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REMOTE SENSING MULTISPECTRAL IMAGE QUALITY ENHANCEMENT USING WAMM BASED IMAGE FUSION

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Abstract

This paper presents the enhancement of multispectral image quality using weighted average merging method under multi level non-sub sampled contourlet transform domain. In remote sensing system the multispectral sensors with high spectral resolution and have a poor spatial quality is compared with panchromatic sensor with higher spatial resolution and a wider spectral bandwidth. An integration of high spatial resolution extracted from PAN images into the high spectral resolution of MS images generates both high spatial and spectral resolution called pan sharpened image. The pan sharpening is done by using pixel level image fusion technique. It involves two different approaches that are, Multilevel NSCT with up sampling and WAMM. By applying up sampling after NSCT, structures and detailed information of the MS images are more likely to be preserved. The low frequency sub band coefficients are fused by entropy measurement and high frequency sub band coefficients are fused with WAMM. The high frequency component has the crucial information within the images like the texture, brightness and contrast. The WAMM takes care of preserving these details much better than other fusion approach. This preserves both spectral and spatial qualities while decreasing computation time. The system simulated result shows that used method provides better resolution rather than prior approaches and it is also measures the performance parameters such as correlation, PSNR, RMSE and percentage residual difference.

Keywords: Non Sub Sampled Contourlet Transform(NSCT),Weighted Average Merging Method(WAMM), Pan sharpening image, entropy measurement, up sampling.

Introduction

In Remote Sensing Systems, the scenes are observed with different resolutions using different sensors. To improve te sensing image quality, the multispectral sensors with high spectral resolution is compared with Panchromatic sensors with high spatial resolution. The spatial information extracted from panchromatic image is fused with the multispectral image in order to obtain the pan sharpened image.For this purpose many fusion algorithms has been proposed such as intensity hue saturation(IHS) and Principle Component Analysis(PCA) but these fusion methods causes spectral distortion in the fused image. The fused image has maximum information for better human perception and image processing tasks such as, segmentation , feature extraction and object recognition. NSCT is efficient in providing directional information and capturing intrinsic geometrical structures of the objects. It has characteristics of high resolution, shift invariance and high directionality. Generally, Pixel level fusion approach is used for obtaining pan sharpened image. This pixel level fusion is performed using gabor filter bank and gradient detection for coefficient selection. Up sampling is done after NSCT to preserve structural and detail information of he MS image. It increases the samples of each multi spectral bands twice at frequency domain to make a better fusion process. Here, up sampling is done by using Bicubic interpolation method. It is an extension of cubic interpolation of interpolating data points on a two dimensional regular grid. NSCT decomposes the source image into low frequency and high frequency sub bands. The high frequency sub bands obtained from the source images after applying NSCT are used for morphing process to get enhanced information. During fusion, the low frequency sub bands remains The NSCT and WAMM techniques are briefly discussed in the following sections. The efficiency of the proposed method is verified by analyzing the performance measures in section IV. Finally the conclusion is presented in section V.

Existing System: NSCT decomposition is to compute the multi scale and different direction components of discrete images. It involves two stages such as non sub sampled pyramid(NSP) and non sub sampled directional filter bank(NSDFB) to extract the texture, contours and detailed coefficients . The NSP decomposes the image into low and high frequency sub bands at each decomposition level and it produces n+1 sub images if decomposition level is n. NSDFB extracts the detailed coefficients from direction composition of high frequency sub bands obtained from NSP. The principle compound analysis cannot be used to fuse high resolution images and low resolution multispectral images because it may distort the spectral information of MS images. It compresses large amount of data without much loss of information. It selects first Eigen value that does not contain all information. The wavelet image fusion technique is widely used in remote sensing because of its multi resolution analysis characteristics. It preserves the spectral characteristics to the maximum while improving the spatial resolution. The disadvantage of wavelet transform is pixel by pixel analysis which is not possible. Intensity Hue Saturation method can improve the spatial details and texture of the fused image. The drawback of IHS technique is that it cannot decompose the image into low and high frequency images.

