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A NOVEL APPROACH FOR FUSION OF PANCHROMATIC AND MULTISPECTRAL IMAGE THROUGH NEURAL NETWORK

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ABSTRACT

In this paper, a new technique for image segmentation from high resolution fused multispectral image is recognized. The proposed techniques are a mixture of image fusion, feature extraction like shape and edge and also perform fused multispectral image classification. Researchers have performed an enormous amount of experiments on multi-focus image fusion techniques. To extract superior quality information and consistency by using multi-focus image fusion and also it is developing into many image processing applications. A fusion method enhances the feature of image and also enlarges the application of these data. The panchromatic image has high spatial information while multispectral image has high spectral information when merging these images to get a high resolution multispectral image. By using spectral and spatial information the feature is extracted to enhance the accuracy of the image. Therefore, conventional methods are suffering from either spatial or spectral characteristics, but the proposed methods save both spectral and spatial characteristics simultaneously. Conventional methods like a high pass filter modified principal component analysis and atour's method. The proposed method uses multi-wavelet transforms through a pulse coupled neural network. Performance can be evaluated based on the classification of fused multispectral image and also investigate the impact of image fusion using selected features of reference and fused image. Using, SVM classifier to build classification experimentation on fused multispectral image. Therefore, the final results of the proposed method are more efficient than the conventional methods.

Keywords: panchromatic image, multispectral image, feature extraction, classifier, neural networks, image fusion methods.

INTRODUCTION

In modern day, fast growth in the field of remote sensing technology (Smith, 2006). The remote sensing system has verified to be great tools for examining the ground surface, environment on a worldwide and area by giving essential land cover, mapping and classification of ground cover features such as flora, soil, water and wooded area (Zeng *et al*., 201). The level of remote sensing images can grow continues at a huge rate of advances in multi-sensor technology. As a result, an increasing amount of image data from multi-sensors has been offered, which includes multi-resolution images, multi-spatio images and multispectral images. Remote sensing information is suitable and simply accessed over a huge part at minimum price, but due to the impact of cloud cover, vaporizer and reflection from remote sensing information are frequently lost and the seasonal deviation will be also affected. To minimize such impacts, usually fused method is adopted. The purpose of multi-sensor image fusion is to put together corresponding and redundant information to offer fused image at a higher quality.

Multi-sensor imagings systems are begin used in the field of satellite system to observe the earth surroundings. Multi-sensor image fusion is primarily used to improve the visual of low resolution satellite images and also analyze the accuracy of fused image. Multi-focus image fusion (Zhang and Jixian, 2010) is the method in which two different sensors are used to collect same images and then generate a new fused image that hold all significant things in focus, which is helpful for a person or machine observation. The application of multi-sensor image fusion includes imaging, computer vision, remote sensing and microscopic imaging system. The quick bird, spot, Ikonos, Landsat and worldview satellite method, gather panchromatic images at high resolution and multispectral images at low resolution. Every satellite system gathers different resolution like 0.8m or 2m resolution for panchromatic images and 4m or 3.8m for multispectral image. Multispectral images cannot be viewed effectively because of insufficient spatial resolution, whereas panchromatic images contain high spatial resolution but the classification cannot be done because of insufficient spectral resolution. The high spectral resolution images (Zhang and Yun, 2008) are essential for ground cover classification while high spatial resolution image are necessary for feature extraction and exact description of image shapes. Hence combine these two types of images to get a high resolution multispectral image.

In the early period, numerous image fusion systems have been projected. Some of these methods depend on spatial domain; transform domain and artificial neural network methods. The spatial domain methods are high pass filter, principal component analysis, intensity-hue-saturation and multiplication methods. The transform domain methods are wavelet transform, shearlet transform and curvelet transform. The transform domain method

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generates better results compared to spatial domain methods. Neural network produce better result compared with spatial and transform domain methods. All above methods can be divided into different types. They are pixel level fusion, feature level fusion and decision level fusion. Pixel level fusion is achieved on a pixel by pixel basis and used to evaluate and merge information from different resource. Feature level is achieved on extraction of various features like direction length, shape and edges. Decision level is a high level fusion which points to a definite objective. Classification accuracy can be evaluated based on accessing the quantity of appropriate classified pixels in numerous randomly preferred locations in a compactly occupied neighborhood in the section. The pan-sharpening has been done by using transform techniques through the neural network. This method should enhance the image and also perform classification of the fused multispectral image.

The purpose of the experiment to obtain cloud covers free images and also acquires more exact and reliable data. This paper shows the necessity of standardized progression in term of image fusion and quality assessment. Hence the results of the experiment are described into image fusion and classification. In this paper, we present a new method for image fusion, which employ spatial and spectral data from PAN and MS image. The projected method is very efficient and provides greater results in image fusion and classification of multispectral images than traditional approaches.

