mn}(B_{mn}-\bar{B})^2)}} \quad \text{...Eq (9)}$$

where $\bar{A}$ and $\bar{B}$ stand for the mean values of the corresponding data set

CC is calculated globally for the entire image.

The formula for RMSE is,[12]

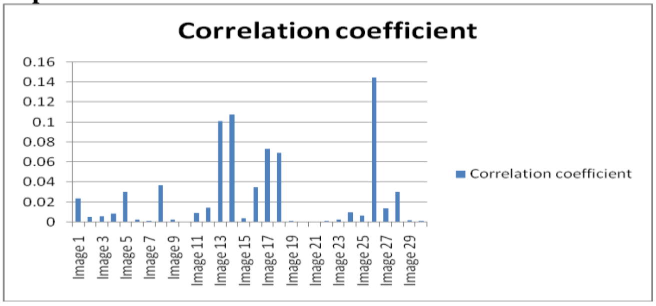
$$RMSE = \sqrt{\frac{\sum_x\sum_i (A_i(x)-F_i(x))^2}{n\times m\times d}} \quad \text{..... Eq(10)}$$

IV. GRAPHICAL REPRESENTATION OF METRICS PARAMETERS FOR IMAGES

For available database, parameters such as correlation coefficient ERGAS, Qave, RASE, RMSE, SAM, SID, Spatial Coefficient &Time for Pansharpeningare extracted. These are shown below:

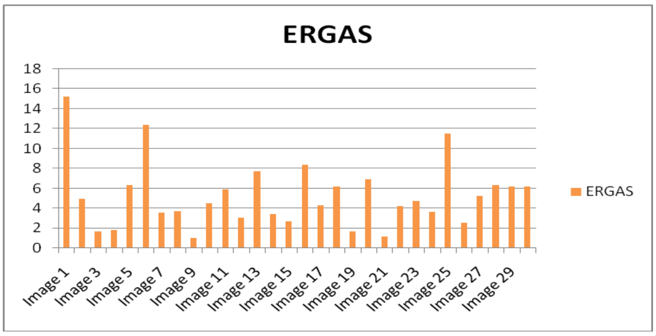
A. REPRESENTATION OF 'CORRELATION COEFFICIENT'

