

Spectral Characteristics and Classification of the Floating Macroalgae in the Yellow Sea

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Abstract

Both the green tide caused by the outbreaks of *Ulva prolifera* and the golden tide caused by the outbreaks of *Sargassum* have appeared in the Yellow Sea and the East China Sea in recent years (Xing *et al*, 2017). The spectral characteristics of floating macroalgae are the basis for the remote detection by optical satellite remote sensing. A total of 10 samples of *Ulva prolifera* and *Sargassum* were collected from June 9, 2017 to June 19, 2017 in the Yellow Sea (33° 37' ~ 36° 30' N, 120° 00' ~ 123° 30' E). The spectral reflectance of them were measured by a hyperspectral spectroradiometer and a multi-spectral imager, respectively. The hyperspectral data was used to analyze spectral characteristics. The threshold method and neural network method based on the multi-spectral image were tested for the classifying of *Ulva prolifera* and *Sargassum*.

In this work, the Virtual-Baseline Floating macroAlage Height (VB-FAH) was calculated for extracting the floating macroalgae (Xing *et al*, 2016). The reasonable threshold was chosen for the classifying of the two macroalgae based on the trough depth (T-depth) and the Virtual-Baseline Floating macroAlage Height (VB-FAH) (Xing *et al*, 2013). And the pixel is regard as *Ulva prolifera* if the value of T-depth is larger than 0.30 or the value of VB-FAH is larger than 0.44. For the neural network method, we did 3 tests with different inputs: the 3-band reflectance image (Image_R), the 3-band reflectance and the T-depth (Image_{R+T-depth}), the 3-band reflectance and the VB-FAH (Image_{R+VB-FAH}). The classification results of the above two methods were compared.

Table 1 Sampling records

Floating macroalgae	Samples
<i>Sargassum</i>	01、04、05、06
<i>Ulva prolifera</i>	02、03、07、08、09、10

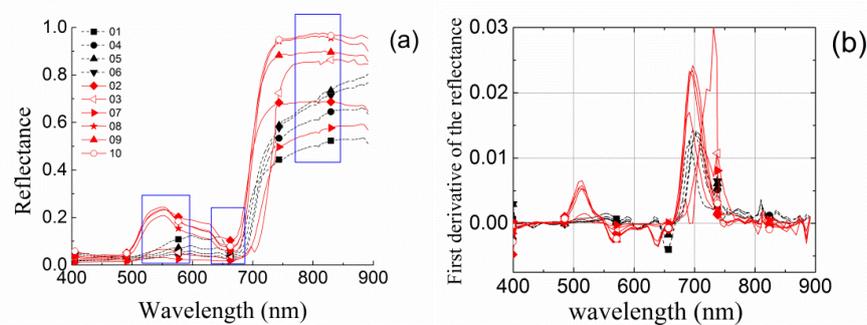


Fig.1. (a) The hyperspectral reflectance of floating macroalgae; (b) First derivative of the spectral reflectance. The red and black lines represents the *Ulva prolifera* and the *Sargassum*, respectively. The blue frame represents the corresponding band range of the multispectral imager.

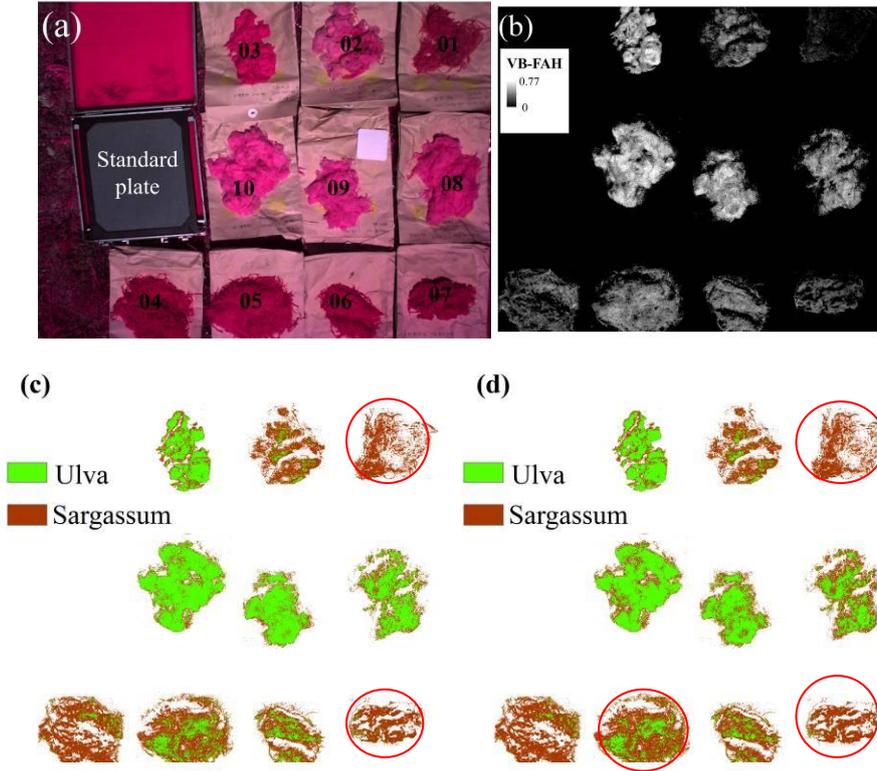


Fig.2. (a) The multi-spectral reflectance image with NIR, Red and Green combination based on the multispectral imager. (b) The macroalgae extraction result by VB-FAH; (c) and (d) are the classification result obtained by the threshold method: (c) T-depth (0.30); (d) VB-FAH (0.44). The sample marked by the red circle is the one with less than 50% accuracy.

