THE PROBLEM OF THE IHS METHOD WHICH EXISTS IN THE QUICK-BIRD IMAGE FUSION AND THE IMPROVEMENT OF IT

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ABSTRACT:

Against the Spectrum distortion problem of the IHS method which exists in the Quick-Bird data fusion, the paper proposes visual-pan band method and Linear weighted matching two methods to improve it, provides the best value scope of the α in the Visual-Pan band method as well as the best weighted values of pan and I when the spatial characteristic and the spectrum characteristic of the linear weighted matching fusion image achieves the best result. The result shows that: when the value of α is between 0.2 and 0.25 can obtains satisfying fusion effect; when the weighted values of pan and I are 0.75 and 0.25, the spatial characteristic and the spectrum characteristic of fusion image can achieve the best result.

1. INTRODUCTION

It extensively applies the quick-bird data during big scale thematic map producing. Improving the fusion effects of Quick-Bird panchromatic and multi-band spectrum data and obtaining higher-quality characteristics and spectral characteristics of fusion image are very important for improving the accuracy of remote sensing image classification and obtaining more precise spot border[Liu，2003]. spectral fidelity、sharpness and space texture definition are pivotal problems of improving thematic map produce quality .The most effectual method to resolve these problems is carrying on fusion processing to the remote sensing images. It’s necessary to improve the algorithm against specific remote data and use because of each fusion algorithm has its application scope. IHS is one of commonly used remote sensing image fusion processing methods. It exists obvious spectral distortion, reduce the spectral fidelity、sharpness and space texture definition during using IHS carry fusion on Quick-Bird data, which affect the visual interpretation application effect of Quick-bird image[Ehlers M. 1991]. Thus, research existing problems of Quick-Bird data fusion and how to improve it have great theoretical and practical significance.

2. EXISTING PROBLEMS OF IHS METHOD

The result of carrying on the fusion to the Quick-Bird data's panchromatic band and multi-spectral band shows that HIS fusion catches the most texture information from the pan-band, and has the maximum clarity, but has had the obvious spectrum distortion, especially in high vegetation coverage environment.

The main reason for this phenomenon is that Quick-Bird satellite panchromatic band spectral coverage is inconsistent with that of the true colour imaging. Quick-Bird satellite panchromatic band spectral coverage is 0.445~0.90μm, but corresponding multi-spectral imaging spectral coverage blue band is 0.45~0.52μm, green band is 0.52~0.6μm, red band is 0.63~0.69μm, near infrared band is 0.76~0.90μm. Quick-Bird panchromatic band includes not only visible band but also near-infrared band. Vegetation in the visible band performance for murk pixel, in the near-infrared band performance for bright pixel． In the I component obtained when carry on IHS transform to the true colour image vegetation performance for murk pixel most, Use panchromatic band replace the I component when IHS fusion, vegetation appear obvious spectral distortions after IHS inverse transform because of vegetation in panchromatic band performance for murk pixel.

3. IMPROVE METHOD

3.1 Visual-Pan Improve Method

Panchromatic image contains part near-infrared image information, thus, subtracts the near-infrared ingredient from the panchromatic can form visible panchromatic band that only contains the visible band information (named VisPan).

$$VisPan = pan - \alpha * Nir \qquad (1)$$

Vispan is visible band image spectrum value; pan is panchromatic image spectrum value; Nir is near infrared image spectrum value; α is modulus, along with different α values, the changes fusion image’s spectral distortion such as Table 1.

Table 1 shows that, along with α value enlargement, the fusion result's spectrum distortion value reduces first, when α =0.3 achieves the minimum value, then along with the α value increases gradually, the fusion result's spectrum distortion value starts to increase. Analyze the visual effect ofthe image, when α =0.3(figure 1(d), (e)), presents the obvious noise in the waters. In the near-infrared band, the waters DN value is low,

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when using larger α value, VisPan images waters' gray value is higher than other's, perform for relatively bright pixels when carry on HIS, result in significant noise. When uses great **α** value, the vegetation part changes dark, the level is not easy to differentiate.

α	B	G	R
0.10	119.78082	144.40662	162.77995
0.20	116.07682	138.68528	161.51990
0.25	114.21042	137.39561	160.89520
0.30	113.58638	135.16046	156.13586
0.40	124.96372	142.26787	169.90991
0.50	133.67339	157.17514	173.59997

Table 1 Different Spectrum Distortion

The results of integrating visual effects and spectral distortion value show that when the value of α is between 0.2~0.25, may obtain the very good fusion effect. In practice, when water area is small, take α = 0.25; when water is area large, take α = 0.2; in other circumstances the value of α is between 0.2 and 0.25.

