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HSV-PCA AND IHS-PCA BASED IMAGE FUSION TECHNIQUES

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ABSTRACT

Image fusion can be described as a process of producing a single image from two or more images that are collected from the same or different sensors. Several situations in image processing require high spatial and high spectral resolution in a single image. The objective of the fusion process is to keep maximum spectral information from the original multispectral image while increasing the spatial resolution. Several methods exist for image fusion. The paper discusses image fusion based on HSV-PCA and IHS-PCA method. PCA will be applied on panchromatic image and HSV or IHS will be applied on multi-spectral image. These images will be fused to form a new image. The resultant image will be assessed based on Entropy.

Keywords: Hue Saturation Value (HSV), Intensity Hue Saturation (IHS), Principle Component Analysis (PCA), Entropy

I. INTRODUCTION

In the field of remote sensing, lower spatial resolution multispectral images need to be fused with higher resolution panchromatic images. The fusion techniques should ensure that all important spatial and spectral information in the input images is transferred into the fused image, without introducing artifacts or inconsistencies, which may damage the quality of the fused image and distract or mislead the human observer. Furthermore, in the fused image irrelevant features and noise should be suppressed to a maximum extent. Image fusion can be performed at pixel, feature and decision levels according to the stage at which the fusion takes place. [1] Classical approaches of image fusion of remotely sensed data such as Principal Component Analysis (PCA), Hue Saturation Value (HSV), Intensity Hue Saturation (IHS) or decision-level fusion have been utilized and proposed in several research articles. The main problem with these approaches is their inability to preserve the spectral signatures of the original MS data. [1]

II. CLASSIC APPROACHES

2.1 HSV

HSV method consists on transforming the R, G and B bands of the multispectral image into HSV components, replacing the value component by the panchromatic image, and performing the inverse transformation to obtain a high spatial resolution multispectral image. This one of the most widely applied fusion procedure for merging panchromatic imagery with three-color multispectral imagery [2]. Corresponding matrix expression of HSV method is follows:

To convert RGB to HSV:

$$\begin{bmatrix} V \\ V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 0.577 & 0.577 & 0.577 \\ -0.408 & -0.408 & 0.816 \\ -0.707 & 0.707 & 1.703 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

$$H = tan^{-1}\left(\frac{V_2}{V_1}\right) \quad (2)$$

$$S = \sqrt{V_2^2 + V_1^2} \quad (3)$$

The gray value Pan image of a pixel is used as the value in the related color image, i.e. in the above equation

To convert HSV to RGB:

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 0.577 & -0.408 & -0.707 \\ 0.577 & -0.408 & 0.816 \\ 0.577 & 0.816 & 0 \end{bmatrix} \begin{bmatrix} V \\ V_1 \\ V_2 \end{bmatrix} \quad (4)$$

2.2 IHS

The Intensity-Hue-Saturation (IHS) transformation decouples the intensity information from the color carrying information. The hue attribute describes a pure color and saturation gives the degree to which pure color is diluted by white light. This transformation permits the separation of spatial information into one single intensity band. There are different models of IHS transformation. The models differ in the method used to compute the intensity value. Smith's hexagonal and triangular models are two of the more widely used models.

Algorithm for IHS fusion method:

- Convert MS_{RGB} into MS_{IHS} image by using appropriate transform.
- After converting image in IHS form resample PAN image as the size of I component.
- Now replace I component of MS_{IHS} by PAN image.
- Apply reverse transform in order to convert image back in MS_{RGB} format. [2, 3]

2.3 PCA

Principal Component Analysis is a mathematical tool which reduces the multidimensional data sets into lower dimensions for analysis. This method determines the weight factor and adds this to each pixel location in input image and takes average of weighted pixel values to produce result at same pixel location. This method works on pixel so it may produce some spectral degradation in fused output image. [4, 5]

PCA maintain image clarity, spectral information loss is slightly better than that of the IHS fusion method.

Steps:

1. Produce the column vectors from input images
2. Calculate the covariance matrix of the two column vectors formed in step1.
3. Calculate the Eigen values and the Eigen vectors of the covariance.
4. Normalize the column vectors.
5. Normalized Eigen vector act as the weight values which, multiply it with each pixel of the input images.
6. Fuse the two scaled matrices will be the fused images matrix. [5]

III. HYBRID METHODS

3.1 Principle Components

PCA summarizes the variation in a correlated multi-attribute to a set of uncorrelated components, each of which is a particular linear combination of the original variables. n The extracted uncorrelated components are called principal components (PC) and are estimated from the eigenvectors of the covariance or correlation matrix of the original variables. Therefore, the objective of PCA is to achieve parsimony and reduce dimensionality by extracting the smallest number components that account for most of the variation in the original multivariate data and to summarize the data with little loss of information. In PCA, uncorrelated PC's are extracted by linear transformations of the original variables so that the first few PC's contain most of the variations in the original dataset. These PCs are extracted in decreasing order of importance so that the first PC accounts for as much of the variation as possible and each successive component accounts for a little less. [6]

3.2 HSV-PCA

Spectral information is mostly reflected on the hue and the saturation. From the visual system, one can conclude that the intensity change has little effect on the spectral information and is easy to deal with. Therefore the Value Component can be replaced by Principal Component 1.

