



UNIVERSITI PUTRA MALAYSIA

**EFFECTS OF DATA TRANSFORMATION AND CLASSIFIER
SELECTIONS ON URBAN FEATURE DISCRIMINATION USING
HYPERSPETRAL IMAGERY**

MUHAMAD AFIZZUL BIN MISMAN

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By

MUHAMAD AFIZZUL BIN MISMAN

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
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Master of Science**

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EFFECTS OF DATA TRANSFORMATION AND CLASSIFIER SELECTIONS ON URBAN FEATURE DISCRIMINATION USING HYPERSPECTRAL IMAGERY

By

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May 2012

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Hyperspectral remote sensing has been used in various applications which include urban applications. Classifying hyperspectral remote sensing data from urban environments is challenging due to spectrally heterogeneous materials with similar spectral properties. There is a lack of studies on the use of hyperspectral technology in urban mapping in Malaysia although it has widely been used in other countries. The selection of mapping techniques in classification which is the selection of data transformation and classifier selections are very essential to acquire maximum mapping accuracy. This research was conducted to study the effects of data transformation and classifier selections in urban feature discrimination using hyperspectral imagery. Two techniques of data transformation are tested in this study which are the spectral derivative and wavelet transformations. Various wavelet parameters which are the selection of wavelet transformation techniques, mother

wavelets, number of vanishing moments and scale or level decompositions have been tested in this study. The selection of classifiers such as Minimum Distance to Mean, Spectral Angle Mapper and Support Vector Machine are also tested in this study. The performance of each parameter tested in this study is assessed through their classification accuracy. McNemar statistical test is used to test the significance difference between two classification results. Three hyperspectral images from two different sensors are tested in this study which are two images came from AisaEAGLE sensor while the other image acquired by AISA CLASSIC sensor. The results show that each transformation parameter and classifier selected gave different results. The classification accuracy derived from derivative transformation is lower than the classification accuracy of reflectance. The right selection of wavelet transformation parameters can give maximum classification accuracy. There is no best wavelet transformation parameters can be determined since the best wavelet transformation parameters of all images are different. Classification using Support Vector Machine gave better accuracy than other classifiers for all images and more robust as it is not affected by the types of data used. The results clearly show the advantages of the Support Vector Machine and wavelet-based data in terms of accuracy. They significantly outperform the other method and achieve overall higher accuracies. Thus, both methods can be considered attractive and useful for the classification of urban hyperspectral data. Wavelet based images of *rbio2.2* (Scale-8 CWT) of first data set and *bior2.8* (Scale-16 CWT) of second data set, and reflectance image of third data set gave highest classification accuracies using SVM classifier which are 96%, 98.4% and 98.4%.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**KESAN-KESAN PEMILIHAN TRANSFORMASI DATA DAN KAEDAH
PENGKELASAN DALAM MEMBEZAKAN BUTIRAN-BUTIRAN DI
BANDAR MENGGUNAKAN IMEJ HIPERSPEKTRAL**

Oleh

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Penderiaan jauh hiperspektral telah banyak digunakan dalam pelbagai aplikasi termasuklah aplikasi pemetaan kawasan bandar. Pemetaan kawasan bandar menggunakan data hiperspektral adalah mencabar kerana setiap butiran mempunyai pembalikan spectral yang hampir sama. Walaupun ia telah banyak digunakan di luar negara, namun kurangnya kajian-kajian penggunaan teknologi hiperspektral bagi pemetaan bandar di Malaysia telah dilakukan. Teknik pemetaan dalam proses klasifikasi iaitu pemilihan bentuk data dan teknik pengkelasan yang tepat adalah amat penting bagi mendapatkan hasil ketepatan yang paling maksimum. Kajian ini dijalankan bagi mengkaji kesan terhadap hasil ketepatan pengkelasan bagi pemilihan transformasi data dan kaedah pengkelasan dalam membezakan butiran-butiran di bandar menggunakan imej hiperspektral. Dua teknik transformasi telah diuji dalam kajian ini iaitu transformasi *derivative* dan transformasi *wavelet*. Pelbagai parameter-parameter bagi transformasi *wavelet* telah dijalankan dalam kajian ini iaitu pemilihan