3.2 Linear Weighting Match Method

Improve the spectrum quality through process the I component that obtain through carrying on IHS direct transform to Quick-Bird panchromatic band with multi-spectrum band. The method is: first carry on IHS transform to true color image which has matched and its combination is 3/2/1, then obtains I (brightness), H (chromaticity), S (saturation) three components; second, carry on histogram match to QB-Pan with I component that obtain I'; obtains I_R according to formula (2) after the linear weighting; at last, carry on inverse transformation to I_R 、H 、S, obtain image that combine matching and weighted.

$$I_R = \omega_{Pan} Pan + \omega_1 I' \qquad (2)$$

$\omega_{Pan} + \omega_1 = 1$. The value of ω_{Pan} and ω_1 were tested in this paper (Table 2) in order to get suitable value of ω_{Pan} and ω_1, and using spectrum distortion and the average gradient to evaluate the fusion results (Table 3).

Modulus	(a)	(b)	(c)	(d)	(e)
α	1/2	2/3	3/4	4/5	5/6
β	1/2	1/3	1/4	1/5	1/6

Table 2 α and β

Spectrum distortion reflects the overall difference degree of spectrum information, and it's direct-viewing reflection of spectrum information difference, it shows that the greater the value the more serious the spectrum distortion. The average gradient $\overline{T}$ of image can reflect sensitively the ability to express subtle details of image, not only can evaluate the clarity, but also can reflect the tiny details contrast and texture characteristics. Generally speaking, the average gradient bigger the fusion result is better.

Combination	Spectrum Distortion			Average Gradient		
	B	G	R	B	G	R
Original image				4.7488	4.6795	4.7287
(a)	105.8556	149.5825	171.3935	9.0573	9.4043	8.3102
(b)	113.7046	149.8244	171.7530	11.0364	11.5102	9.9227
(c)	118.0301	149.9365	171.5089	12.0684	12.6027	10.7509
(d)	119.6668	150.0118	171.6592	12.7076	13.2700	11.2691
(e)	121.0386	150.0458	172.0309	13.1316	13.7248	11.6214
IHS	133.6733	157.1751	173.5999	15.3584	15.7580	13.8794

Table 3 Spectrum Distortion and Average Gradient

We can see from Table 3 that along with the weight of pan-band (ω_{Pan}) gradually increased the spectrum distortion degree increases, blue band is the most obvious, the clarity of the image also gradually increase meanwhile. Comprehend image visual effect and Table 3 statistical values, we find that spatial characteristics and spectral characteristics of the fusion image achieve the best(figure 2(c)) when ω_{Pan} =3/4， ω_1 =1/4.

4. CONCLUSIONS

Using IHS exist a certain degree of spectrum distortion, but spatial texture information of the result is clear, and vegetation is very clear because near-infrared component exist in Pan-band, can see the difference clearly between the different vegetation texture. Thus, using the false coloured combination (NIR, R, G) carries on the IHS fusion when extract vegetation information base on Quick-Bird data not only reduce spectrum distortion, but also obtain clearer spatial texture and spectral signatures.

REFERENCES

LIU Zhe, HAO Chongyang, LIU Xiaoxiang, et al. 2003. Pixel-Based Image Fusion between PAN Image and Multispectral Image. *JOURNAL OF DATA ACQUISITION & PROCESSING*, *Volume* 18, No 3: 296-301.

Zhe Jing, He GuoJin. 2005. Shortages of the Data Fusion Approaches to High-resolution Satellite Images and Expected Improvements. Remote Sensing Information. No 4: 45-48.

HAN Ling, WU Hanning. 2005. Objective Analysis and Quality Evaluation of Multi-source Remote Sensing Image Information Fusion at Pixel Level. Remote Sensing Information. No5：40-44.

WANG Dapeng, WANG Zhoulong, LI Deyi. 2006. Orchard Information Extraction From the SPOT-5 Image Based on Sub-region and Hierarchical Theory. Remote Sensing for Land & Resources. No 3: 61-64.

QI Jianwei, ZHU Dehai, YANG Qinghua. 2006. The Application of Multisource Data to renewing the Land-use Map of Xi'an ity. Remote Sensing for Land & Resources. No 3: 66-68.

LI Cunjun, LIU Liangyun, WANG Jihua, et al. 2004. Comparison of Two Methods of Fusing Remote Sensing Images with Fidelity of Spectral Information. Journal of China Figure andf Image. Volume 9, No11: 1376-1385.

SUN Ronghua, GUO Defang. 2005. Study on Fusion Algorithms of SPOT-5 PAN and Multi-spectral Images. Remote Sensing Technology and Application. Volume 20, No 3: 366-370.