The Algorithm is as follows:

- Apply HSV for multi-spectral image
- Apply PCA for Panchromatic Image
- Separate the PC1 component of the Panchromatic Image
- Replace the Value component of multi-spectral image with the PC1 component of panchromatic image
- Show the new image thus created
- Calculated the Entropy and Correlation Coefficient

3.3 Original Image: 1 Ithaca, NewYork: Metadata file

All satellite image files, TIF and Lan, were generated from the same Landsat 7 ETM+ scene. Included in the download folder are two Lan files that were generated using MultiSpec software. Due to different download speeds and educational applications a smaller lan file, 512 by 512 pixels, was subsetted from the larger 1000 pixel by 1000 pixel file. In addition, another lan file was added of the panchromatic data. In addition to the Lan files, numerous color composite images were generated using MultiSpec. Each of these images enhances different features of the satellite image. The color composites were saved as Tif files and retain their geographic information. The Tif colour composites were 2 percent tail clipped enhanced instead of showing the entire range of the data.

LAN files and name: 2001_08_25_ITHAC.LAN, 6.6 mb

Lines: 1000 Number of bands: 7

Columns: 1000 Band Format: BIL

2001_08_25_ ITHAC_S.LAN, 6.6 mb

Lines: 512 Number of bands: 7

Columns: 512 Band Format: BIL

2001_08_25_ ITHAC_PAN.LAN, 1.5 mb

Lines: 1243	Number of bands: 1
Columns: 1275	Band Format: BIL

IV. RESULTS

Fig 1. Original MS image

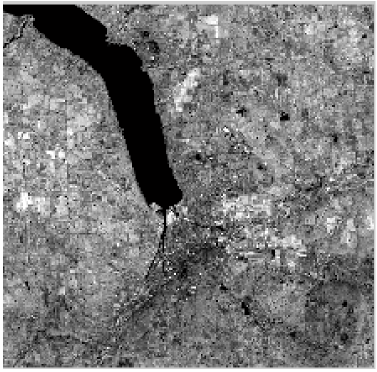

Fig 2. PAN Image

Fig 3. RGB Image

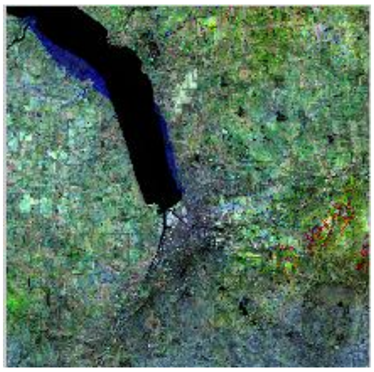

Fig 4. Fused Image

Fig. 1 shows the original MS image. Fig. 2 shows the- panchromatic image on which PCA has been applied. Fig. 3 shows the multi-spectral image on which HSV has been applied. Fig. 4 shows the Fused Image i.e. the image obtained by fusion of Fig. 2 and Fig. 3.

4.1 Assessment Parameter

4.1.1 Entropy

For the evaluation of information quantity contained in an image entropy index is calculated, if its value comes high it means information in fused image is high and improved image is produced after fusion.

$$H = -\sum_{i=1}^{G} P(i)\log_2(P(di)) \quad (5)$$

Where G is total of grey levels and P is probability distribution of each level. [4]

Table shows entropy values for different methods. At the start entropy of input image is given. And then entropy of all remaining images is being compared with the input image. Table shows that almost all methods with improved entropy values.

Table 4.1 Entropy Values For Different Methods.

Method	Entropy
Input MS image	5.971
HSV Method	6.58
PCA Method	7.32
HSV-PCA	7.3075

V. CONCLUSION

From the results obtained as shown in Table 1, we can observe that the entropy value of the original input image is 5.971. After applying the new method the entropy value has increased to 7.3075. Hence it can be concluded that the new method i.e. HSV-PCA gives better fusion of images than the classic ones. Also from visual point of view the hybrid method has better visual quality.

REFERENCES

[1] Rajvi Patel, Manali Rajput, Pramit Parekh, Comparative Study on Multi-focus Image Fusion Techniques in Dynamic Scene, International Journal of Computer Applications (0975 – 8887) Volume 109 – No. 6, January 2015

[2] Rohan Ashok Mandhare, Pragati Upadhyay,Sudha Gupta, HSV Based Satellite Image Fusion, International Journal of Emerging Trends in Electrical and Electronics (IJETEE – ISSN: 2320-9569) Vol. 4, Issue. 1, June-2013

[3] Firouz Abdullah Al-Wassai1, N.V. Kalyankar2, Ali A. Al-Zuky3, The IHS Transformations Based Image Fusion, computer vision and pattern recognition, 19 july 2011

[4] Sukhpreet Singh, Rachna Rajput, A Comparative Study of Classification of Image Fusion Techniques, International Journal Of Engineering And Computer Science ISSN:2319-7242 Volume 3 Issue 7 July, 2014 Page No. 7350-7353

[5] C. Morris, R.S. Rajesh, Two Stage Spatial Domain Image Fusion Techniques, ICTACT Journal On Image And Video Processing: Special Issue On Video Processing For Multimedia Systems, August 2014, Volume: 05, Issue: 01

[6] http://www.cabnr.unr.edu/Saito/classes/ers701/pca2.pdf

[7] Rohan Mandhare, Sudha Gupta, Pixel-Level Image Fusion Using Brovey Transform And Wavelet Transform, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol. 2, Issue 6, June 2013

[8] Rajvi Patel, Manali Rajput, Pramit Parekh, Comparative Study on Multi-focus Image Fusion Techniques in Dynamic Scene, International Journal of Computer Applications (0975 – 8887) Volume 109 – No. 6, January 2015