A BAND RATIO APPROACH FOR CLASSIFICATION IN SHADED AREA

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ABSTRACT: The shadow effect is always a major problem for optical remote sensing images classification. This effect is occurred because of topography terrain or clouds, which may cause the same material classified into two different classes. One feature of shaded area in optical images is that the values of all bands are small and this property can provide useful information to reduce the shadow effect. The band ratio approach should play an important role to eliminate the shadow effect. In this study, we proposed the adjacent band ratio approach to reduce the shaded effect and also employ an unsupervised classification algorithm. The experiment result showed that, the ratio approach certainly has potential to improve the classification performance in shaded region.

1. INTRODUCTION

The topographic and cloud effect usually introduce shadow in remote sensing images (Fig. 1). Since the obstructing of sun light could cause the variation of spectra in shaded region and also causes some error in image classification (Schott, 1997). Hence, this is an important issue to reduce the shadow influence before image classification. There are several successful approaches to remove the shadow. Berbar and Gaber had used wavelet transform to merge two images by substitute the clouds and shadows to clear pixels (Berbar and Gaber, 2004). Chen et al. detected the clouds and shadows in a single image and search some pixels to replace them to produce a cloud free and seamless image by image pyramid approach (Chen et al., 2005). Drew et al. used flash and non-flash image pair to detect the flash and ambient shadows outlier pixels and reconstruct to a shadow free image (Drew et al., 2006). Campbell also employs the superior ability of microwave to detect the shaded region and then improve the classification performance for optical satellite images (Campbell, 1992). All of above works follow the principle to locate pixels under the shadows or clouds and replace them with some clear pixels. In this study, we like to deal with this problem from another point of view. It is based on the ratio between different bands in the same scene to eliminate the topography shadows (Crippen, 1988). It is showed that the same materials should scatter alone a line on the scatter plot with different levels of shaded effect. Our proposed algorithm adopts the band ratio approach to calibrate the pixels to reduce the shaded effect.
Our approach is use the band ratio to eliminate the shaded influence. After the band ratio process, we also apply the Principle Component Analysis (PCA) to remove the noisy ratio features and reduce the data dimensionality. The ratio features data will be then processed by an unsupervised classification algorithm. The Automatic Target Detection and Classification Algorithm (ATDCA, Ren and Chang, 2003) could eliminate the undesired target by Orthogonal Subspace Projection (OSP, Harsanyi and Chang, 1994). ATDCA could search for potential spectra on scatter plot as the endmembers in the images cube (ratio features). Owing to our approach is based on the linear mixture model, the subpixel classification can also be obtained by Least Square (LS) classifier. Our experimental results show that the shaded effect is diminished and the classification performance is improved as well.

2. METHODOLOGY

The shadows always have some character in remote sensing image spectral bands. When the pixel is under shadow, the reflectance of all bands is lower than the original spectra and this character can be considered to eliminate the shadow by a simple division. In this study, we adopt a well known ratio technique to calibrate the shaded region pixels to the normal magnitude. Our method selected the pairs of bands to divide to each other to eliminate the shaded influence and also produced the ratio features. After ratio process, we also use PCA to arise the SNR (Signal to Noise Ratio) of the ratio features. Finally, we employ ATDCA (Ren and Chang, 2003) to search for the endmembers and also use LS method to unmix the ratio features to obtain the abundance of each material (endmember) for classification.

2.1 Band Ratio Process

When the pixel is under shadow, all of the spectral values should have low value. Therefore, the ratio approach should able to lighten the shadow. However, the response between the shadow and non-shadow pixel may not the same in different wave length bands. Owing to this reason, we select the adjacent bands to divide each other to obtain the ratio features. Beside the ratio process, we also employ PCA (Principle Component Analysis) to gather most of the information to the few ratio features. By means of PCA the noisy ratio features could be removed and the SNR (Signal to Noise Ratio) could be improved and the dimensionality of the ratio features could be reduced.
2.2 ATDCA

The ratio features acquired from Band Ratio Process will be used to ATDCA for classification. The ATDCA is an unsupervised classification algorithm. The ATDCA (Ren and Chang, 2003) is based on OSP (Orthogonal Subspace Projection (Harsanyi and Chang, 1994) to eliminate the undesired signature and match for the desired signature. ATDCA also search for the pixel with maximum length from the images as the first potential endmember, and then project all data points to its orthogonal subspace to eliminate this pure pixel spectrum. After that, the second potential endmember is extracted with the maximum magnitude in this subspace. This procedure is repeated to search for the rest potential endmembers.

2.3 Unmixing

In this study, we assume all the data points should fit with the linear mixture model (Fig. 1). As shown in the following equation, the data point \( r \) can be composed by the materials endmembers spectra \( M \), materials abundance \( \alpha \) and noise \( n \).

\[
r = M \ast \alpha + n
\]

After the radial projection (section 2.2) all the data points had been projected between the two endmembers. We use the LS method to unmix the projected pixel spectra by endmembers, the abundance of each material could be obtained.

\[
\alpha = (M^T \ast M)^{-1} \ast M^T \ast r
\]

3. EXPERIMENTAL RESULT

A Hyperion Hyperspectral image scene in mountain region had been chosen for experiment. Due to the topographic effect in mountain region the shaded area can be easily observed (Fig. 1).

3.1 Hyperspectral images

The Hyperion Hyperspectral image have 242 spectral bands (355 nm ~ 2,577 nm) from Visible to Short Wave Infrared light, and the spatial resolution is 30 meters. After remove the water absorbed and noisy bands, we only use 106 bands to analyze shadow effect and classification (Fig. 1).

![True Color Image](image)

**Figure 1.** Hyperion image in mountain region of south Taiwan. The true color image is stacked by the averaging of the corresponding bands of the three primary colors (red, green, blue).
3.2 ATDCA result

Figure 2 shows the classification result of ATDCA. It is obvious that the shadow had been strongly interfered of the classified result. Especially in the vegetation classes, the area of vegetation is hard to identify.

3.3 Band Ratio Process result

Since the shadow had affected the classification performance significantly, in this study, we proposed Band Ratio Process to reduce the shaded influence. The Band Ratio Process only selected the adjacent bands to figure the ratio features. In this study, we produced 105 ratio features. Followed by PCA, we extract 50 features for classification. After Band Ratio Process, we also employ ATDCA to classify the ratio features. Figure 3 shows the classified result, the topographic shadow effect of vegetation had been removed and the distribution of vegetation is easy to be identified. The river and soil had also been classified clearly.

Figure 3. The Band Ratio Process classification result. (d) should be the river, soil and village. (f) represents the vegetation distribution.
4. DISCUSSION AND CONCLUSION

We develop an algorithm to reduce the shadow effect and try to improve the classification performance. Our approach utilized the adjacent band ratio to reduce the topographic shadow influence. Experimental result shows that our method can successfully reduce the shadow effect and improved the performance for classification. However, further investigation is required to find a better way to select the ratio bands to identify the materials more precisely.

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REFERENCES


