

EVALUATION OF CONVENTIONAL DIGITAL CAMERA SCENES FOR THEMATIC INFORMATION EXTRACTION

H. S. Lim, M. Z. MatJafri and K. Abdullah

School of Physics
Universiti Sains Malaysia,
11800 Penang

ABSTRACT

A study was carried out to assess the capability of a personal digital camera to provide useful remotely sensed images for land cover mapping. A Kodak DC290 digital camera was employed to capture images of several test sites. The airborne platform used in this study was a light aircraft, Cessna172Q, flown at an average altitude of 8000 ft above sea level during image acquisitions. The standard supervised classification techniques, such as the maximum likelihood, minimum distance-to-mean and parallelepiped, were applied to the multispectral images consisted of red, green and blue bands. Training sites were selected within each scene and five land cover classes were assigned to each classifier. The relative performance of the techniques was evaluated. The accuracy of each classification map was assessed using the reference data set consisted of a large number of samples collected per category. The study revealed that the maximum likelihood classifier produced superior result and achieved a high degree of accuracy. The preliminary result indicates that a conventional digital camera can be a useful tool for remote sensing.

Introduction

The increasing availability of remote-sensing images, acquired periodically by satellite sensors on the same geographical area, makes it extremely interesting to develop the monitoring systems capable of automatically producing and regularly updating land-cover maps of the considered site (Bruzzone, et al., 2002). Airborne remote sensing was selected in this present study because of several reasons. First was the airborne images can provides higher spatial resolution for mapping a small study area. Second was the airborne data acquisition can be carried out according to our planned surveys. It's not like the satellite data was fixed on time of satellite overpass the study area only. Third, for airborne remote sensing, atmospheric correction was not need to apply to the analysis data because atmospheric correction only improves R^2 and RMS significantly for turbidity, this is an advantage since one step of the retrieval process can be eliminated (Koponen, et al., 2002). The objective of this study is to investigate the potentiality of using digital camera imagery for land cover mapping. In this study, images captured from a digital camera were used for land cover mapping. Supervised classification methods were applied to the digital images. Many researchers used the Maximum Likelihood method in their study (Donoghue and Mironnet, 2002). The monitoring task can be accomplished by supervised classification techniques, which have proven to be effective categorization tools (Bruzzone, et al., 2002). Accuracy assessment also has been done in this study.



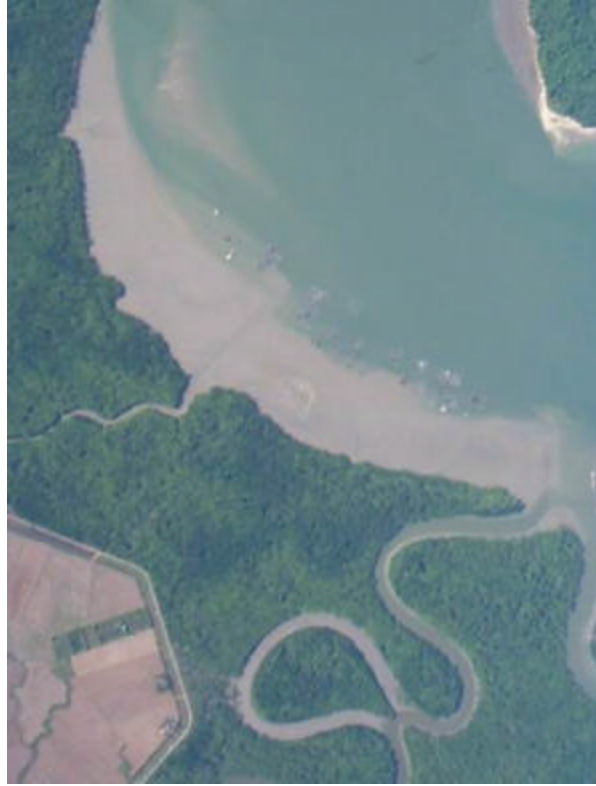
Source: Microsoft Corp., 2001.