teknik transformasi, *mother wavelet*, *vanishing moment* dan tahap dekomposisi bagi transformasi *wavelet* dikaji. Dalam pemilihan teknik klasifikasi pula, tiga kaedah pengkelasan telah diuji iaitu *Minimum Distance to Mean*, *Spectral Angle Mapper* dan *Support Vector Machine*. Perbandingan hasil ketepatan pengkelasan bagi setiap pemilihan teknik pengkelasan dibuat bagi menilai prestasi setiap parameter yang dikaji. Ujian statistik McNemar digunakan dalam kajian ini bagi membandingkan signifikansi diantara dua hasil pengkelasan daripada dua parameter yang berbeza. Tiga set imej hiperspektral digunakan dalam kajian ini iaitu dua set imej dari penerima AisaEAGLE dan satu set imej dari penerima AISA. Hasil kajian menunjukkan bahawa setiap pemilihan parameter transformasi dan teknik pengkelasan yang berbeza memberikan hasil ketepatan yang berbeza. Bagi pengkelasan menggunakan data transformasi *derivative*, ia memberikan hasil pengkelasan yang lebih rendah berbanding data asal. Pemilihan parameter *wavelet* yang tepat memberikan hasil ketepatan yang maksimum. Melalui perbandingan antara parameter transformasi *wavelet* terbaik bagi setiap imej hiperspektral, tiada parameter transformasi *wavelet* yang spesifik yang terbaik dapat ditentukan kerana setiap transformasi *wavelet* terbaik bagi setiap imej hiperspektral adalah berbeza. Pengkelasan menggunakan teknik klasifikasi *Support Vector Machine* memberikan hasil klasifikasi yang lebih baik dan konsisten berbanding teknik klasifikasi yang lain kerana ia tidak memberi kesan yang besar terhadap jenis data input yang digunakan. Hasil kajian ini jelas menunjukkan bahawa teknik klasifikasi *Support Vector Machine* dan data berasaskan *wavelet* memberikan kelebihan dalam pengkelasan yang lebih tepat. Maka kedua-dua kaedah ini boleh digunakan dalam pengkelasan kawasan bandar menggunakan data hiperspektral. Ketepatan pengkelasan yang maksimum dicapai dengan menggunakan kaedah *Support Vector Machine* bagi imej *rbio2.2* (Skala-8 CWT) dan *bior2.8*

(Skala-16 CWT) bagi set data pertama dan kedua dan imej pembalikan spektral bagi set data ketiga adalah 96%, 98.4% dan 98.4%.



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I certify that a Thesis Examination Committee has met on 11 May 2012 to conduct the final examination of Muhamad Afizzul bin Misman on his thesis entitled **“Effects of Data Transformation and Classifier Selections on Urban Feature Discrimination using Hyperspectral Imagery”** in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Master of Science (GIS and Geomatic Engineering).

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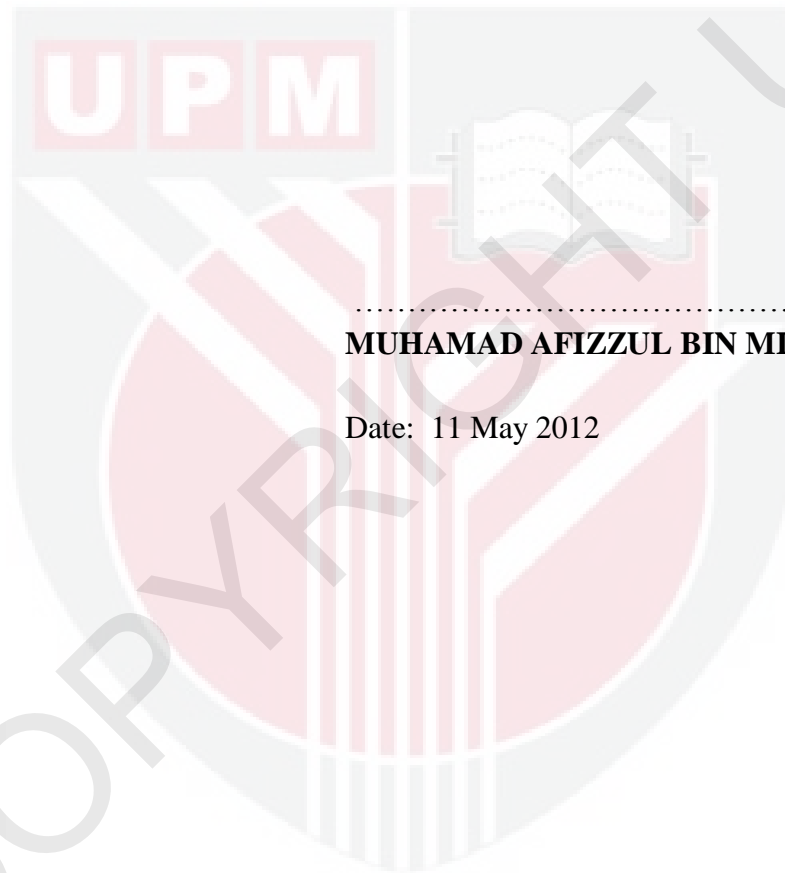
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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledge. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



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