LITERATURE REVIEW

Image fusion is the process of joining high spatial data with high spectral data to generate a single fused image. The fused image contains additional information and it is more appropriate for visual observation. Several researches have been done on developing different algorithms for image fusion and its application like image segmentation and image classification. A variety of image fusion methods like a high pass filter, Brovey transform, modified hue- intensity-saturation (Tu *et al*., 2011), principal component analysis (Shah and Younan, 2012)offers improved results in spatial characteristics and gives unclear results in spectral characteristics. Wavelet transforms (Demirel and Anbarjafari, 2010), contourlet transform, curvelet transform, atour's (Mallat, 1998) and shearlet transform gives enhanced results in spectral characteristics and provide blurred results in spatial characteristics. A suitable image fusion provides both spectral and spatial characteristics simultaneously. The above methods suffer from either spatial or spectral characteristics. In order to avoid the drawback of above method a multi-wavelet transform is used through the pulse coupled neural network and also perform image classification for accurate measurements. The multi-wavelet transform is a successful method to make low dimensional linear subspace demonstration of high dimensional data such as images. In this paper, multi-wavelet transform is used to arrest the feature like the shape and edges of things in the source image and the local feature of the sparse matrix are calculated to stimulate the PCNN. Therefore the proposed method produces an efficient multispectral image. The fused image has been evaluated based on the classification of multispectral image using support vector machine (SVM) classifier. Finally the results are compared to different types of image fusion techniques.

PROPOSED METHOD

In this segment, a new technique for multi-sensor image fusion is projected (Hall and Llinas, 2007). The proposed method uses multi-wavelet transform for image fusion after that the accuracy can be estimated based on the classification of fused multispectral images using SVM classifier and compares the results with different types of fusion techniques. The proposed block diagram is shown in figure 1. By using multi-wavelet transform, the fused image contains more information. Since, it has the capability to join the images with different frequencies. Multi-wavelet transform provides compact support, orthogonality, regularity and multi-scale are used to represent the images with different direction, but these characteristics are not achievable in discrete wavelet transform. The artificial neural network is a great tool for image fusion techniques than multi-resolution tool. By using pulse coupled neural network (Broussard et al., 2009) with multi-wavelet transform the fused image offers high fusion details and also calculate the accuracy with the help of classification of fused multispectral images the results of this method is more powerful than conventional methods.

The proposed block diagram consists of following steps. The Panchromatic and Multispectral image should be in the same size, Decompose the Pan and MS image into various blocks with definite size using multi-wavelet transform, Spatial frequency feature of both of the image is extracted and normalize the feature and then apply pulse coupled neural network then finally, to obtain the high resolution fused multispectral image. This section gives brief description about image fusion, feature extraction and classification methods.

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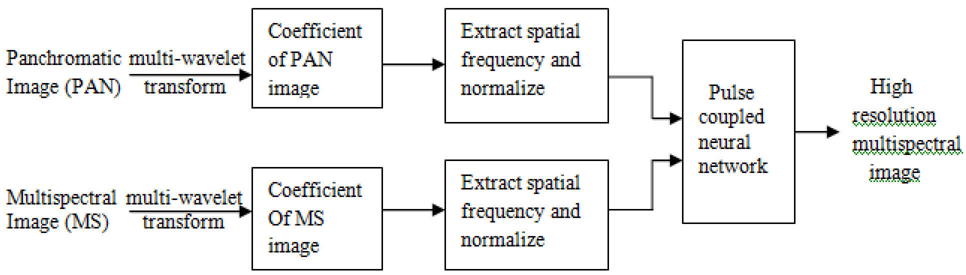

Figure-1. Block diagram of proposed system.

Image fusion using multiwavelet transform through pulse coupled neural network

Multi-wavelet transform is extensions of discrete wavelet transform (Mallat, 1998). The variation between multi-wavelet transform and discrete wavelet transform is a scaling function.

(i) (ii)

Figure-2. (i) Panchromatic image (ii) Multispectral image.

L0L0	L1L0	L0H0	L1H0
L0L1	L1L1	L0H1	L1H1
H0L0	H1L0	H0H0	H0H1
H0L1	H0L0	H0H1	H1H1

Figure-3. Decomposition of multi-wavelet transforms techniques.

Figure-2 explains the panchromatic and multispectral image. Multi-wavelet transform has more scaling function for image representation and also it is the latest one for research field. Therefore multi-wavelet transform achieve higher results than discrete wavelet transform. Geronimo-Hardin-Massopust (GHM), Shen-Tan-Tham (ST), Chu-Lian (CL) (Geronimo et al., 1994), knows multi-wavelet transform. Integration of symmetric, compact support and orthogonality is provided by multi-wavelet transform but these properties are not provided by discrete wavelet transform. The discrete wavelet transform represent the scaling element *(t)* and wavelet element *Ψ (t)* whereas multi-wavelet transform are represented by a set of scaling element *ϕ(t)≡ ϕ1 t ϕ2 t ……ϕr(t)* and set of wavelet element *Ψ(t)≡ Ψ1 t Ψ2 t ……Ψr(t).* Every decomposition has 16 sub-bands in multi-wavelet transform.