Proposed Algorithm: Various methods exist for image fusion such as IHS Transformation, Principle Compound Analysis, Discrete Wavelet and Curvelet transformations. There are certain limitations for these methods. These methods have more color and spectral distortions and poor discriminatory power. Due to sub sampling the representation of contour edges is limited. Hybrid fusion technique in pixel level is used in the proposed method. WAMM technique is used to fuse the high frequency images and entropy measurement to fuse the low frequency images. The high frequency sub bands of two source images obtained from NSCT are fused using WAMM technique to get the enhanced information. The fusion of remote sensing images is an effective way to use the large volume of data from multiple images. Thus it can overcome the problem of information deficiency during artificial extraction of remote sensing images. Hybrid fusion techniques in pixel level are more efficient than traditional techniques. WAMM is used in the high frequency sub bands to obtain the fusion coefficient. The high frequency sub bands have crucial information like the texture, brightness and contrast within the images. The WAMM preserves these details much better than any other fusion methods.

The WAMM can be formulated as:

$$C_F^{\{s,d\}}(i,j)=w_{\max}C_A^{\{s,d\}}(i,j)+w_{\min}C_B^{\{s,d\}}(i,j),\quad E_A(i,j)\geq E_B(i,j); \qquad (1)$$

$$C_F^{\{s,d\}}(i,j)=w_{\min}C_A^{\{s,d\}}(i,j)+w_{\max}C_B^{\{s,d\}}(i,j),\quad E_A(i,j)< E_B(i,j); \qquad (2)$$

The weights are estimated as:

$$W_{\min}=0, W_{\max}=1, \qquad M_{AB}(p)<T; \qquad (3)$$

$$W_{\min}=\frac{1}{2}-\frac{1}{2}\left(\frac{1-M_{AB}}{1-T}\right), W_{\max}=1-W_{\min}, \qquad other \qquad (4)$$

Where, T denote the threshold and T ϵ (0, 0.5) .

When the weight is zero, this means the substitution of an image by another. $M_{AB}(P)$ is called as the match measure which is defined as

$$M_{AB}(p)=\frac{2\sum_{s\in S,t\in T} w(s,t)C_A^{\{s,d\}}(m+s,n+t)C_B^{\{s,d\}}(m+s,n+t)}{E_A(p)+E_B(p)} \qquad (5)$$

In WAMM algorithm, the energies of high frequency coefficients of PAN and MS images are found. Then it will be internally compared with the threshold value. This result decides the further process to take place. Finally the energy of panchromatic image is compared with the multispectral image, and the resultant output will produce the fused high frequency coefficients. WAMM obtained better results in NSCT domain than the wavelet domain as it preserves more edges and keeps the visual quality intact in the fused image.

Entropy is the amount of information in an image. When the entropy value is high it shows more information content and vise-versa. It is calculated on the low frequency components of the input images.

$$H(S) = -\sum P(X)\log P(X) \quad (6).$$

Experimental Results: The efficiency of the fusion approach can be evaluated by computing the following matrices like correlation coefficient, root mean square error, peak signal to noise ratio, percentage residual difference and structural similarity index. The issue in the performance evaluation of an image fusion algorithms is that the unavailability of reference images. In addition, relevant research shows that a single measurement cannot be consistent with human visual perception.

1) Qualitative approaches: It involves visual comparison of the input images and the output image.

2) Quantitative approaches: It involves a set of pre-defined quality indicators for measuring the spectral and spatial similarities between the fused image and the orginal images.