Paper ID: E&TC11



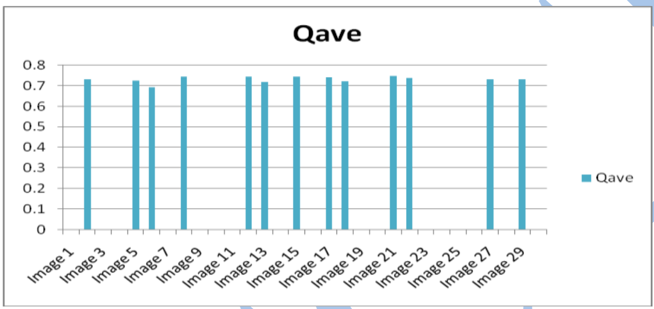
Graph 1: Correlation Coefficient

B. REPRESENTATION OF ‘ERGAS’



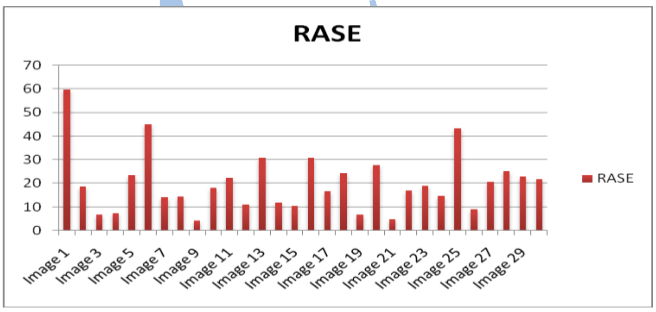
Graph 2: ERGAS

C. REPRESENTATION OF ‘Qave’



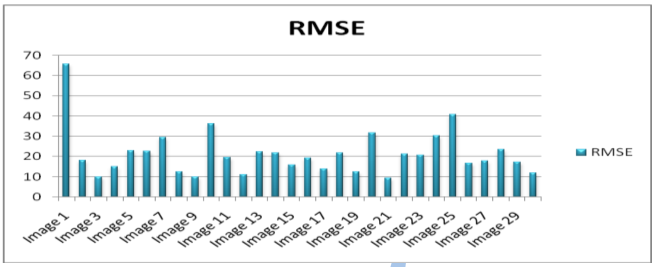
Graph 3: Qave

D. REPRESENTATION OF ’RASE’



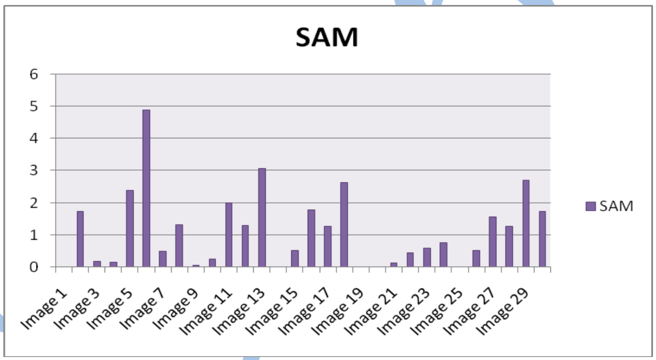
Graph 4: RASE

E. REPRESENTATION OF ‘RMSE’



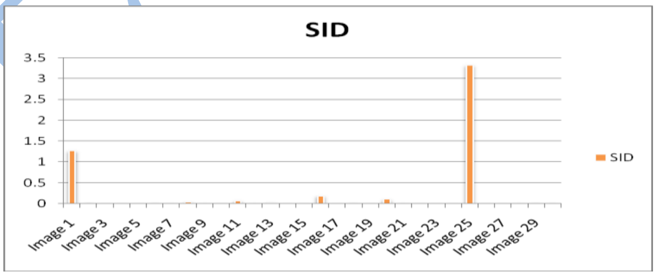
Graph 5: RMSE

F. REPRESENTATION OF ’SAM’



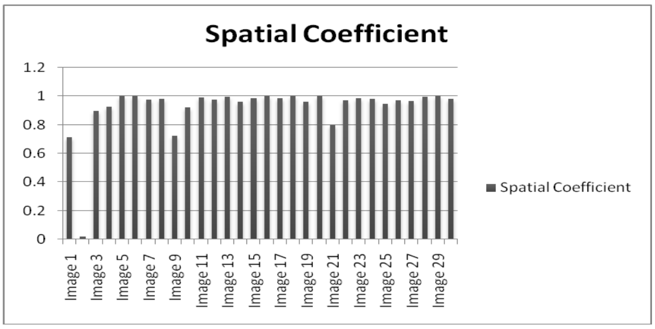
Graph 6: SAM

G. REPRESENTATION OF ’SID’



Graph 7: SID

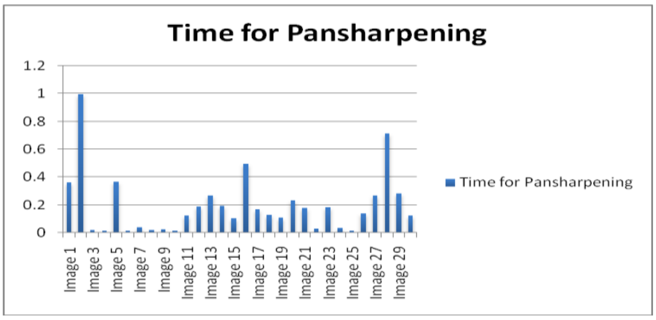
H. REPRESENTATION OF ‘spatial coefficient’



Graph 8: Spatial Coefficient

Paper ID: E&TC11

I. REPRESENTATION OF' Time for Pan sharpening'



Graph 9: Time for pan sharpening

V. CONCLUSION

Remote sensing imaginary, has wide range of applications in different areas. To obtain more precise details of particular region, Pan sharpening operation is performed. In Pan sharpening process, high-resolution panchromatic and lower resolution multispectral images are merged to create a single high-resolution color image. Further, this image is used to obtain, Green (vegetation) and Blue (water bodies) BW area. These are useful for applications such as mapping of transportation network, disaster management and urban monitoring.

VI. REFERENCES

[1] Jiang C., Zhang, H., Shen H., Zhang, L.– "Two-Step Sparse Coding for the Pan-Sharpening of Remote Sensing Images", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, Volume 7, Issue 5, PP. 1792 - 1805, May 2014.

[2] Diego Renza, Estibaliz Martinez, and Agueda Arquero, "A New Approach to Change Detection in Multispectral Images by Means of ERGAS Index", IEEE Geoscience And Remote Sensing Letters, VOL. 10, No. 1, January 2013.