Table 2 The accuracy of each sample (%)

		T-depth	VB-FAH
<i>Sargassum</i>	01	99.82↑	99.46
	04	84.02↓	85.55
	05	50.79↑	48.67
	06	52.06↓	53.35
	Mean	71.67↓	71.76
<i>Ulva prolifera</i>	02	22.58↓	29.23
	03	82.02↓	85.82
	07	13.87↑	9.15
	08	79.64↑	70.27
	09	84.81↑	83.15
	10	88.32↑	87.66
	Mean	61.87↑	30.88

Note: ‘↑’ represents that the accuracy of T-depth is higher than that of VB-FAH, and ‘↓’ is the opposite. The formula of calculated accuracy: $A = N_{\text{classify}_i} / N_{\text{total}_i}$, where A is the classification accuracy, N_{classify_i} is the sum of the *Ulva* or *Sargassum* pixels classified correctly of each sample, N_{total_i} is the total number of *Ulva* or *Sargassum* pixels of each sample extracted by the VB-FAH, i is the sample number.

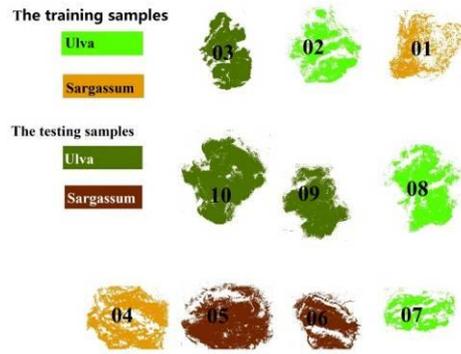


Fig.3. The training samples and the testing ones

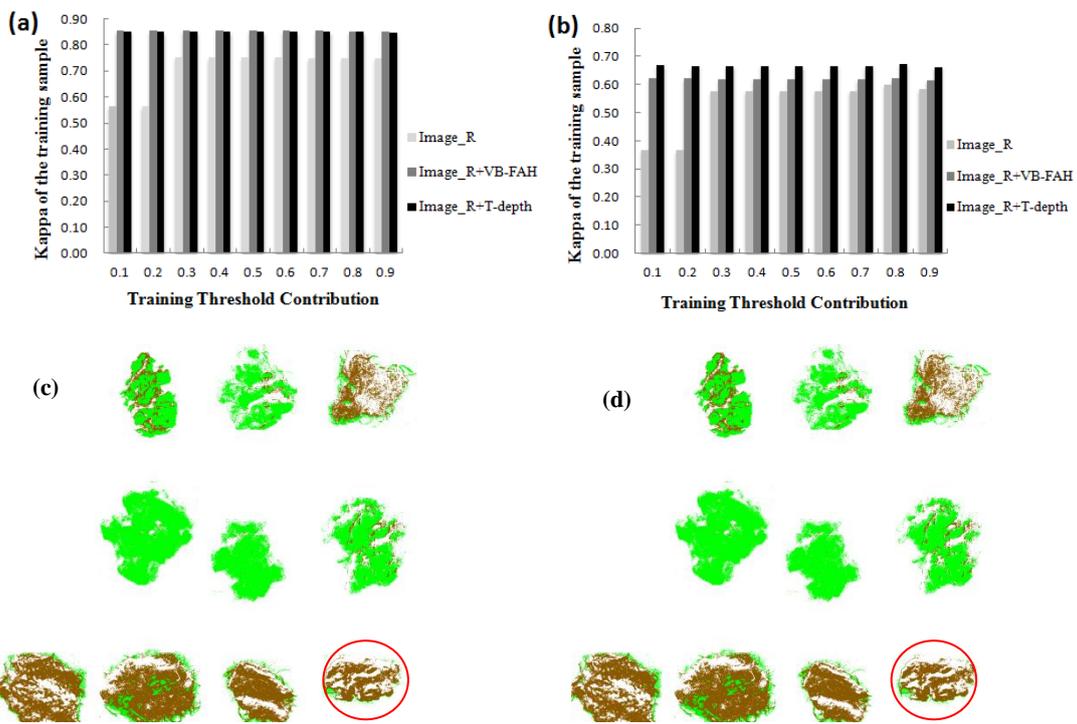


Fig. 4. Comparison of Kappa of neural network classification results. (a) Kappa of the training samples; (b) Kappa of the testing samples. The neural network classification results: (c) Image_{R+VB-FAH}; (d) Image_R, Image_{R+T-depth} and Image_{R+VB-FAH} represents the multispectral reflectance image, the composited image of reflectance and the T-depth and the composited image of reflectance and the VB-FAH, respectively.

References

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