The low pass sub-bands contain four blocks. These blocks represent different types of spectral characteristics, whereas high pass sub-bands contain similar characteristics. The low pass sub-bands contain rough information, but high pass sub-bands contains high detailed information. By using different types of merging process, we can combine both high pass and low pass sub-bands to a get highly fused image. Figure-3 shows decomposition of panchromatic and multispectral image using multi-wavelet transform method. Multi-resolution analysis (Goodman and Lee, 1994) is represented by using scaling element in equation (1)

$$\varphi\ t = Ck\varphi\ 2t-k\ k \qquad (1)$$

where Ck is the coefficients related to scaling element.

$$(t)= Dk\varphi\ 2t-k\ k \qquad (2)$$

Multi-wavelet transform are implemented by using high and low pass filter banks instead of scalars. The low and high pass sub bands are represented in transform domain is given in equation 3

$$\begin{bmatrix}\phi_1 t\\ \phi_2 t\end{bmatrix} = \sqrt{2}\sum_k M_k \begin{bmatrix}\phi_1(2t-k)\\ \phi_2(2t-k)\end{bmatrix} \qquad (3)$$

$$\begin{bmatrix}\varphi_1 t\\ \varphi_2 t\end{bmatrix} = \sqrt{2}\sum_k N_k \begin{bmatrix}\varphi_1(2t-k)\\ \varphi_2(2t-k)\end{bmatrix} \qquad (4)$$

Feature selection

The choice of different feature is an important duty for feature level, multi-focus image fusion. In image fusion techniques some amount of images is very clear and some amounts of image are distorted. So, the clarity

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depends on the selection of appropriate features. In this section we have to observe five different kinds of feature. They are edge information, contrast visibility, variance, spatial frequency and energy of gradient.

Edge information

By using edge detector, the edge pixel can be originated at the image blocks. The edge information says about the edge pixel present in the image blocks or not. If the present pixel belongs to some edge in the image it gives 1 or else it gives 0.

Contrast visibility Maziyar et al. used to measure the variation of a block of pixel and closely related with the clarity of the image block. The contrast visibility is given as

$$\frac{1}{r*s}\sum_{(p,q)\in b_m}\frac{|P(p,q)-\mu_m|}{\mu_m} \tag{5}$$

where p and q represent dimensions of image with block of m, μ_m is the mean of the image.

Variance: It is used to measure expand of focus in an image block. The variance can be measured by using this equation

$$\sum_{r*s}\sum_{p=1}^{r}\sum_{q=1}^{s}\left(P(p,q)-\mu\right)^2 \tag{6}$$

where p and q represent dimensions of image block, μ_m is the mean of the image.

If the variance value is very high, it gives maximum extension of focus, otherwise it gives minimum extension of focus.

Spatial Frequency (Maziyar Khosravi and Mazaheri Amin, 2011): It is used to measure the clarity of image. The movement level image was calculated by using spatial frequency. The frequency varies along rows and columns of images. It is calculated by using this equation

$$sp=\sqrt{(RF)^2+(CF)^2}$$
$$RF=\sqrt{\frac{1}{r*s}\sum_{p=1}^{r}\sum_{q=2}^{s}[P(p,q)-P(p,q-1)]^2}$$
$$cF=\sqrt{\frac{1}{r*s}\sum_{q=1}^{r}\sum_{p=2}^{s}[P(p,q)-P(p-1,q)]^2} \tag{7}$$

where P is the image and p, q is the dimension of the image.

Energy of gradient: It is used to measure the quantity of focus in an image. If the EOG value is very high, it gives a maximum quantity of focus, otherwise it gives minimum quantity of focus.

$$\sum_{p=1}^{r-1}\sum_{q=1}^{s-1}\left(a_p{}^2+a_q{}^2\right) \tag{8}$$

where p and q represent dimensions of image block. The energy of gradient can calculate by using the above equation.

Classification

The various image fusion methods use to improve the quality of fused image and also measures the accuracy based on the classification of the fused multispectral image. Variety of classifier is used to measure the accuracy, but here we use only one classifiers like SVM classifier and finally compare the results with different types of image fusion techniques. SVM classifier produces superior results than other classifier. Hence, these classifiers are more appropriate for this experiment. In remote sensing, image fusion has to be pre-processed to avoid environment effects and sensor faults. Finally, the image fusion is done with the help of pixels present on the similar position.