[3] Yun Zhang , Mishra, R.K.- " A review and comparison of commercially available pan-sharpening techniques for high resolution satellite image fusion", IEEE International conf. on Geoscience and Remote Sensing Symposium (IGARSS), 2012 ISSN :2153-6996, PP 182 – 185, July 2012

[4] Liangpei Zhang, Huanfeng Shen, Wei Gong, and Hongyan Zhang –"Adjustable Model-Based Fusion Method for Multispectral and Panchromatic Images'' IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics, Volume: 42 , Issue: 6 , PP. 1693 – 1704, Dec. 2012

[5] Shutao Li, and Bin Yang – "A New Pan-Sharpening Method Using Compressed Sensing Technique", IEEE Transactions on Geoscience And Remote Sensing, Volume 49, No. 2, PP 738 - 746, February 2011

[6] Firouz Abdullah Al-Wassai, N.V. Kalyankar, Ali A. Al-Zuky, "The IHS Transformations Based Image Fusion", Computer Vision and Pattern Recognition (cs.CV),19 July 2011

[7] K. Panetta, S. Agaian, Y. Zhou, and E. J. Wharton- "Parameterized logarithmic framework for image enhancement", IEEE Trans. Syst., Man, Cybern. B, Cybern., Volume. 41, Issue. 2, PP. 460–473, Apr. 2010.

[8] Shuo-Li Hsu, Peng-Wei Gau, I-Lin Wu, and Jyh-Horng Jeng, "Region-Based Image Fusion with Artificial Neural Network" , World Academy of Science, Engineering and Technology Vol:3 2009-05-20

[9] Garzelli, A., Nencini, F., Capobianco, L.- "Optimal MMSE Pan Sharpening of Very High Resolution Multispectral Images" , IEEE Transactions on Geoscience and Remote Sensing, Volume:46 , Issue: 1 , PP 228 – 236 , Jan. 2008

[10] V. P. Shah, N. H. Younan, and R. L. King, "An efficient pan-sharpening method via a combined adaptive PCA approach and contourlets," IEEE Trans. Geosci. Remote Sens., Volume: 46, no. 5, pp. 1323–1335, May 2008.

[11] C. Thomas, T. Ranchin, L. Wald, and J. Chanussot, "Synthesis of multispectral images to high spatial resolution: A critical review of fusion methods based on remote sensing physics," IEEE Trans. Geosci. Remote Sens., vol. 46, no. 5, pp. 1301–1312, May 2008.

[12] Melissa Strait, Sheida Rahmani, Daria Markurjev, "Evaluation of Pan-Sharpening Methods" , August 2008

[13] Sumalatha Kuthadi, "Detection Of Objects From High-Resolution Satellite Images", May 2005.

[14] X. Otazu, M. Gonzalez-Audicana, O. Fors, and J. Nunez, "Introduction of sensor spectral response into image fusion methods. Application to wavelet-based methods," IEEE Trans. Geoscience and Remote Sensing, Vpolume 43, no. 10, pp. 2376–2385, Oct. 2005.

[15] Boccardo, P., Mondino, E.B., Tonolo, F.G. " Urban areas classification tests using high resolution pan-sharpened satellite images" , 2nd GRSS/ISPRS Joint Workshop on Remote Sensing and Data Fusion over Urban Areas, 2003. PP 268 – 272, May 2003.

[16] T. Ranchin, B. Aiazzi, L. Alparone, S. Baronti, and L. Wald, "Image fusion—The ARSIS concept and some successful implementation schemes," ISPRS J. Photogramm. Eng. Remote Sens., Volume. 58, nos. 1–2, pp. 4–18, 2003.

[17] Zhou Wang, Alan C. Brovik, "A universal Image Quality Index" , IEEE Signal processing Letters, VOL. XX, No. Y, March-2002.

[18] C. A. Laben and B. V. Brower, "Process for enhancing the spatial resolution of multispectral imagery using pan-sharpening," U.S. Patent 6 011 875, Jan. 4, 2000.

[19] T. Ranchin and L. Wald, "Fusion of high spatial and spectral resolution images: The ARSIS concept and its implementation," Photogramm. Eng. Remote Sens., Volume. 66, no. 1, pp. 49–61, 2000.

[20] Space-Imaging, Thornton, CO, USA. (2000). Geoeye IKONOS Scene Data [Online]. Available: http://ftp://ftp.glcf.umiacs.umd.edu/glcf

Paper ID: E&TC11

[21] L. Wald,- “Some terms of reference in data fusion,” IEEE Trans. Geosci. Remote Sens., Volume 37, Issue 3, PP. 1190–1193, May 1999.
[22] Lillesand and Kiefer , ”Correction for Sensor System Detector Errors Review” , 1994, p536-541
[23] Harold Hough:Satellite Surveillance, Loompanics Unlimited, 1991, ISBN 1-55950-077-8
[24] Gene Rose.“Pan Sharpening”.
[25] Osmar Abílio de Carvalho Jr, & Paulo Roberto Meneses, “Spectral Correlation Mapper (SCM): An Improvement on the Spectral Angle Mapper (SAM)”