

Material Class Mapping By Reflectance Matching Of Hyper/multispectral Imagery

A Dissertation submitted towards the partial fulfilment of
the requirement for the award of degree of

**Master of Technology
in
Signal Processing & Digital Design**

Submitted by
Rishi Patel
2K15/SPD/13

Under the supervision of
Dr. N.S. RAGHAVA
(Professor, Department of ECE)



**Department of Electronics & Communication Engineering
Delhi Technological University
(Formerly Delhi College of Engineering)
Delhi-110042
2015-2017**



DELHI TECHNOLOGICAL UNIVERSITY

Established by Govt. Of Delhi vide Act 6 of 2009

(Formerly Delhi College of Engineering)

SHAHBAD DAULATPUR, BAWANA ROAD, DELHI-110042

CERTIFICATE

This is to certify that the dissertation title “**Material Class Mapping By Reflectance Matching Of Hyper/multispectral Imagery**” submitted by **Mr. RISHI PATEL, Roll. No. 2K15/SPD/13**, in partial fulfilment for the award of degree of Master of Technology in “**Signal Processing and Digital Design (SPDD)**”, run by Department of Electronics & Communication Engineering in Delhi Technological University during the year 2015-2017, is a bonafide record of student’s own work carried out by him under my supervision and guidance in the academic session 2016-17. To the best of my belief and knowledge the matter embodied in dissertation has not been submitted for the award of any other degree or certificate in this or any other university or institute.

Dr. N.S. RAGHAVA

Supervisor

Professor (ECE)

Delhi Technological University

Delhi-110042

DECLARATION

I hereby declare that all the information in this document has been obtained and presented in accordance with academic rules and ethical conduct. This report is my own work to the best of my belief and knowledge. I have fully cited all material by others which I have used in my work. It is being submitted for the degree of Master of Technology in Signal Processing & Digital Design at the Delhi Technological University. To the best of my belief and knowledge it has not been submitted before for any degree or examination in any other university.

Rishi Patel
M. Tech. (SPDD)
2K15/SPD/13

Date: JULY, 2017

Place: Delhi Technological University, Delhi

ACKNOWLEDGEMENT

I owe my gratitude to all the people who have helped me in this dissertation work and who have made my postgraduate college experience one of the most special periods of my life.

Firstly, I would like to express my deepest gratitude to my supervisor Dr Prof.. N.S. RAGHAVA, Professor (ECE) for his invaluable support, guidance, motivation and encouragement throughout the period during which this work was carried out.

I also wish to express my heart full thanks to my classmates especially ARUN, as well as staff at Department of Electronics & Communication Engineering of Delhi Technological University for their goodwill and support that helped me a lot in successful completion of this project.

Finally, I want to thank my parents, family and friends for always believing in my abilities and showering their invaluable love and support.

RISHI PATEL
M. Tech. (SPDD)
2K15/SPD/13

ABSTRACT

The main objective of this study is material mapping in hyperspectral image with the help of spectral reflectance matching. Presence of reflectance curve is the heart and soul of any operation performed, considering hyperspectral imagery. Certain material shows unique or characteristic reflectance plot known as signature plot or footprint within the range of spectrum. This feature of Hyperspectral image is exploited in case of material mapping. Visible materials like road, plantation, rooftops etc or even invisible materials like, soil constituents (carbonates, Na, K salts, water presence) or even the presence of ores of minerals (e.g. cuprite, alunite) beneath the surface of the earth can be predicted with sufficient accuracy. Hyperspectral data pose challenges to image interpretation, because of the need for calibration, redundancy in information, and high data volume due to large dimensionality of the feature space.