A. Peak Signal to Noise Ratio

It is the ratio between the maximum possible power of a signal to power of noises in an image that affects the age quality. PSNR is generally represented in terms of the logarithmic decibel scale. When the PSNR value is large, the image quality is high where as when the PSNR value is sm all there occurs a great distortion between the input image and the fused image.

$$PSNR=10*\log10(255*255/MSE) \quad (6)$$

Where Mean Square Error stands for the mean-squared difference between the cover image and the stego image. MSE is defined as

$$MSE=1/(M*N)\sum\sum(a_{ij}-b_{ij})^2 \quad (7)$$

In this above equation a_{ij} means the pixel value at position (i,j) in the input image and b_{ij} is the pixel value at the same position in the output image.

B. Correlation Coefficients

Correlation coefficient is a measurement of the degree of changes to one variable predicts the changes to the value of another variable. The values increases or decreases in tandem for positively correlated variables. Higher value of correlation means that more information is preserved.

Correlation=sum(sum(B*A))/Sqrt(sum(sum(B*A))*sum(sum(A*A))) (8)

Where, B is the difference between fused image and its overall mean value. A is the difference between source image and its overall mean value.

C. Rmse

The square root of the mean/average of the square of all of the error. The use of RMSE is very common and it makes an excellent general purpose error metric for numerical predictions compared to the similar Mean Absolute Error, RMSE amplifies and severely punishes large errors.

$$\mathrm{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2} \qquad (9)$$

Table-1: Performance analysis of Pan Sharpened Image.

PERFORMANCE MEASURES	PSNR	RMSE	CC	SD	PRD
VALUES OF FUSED IMAGES	37.8398	10.6945	0.9779	8.2220	0.0994

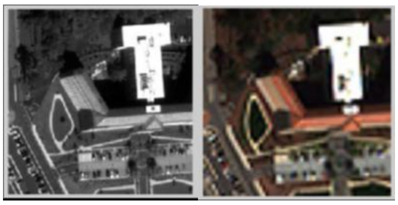

Fig-I. Input PAN and MS images.

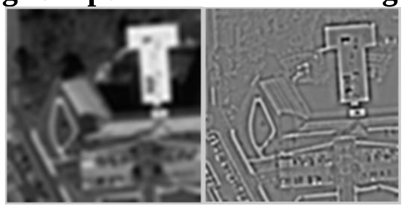

Fig-2: NSCT coefficients level 1 and level 2.

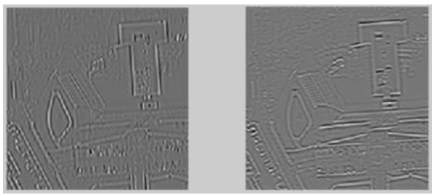

Fig-3: NSCT coefficients level 3.

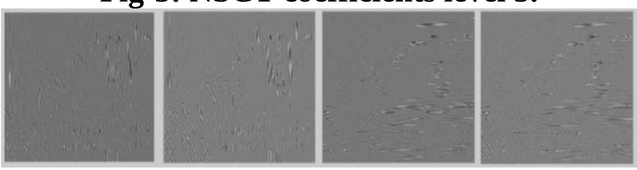

Fig-4: NSCT coefficients level 4.

Fig-5: PAN Sharpened image.

The PAN and MS images after undergoing multilevel NSCT and WAMM algorithm, inverse NSCT is applied to fuse the images .This produces a Pan sharpened image. The Pan sharpened image consists of better spatial and spectral information comparing to the input images.

Conclusion

Thus the spatial information from the panchromatic image is extracted and it is fused with the multispectral image in order to get the pan sharpened image. A novel fusion is based on NSCT and WAMM is proposed for the pan sharpened image. NSCT algorithm is more suitable for image fusion because of superiorities such as multi-resolution, multi-directional and shift invariance. WAMM works better in the NSCT domain than any other transformation. Thus the WAMM preserves both the spectral and spatial quality while decreasing the computation time also. The low frequency sub band obtained after NSCT decomposition consists of approximate coefficients and the high frequency sub band consists of detailed coefficients. Therefore the low frequency sub bands are further taken for multilevel NSCT decomposition. The final fused image is capable of producing better information rather the individual PAN and the multispectral source images respectively.

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