RESULTS AND DISCUSSIONS

In this study, we have to executed a SVM classifier in order to measures the performance of accuracy for various types of image fusion techniques. A fused multispectral image demonstrating different sorts of land covers and environment was used as the test image for classification. As seen in the below images the output of proposed image fusion method is more smooth as compared with other image fusion techniques. Figure 4 shows the output of various types of image fusion techniques. Figure-5 is the output binary image after applying canny edge detection algorithm to detect the edges of high resolution panchromatic image.

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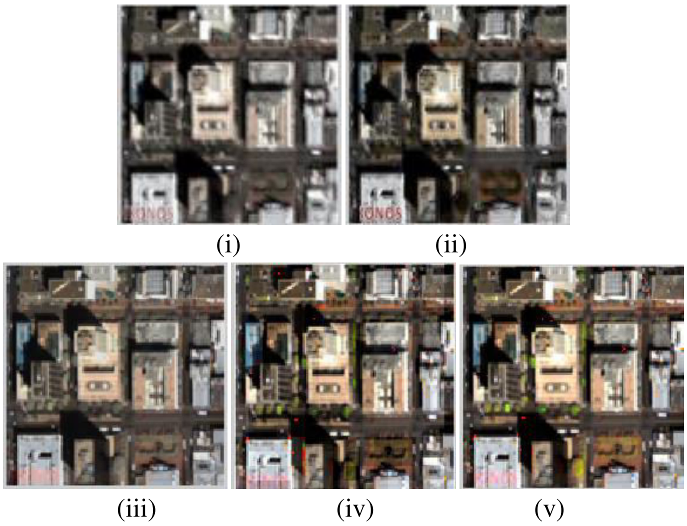

Figure-4. Image fusion result of (i) High pass filter (ii) Principal component analysis (iii) modified Intensity-hue-saturation (iv) Multiplication method (v) Proposed method.

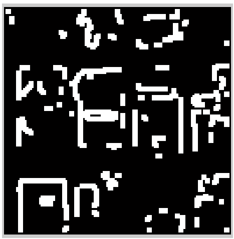

Figure 5. Binary images with edges of the panchromatic image.

Figure-6 is used for SVM classification along with the training sets for the specified classes. The probability for a pixel to belonging to a particular class is calculated and the same is repeated for all the classes and the pixel is assigned with a class which has the maximum probability. This is done till all the pixels in the image are classified. The output of the SVM Classification which is classified based on the training data. This is given to MRF to enhance the classification as well as to increase the accuracy.

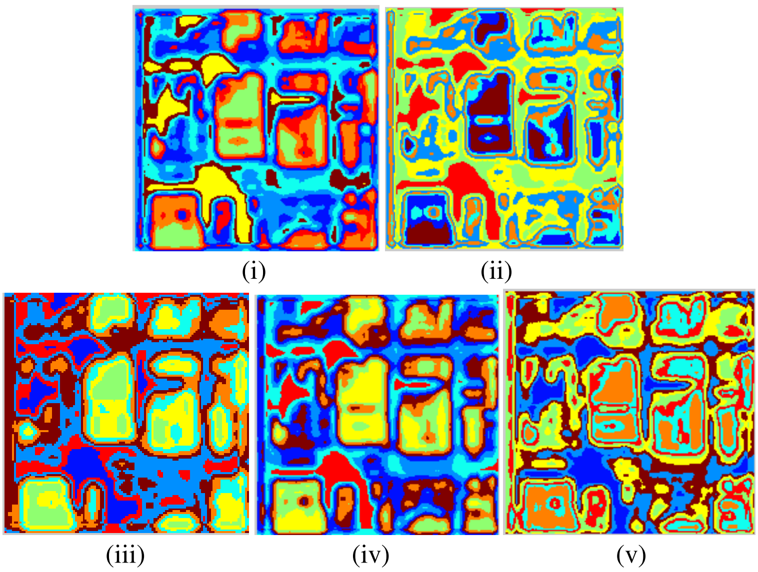

Figure-6. SVM classification for (i) High pass filter (ii) Principal component analysis (iii) modified Intensity-hue-saturation (iv) Multiplication method (v) Proposed method.

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Table-1 shows the overall accuracy for the various types of image fusion methodologies like high pass filter, principal component analysis, modified hue-saturation-intensity, Brovey transform and proposed method. From the table, the output of the proposed method gives better results compared with other image fusion methods.

Table-1. Overall accuracy of the various fused multispectral image.

Methods	Overall accuracy
High pass filter	75%
Principal component analysis	81%
Modified intensity-hue-saturation	85%
Brovey transform	89%
Proposed method	93%

CONCULSIONS

In this experiment, clearly shows that SVM classification is not a solution, it is evident the regions are misclassified. In order to decrease the misclassification we want to take into appropriate data available about the image. Finally the proposed method provides good results than other image fusion methods along with Classification. A combined approach to classification using Object based methods and contextual information available about the image, seems promising and needs further exploration.

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