Figure 1. The study area

Merbok River estuary was chosen as the study area in this study. The study area is located at latitude 5° 39' N to 5° 41' N and longitude 100° 20' E to 100° 24' E (Figure 1). The images were captured from a light aircraft flying at an altitude of 8000 feet on 9 March 2002.

Data Analysis And Result

The size of the airborne colour digital images used in this study of the Merbok River estuary, Kedah is 1200 pixels by 1792 lines namely Area A, Area B and Area C (Figure 2). Three supervised classification methods were performed to the digital images (Maximum Likelihood, Minimum Distance-to-Mean, and Parallelepiped). Training sites were needed for supervised classification and selected based on the colour in present study. The digital image was classified into 4 classes, such as water, forest, land and urban. Accuracy assessment was done in this study to compute the probability of error for the classified map. A total of 200 samples were chosen randomly for the accuracy assessment. Many methods of accuracy assessment have been discussed in remote sensing literatures. Three measures of accuracy were tested in this study, namely overall accuracy, error matrix and Kappa coefficient. In thematic mapping from remotely sensed data, the term accuracy is used typically to express the degree of 'correctness' of a map or classification (Foody, 2002). Figure 3 shows the flow chart for data processing of the images.



(a) Area A



(b) Area B



(c) Area C

Figure 2: Digital images used in image classification

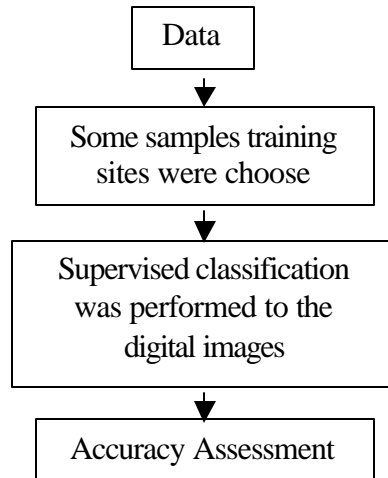


Figure 3: Flow chart for data processing of the images

(A) Area A

Kappa coefficient and overall accuracy results of the three measures of accuracy are shown in Table 1. The overall accuracy is expressed as a percentage of the test-pixels successfully assigned to the correct classes. The results obtained are presented in Tables 1, 2 and 3, where the overall classification accuracy, the confusion matrix and the accuracy of each class using Maximum Likelihood, minimum distance-to-mean and parallelepiped classification are given, respectively. From the present analysis, one can see that the Maximum Likelihood classifier produced the best image classification accuracy with the highest overall accuracy and Kappa coefficient. The overall classification accuracies achieved by the proposed Maximum Likelihood classifier on the digital image is 92.00 %. This followed by the Minimum Distance-to-Mean with the overall classification accuracy of 85.50%, and Parallelepiped resulted in the overall classification accuracy of 67.00%. A classified image using Maximum Likelihood classifier is shown in Figure 4.

Table 1: The overall classification accuracy and Kappa coefficient

Classification method	Overall classification accuracy (%)	Kappa coefficient
Maximum Likelihood	92.00	0.884
Minimum Distance-to-Mean	88.50	0.832
Parallelepiped	67.000	0.561

Table 2: The confusion matrix results

Classified Data	Reference Data				
	Forest	Water	Turbid Water	Land	Total
Forest	72	2	0	1	75
Water	3	65	3	1	72
Turbid Water	0	4	33	1	38
Land	0	0	0	14	15
Total	76	71	36	17	200

Table 3: The accuracy of each class using Maximum Likelihood classification.

