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 $\alpha$ 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 $\alpha$ 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 0.445~0.90 $\mu$m, but corresponding multi-spectral imaging spectral coverage blue band is 0.45~0.52 $\mu$m, green band is 0.52~0.6 $\mu$m, red band is 0.63~0.69 $\mu$m, near infrared band is 0.76~0.90 $\mu$m. 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, in the near-infrared band performance for bright 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).

\[
\text{VisPan} = \text{pan} - \alpha \times \text{Nir}
\]

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

Table 1 shows that, along with $\alpha$ value enlargement, the fusion result's spectrum distortion value reduces first, when $\alpha = 0.3$ achieves the minimum value, then along with the $\alpha$ value increases gradually, the fusion result's spectrum distortion value starts to increase. Analyze the visual effect of the image, when $\alpha = 0.3$ (figure 1(d), (e)), presents the obvious noise in the waters. In the near-infrared band, the waters DN value is low,
when using larger $\alpha$ 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 $\alpha$ value, the vegetation part changes dark, the level is not easy to differentiate.

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>B</th>
<th>G</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>119.78082</td>
<td>144.40662</td>
<td>162.77995</td>
</tr>
<tr>
<td>0.20</td>
<td>116.07682</td>
<td>138.68528</td>
<td>161.51990</td>
</tr>
<tr>
<td>0.25</td>
<td>114.21042</td>
<td>137.39561</td>
<td>160.89520</td>
</tr>
<tr>
<td>0.30</td>
<td>113.58638</td>
<td>135.16046</td>
<td>156.13586</td>
</tr>
<tr>
<td>0.40</td>
<td>124.96372</td>
<td>142.26787</td>
<td>169.90991</td>
</tr>
<tr>
<td>0.50</td>
<td>133.67339</td>
<td>157.17514</td>
<td>173.59997</td>
</tr>
</tbody>
</table>

Table 1 Different Spectrum Distortion

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

$$I_R = \omega_{Pan}Pan + \omega_1I'$$

(2)

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

<table>
<thead>
<tr>
<th>Modulus</th>
<th>$\alpha$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>1/2</td>
<td>1/3</td>
</tr>
<tr>
<td>$\beta$</td>
<td>1/2</td>
<td>1/3</td>
</tr>
</tbody>
</table>

Table 2 $\alpha$ and $\beta$

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 $\overline{\nabla}$ 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.

<table>
<thead>
<tr>
<th>Combinatio n</th>
<th>Spectrum Distortion</th>
<th>Average Gradient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original image</td>
<td>4.7488</td>
<td>4.6795</td>
</tr>
<tr>
<td>(a)</td>
<td>105.8556</td>
<td>149.5825</td>
</tr>
<tr>
<td>(b)</td>
<td>113.7046</td>
<td>149.8244</td>
</tr>
<tr>
<td>(c)</td>
<td>118.0301</td>
<td>149.9365</td>
</tr>
<tr>
<td>(d)</td>
<td>119.6668</td>
<td>150.0118</td>
</tr>
<tr>
<td>(e)</td>
<td>121.0386</td>
<td>150.0458</td>
</tr>
<tr>
<td>IHS</td>
<td>133.6733</td>
<td>157.1751</td>
</tr>
</tbody>
</table>

Table 3 Spectrum Distortion and Average Gradient

We can see from Table 3 that along with the weight of pan-band ($\omega_{Pan}$) 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 $\omega_{Pan} = 3/4$, $\omega_1 = 1/4$.

### 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.

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Figure 1 The fusion images of different $\alpha$ values, before Visual-Pan band was improved((f)) and it has been improved( (a) ~ (e) )
Figure 2  fusion result of different $\omega_{\text{pan}}$ and $\omega_1$ values, linear weighted matching