XU Rongfeng, XU Hanqiu. 2004. Evaluation on Image Fusion Algorithms of Landsat-7 ETM+ PAN Band and Multispectral Band. Geo-information Science. Volume 6, No 1: 99-103

WU Lianxi, LIANG Bo, LIU Xiaomei, et al. 2005. A Spectral Preservation Fusion Technique for Remote Sensing Images. Acta Geodaetica et Cartographica Sinica. Volume 34, No 2: 118-122,128

Ehlers M. 1991. Multisensor Image Fusion in Remote Sensing.

ISPRS Journal of Photogrammetry and Remote Sensing. NO 46: 19-30.

[12] Pouran Behnia. 2005. Comparison Between Four Methods for Data Fusion of ETM+ Multispectral and Pan Images. Geo-spatial Information Science. Volume 8, No 2: 98-103.

J.G.LIU. 2000. Smoothing Filter-based Intensity Modulation: a Spectral Preserve Image Fusion Technique for Improving Spatial Details. INT.J. REMOTE SENSING. Volume 21, No 18: 3461-3472.

Yun Zhang, Gang Hong. 2005. An IHS and Wavelet Integrated Approach to Improve Pan-Sharpening Visual Quality of Natural Colour IKONOS and Quick-Bird Images. Information Fusion. No 6: 225-234.

Yangrong Ling, Manfred Ehlers, E. Lynn Usery，et al. FFT-Enhanced IHS Transform Method for Fusing High-resolution Satellite Images. ISPRS Journal of Photogrammetry and Remote Sensing, Volume 61, Issue 6, February 2007, Pages 381-392

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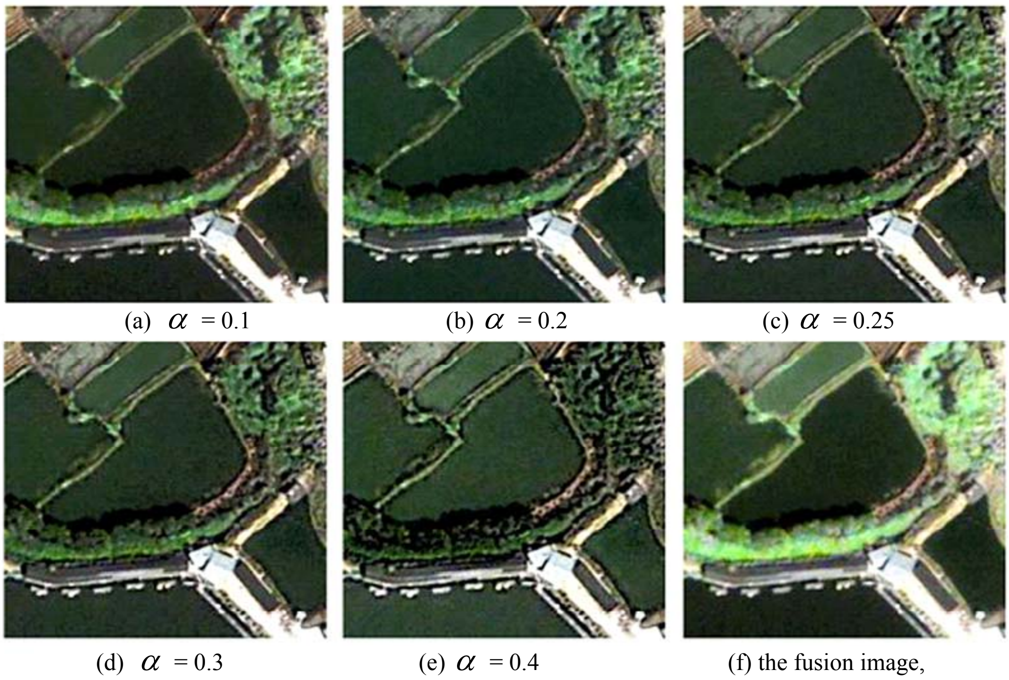

(a) α = 0.1 (b) α = 0.2 (c) α = 0.25

(d) α = 0.3 (e) α = 0.4 (f) the fusion image, IHS direct transform

Figure 1 The fusion images of different α values, before Visual-Pan band was improved((f)) and it has been improved((a) ～(e))

(a) $\omega_{Pan} = 1/2, \omega_1 = 1/2$.　(b) $\omega_{Pan} = 2/3, \omega_1 = 1/3$　(c) $\omega_{Pan} = 3/4, \omega_1 = 1/4$

(a) $\omega_{Pan} = 4/5, \omega_1 = 1/5$.　(b) $\omega_{Pan} = 5/6, \omega_1 = 1/6$　(f) the fusion image, IHS direct transform

Figure 2　fusion result of different ω_{Pan} and ω_1 values, linear weighted matching