Class	Maximum Likelihood	
	Producer Accuracy (%)	User Accuracy (%)
Forest	94.737	96.000
Water	91.549	90.278
Turbid Water	91.667	86.842
Urban	82.353	93.333

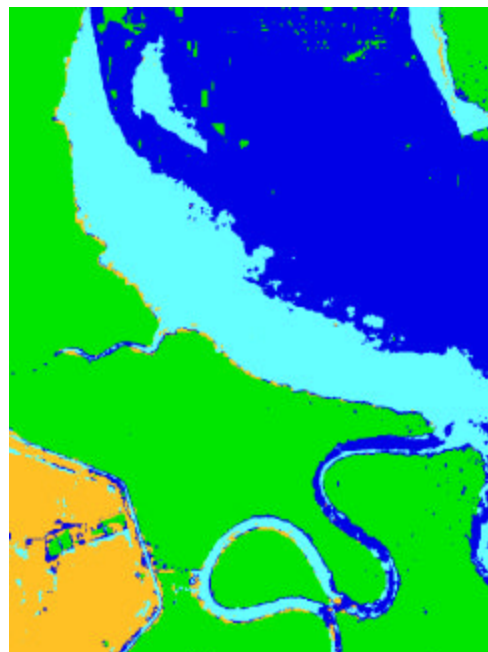


Figure 4: The classified image obtained using Maximum Likelihood classifier for Merbok River estuary (Green = Forest, Blue = Water, Orange = Land, and Light Blue = Turbid Water)

(B) Area B

The Kappa coefficient and overall accuracy value for the three-classification technique are shown in Table 4. The others accuracy assessment results are presented in Tables 5 and 6, where the Kappa coefficient, the confusion matrix and the accuracy of each class using Maximum Likelihood, minimum distance-to-mean and parallelepiped classification are given, respectively. From the present analysis, one can see that the Maximum Likelihood classifier produced the best image classification accuracy with the highest overall accuracy and Kappa coefficient. The overall classification accuracies achieved by the proposed Maximum Likelihood classifier on the digital image is 95.00 %. This followed by the Minimum Distance-to-Mean with the overall classification accuracy of 73.00%, and Parallelepiped resulted in the overall classification accuracy of 1.00%. A classified image using Maximum Likelihood classifier is shown in Figure 5.

Table 4: The overall classification accuracy and Kappa coefficient

Classification method	Overall classification accuracy (%)	Kappa coefficient
Maximum Likelihood	95.000	0.866
Minimum Distance-to-Mean	73.000	0.457
Parallelepiped	1.000	0.008

Table 5: The confusion matrix results

Classified Data	Reference Data				
	Grass	Water	Land	Urban	Total
Grass	21	1	0	0	22
Water	0	154	1	0	155
Land	2	2	12	4	20
Urban	0	0	0	3	3
Total	23	157	13	7	200

Table 6: The accuracy of each class using Maximum Likelihood classification.

Class	Maximum Likelihood	
	Producer Accuracy (%)	User Accuracy (%)
Grass	91.304	95.455
Water	98.089	99.355
Land	92.308	60.000
Urban	42.857	100.000

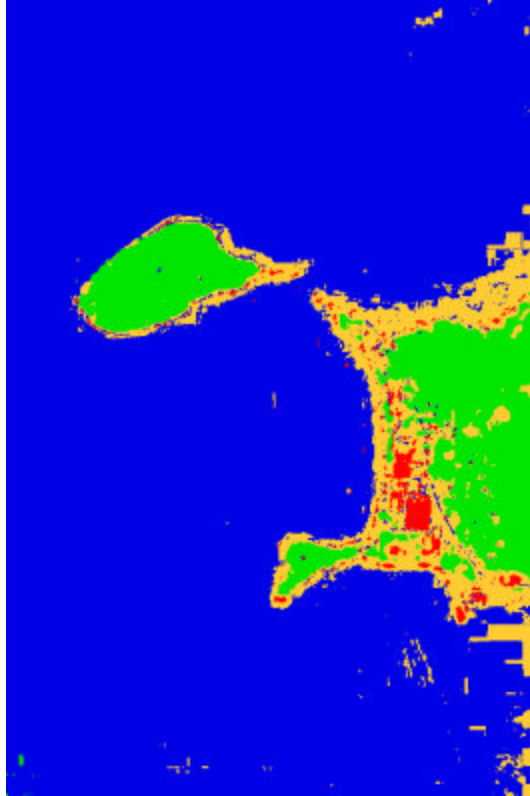


Figure 5: The classified image obtained using Maximum Likelihood classifier for Merbok River estuary (Green = Forest, Blue = Water, Orange = Land, and Red =Urban)

(C) Area C

The Kappa coefficient and overall accuracy value for the three-classification technique are shown in Table 7. The others accuracy assessment results are presented in Tables 8 and 9, where the Kappa coefficient, the confusion matrix and the accuracy of each class using Maximum Likelihood, minimum distance-to-mean and parallelepiped classification are given, respectively. From the present analysis, one can see that the Maximum Likelihood classifier produced the best image classification accuracy with the highest overall accuracy and Kappa coefficient. The overall classification accuracies achieved by the proposed Maximum Likelihood classifier on the digital image is 79.50 %. This followed by the Minimum Distance-to-Mean with the overall classification accuracy of 76.50%, and Parallelepiped resulted in the overall classification accuracy of 10.00%. A classified image using Maximum Likelihood classifier is shown in Figure 6.

Table 7: The overall classification accuracy and Kappa coefficient

Classification method	Overall classification accuracy (%)	Kappa coefficient
Maximum Likelihood	79.50	0.70
Minimum Distance-to-Mean	76.50	0.652
Parallelepiped	10.00	0.069

Table 8: The confusion matrix results

Classified Data	Reference Data				
	Grass	Water	Land	Urban	Total
Grass	59	2	3	1	65
Water	5	72	10	2	89
Land	1	1	22	3	27
Urban	2	2	9	6	19
Total	67	77	44	12	200

Table 9: The accuracy of each class using Maximum Likelihood classification.

Class	Maximum Likelihood	
	Producer Accuracy (%)	User Accuracy (%)
Grass	88.060	90.769
Water	93.506	80.899
Land	50.000	81.481
Urban	50.000	31.579

Conclusion

In this study, Maximum Likelihood was the best classifier to extract thematic information from remote sensed imagery. The high spatial resolution images gave a more detail deposition mapping of the classified map. So it is good for a small coverage of study area. From the result of the accuracy assessment, we were quite confident of the classified shown. Digital camera imagery provides a cheaper way to acquired remote sensed imagery for land cover mapping.

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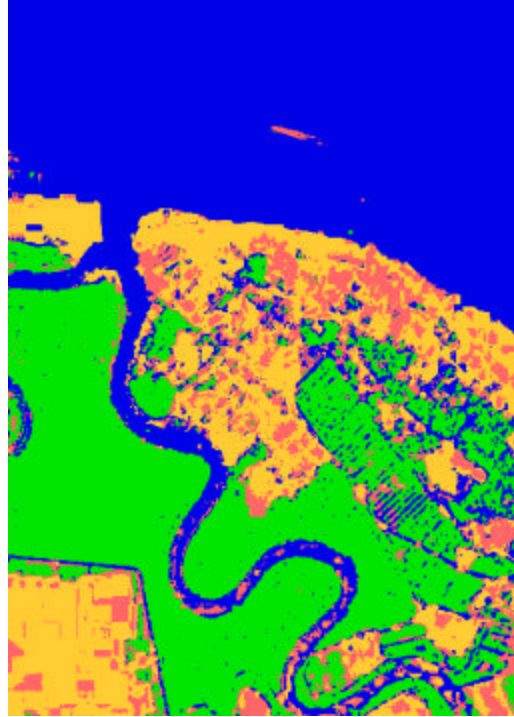


Figure 6: The classified image obtained using Maximum Likelihood classifier for Merbok River estuary (Green = Forest, Blue = Water, Orange = Land, and red = Urban)

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