In this project, hyperspectral image classification, band reduction and new technique for hyperspectral image classification is proposed and implemented. Both visual and quantitative results are calculated with the help of matlab. This project also designs a basic toolbox in MATLAB for processing and classification of hyperspectral image. Processing of hyperspectral image is divided into five modules, each performing specific operation. First, Acquisition of hyper-multispectral image and display of its basic properties. Second, Formulation of classes with the help of user selecting points over displayed hyper-multispectral image. For the images in which signature reflectance library is already available user help for the selection of spectral signature is not required. Third, Reduction of Dimension of hyperspectral image up to user specified number of bands and calculation of the amount of information lost. Fourth, Material class mapping by reflectance Matching of hyper\multispectral image using traditional SAS, SDS, SCS deterministic approach. New method proposed for material classification over traditional SAS, SDS, SCS approach, (regression transform is used over reflectance curve to obtained separate regression distance class matrix) displaying the result using windowing technique and enhancing the output using Floyd dithering technique. Fifth, this part calculates the number of pixels, amount of area classified under each class, processing time, accuracy comparison between traditional and proposed techniques.

Proposed method shows considerable improvement both visually and quantitatively over previous method. For the data set downloaded who's ground truth is not available, pictorial result is shown and quantitative analysis is done for the images with ground truth present.

INDEX

<i>Certificate</i>		<i>I</i>
<i>Declaration</i>		<i>Ii</i>
<i>Acknowledgement</i>		<i>Iii</i>
<i>Abstract</i>		<i>Iv</i>
<i>Index</i>		<i>V</i>
<i>List of figures</i>		<i>Viii</i>
<i>List of abbreviations</i>		
1	Introduction	1
	1.1 Hyper/multispectral imaging	1
	1.1.1 Spectral image basics	2
	1.1.2 Hyperspectral image sensors	4
	1.1.3 Hyperspectral data acquisition	4
	1.1.4 Motivation behind the use of hyperspectral imagery	5
	1.2 Endmember detection and class selection	5
	1.3 Band selection	6
	1.4 Problem statement	6
	1.5 Overview of the research	7
2	Literature review	8
	2.1 Existing hyperspectral image classification technique	8
3	Methodological approach	13

3.1.	Review of SAS, SDS, SCS classifier	13
3.1.1	Spectral distance classifier	14
3.1.2	Spectral correlation classifier	14
3.1.3	Spectral angle classifier	14
3.1.4	Algorithm	15
3.1.5	Flowchart	16
3.2	Hyper/multispectral dimension reduction using principal component analysis	17
3.2.2	Implementation of pca on N-D database algorithm	17
3.2.3	Flowchart	19
3.3	Review of regression transformation or projection algorithm	20
3.3.1	Algorithm of regression transform on hyperspectral image	21
3.2.2	Flowchart	24
3.4	Windowing technique	25
4	Results	27
4.1	Class selection	29
4.2	Band reduction results	31
4.3	Classifier results	32
4.4	Evaluation matrix	35
4.4.1	Confusion matrix	35
4.4.2	Precision	36
4.2.3	Recall	36

4.2.4	F-1 Score	36
4.2.5	Accuracy	36
4.5	Confusion matrix creation	37
4.5.1	Confusion matrix	37
4.5.2	Precision, recall, F 1 score	37
4.5.3	Accuracy	37
5	Conclusion and future work	39
	References	40

LIST OF FIGURES

1	Multi/hyperspectral data comparison	1
---	-------------------------------------	---

2	Difference between multispectral and hyperspectral	2
3	Electromagnetic spectrum	2
4	Reflectance plot	3
5	Reflectance of materials	3
6	Hyperspectral image acquisition	4
7	Spectral Reflectance curve of material	6
8	Block diagram of Bayesian classification	9
9	Bayesian class	10
10	Classification flow diagram	11
11	Classified image	11
12	SAS, SDS, SCS classified image	12
13	Pixel vector notation	13
14.1	Projection dimension reduction	17
14.2	Hyperspectral data matrix	17
15	Classified image matrix	25
16-17	Windowing technique	26
18	Graphical user interface	27
19,20,21	Selection of roads, rooftops, plantation	29
22	Reflectance curve of selected class	30
23,24,25,26	Band reduction results	31
27	Test images	32
28-34	Test results	33,34
35	Confusion matrix	35
36	Confusion matrix table	37

LIST OF ABBREVIATIONS

2.1	Cohen et al.'s system performance	25
2.2	Bartlett et al.'s system performance	26
2.3	Zheng et al.'s system performance	30

2.4	Wang and Yin's system performance	34
4.1	Precision, recall and F1-score of result	51
4.2	Results of emotion recognition system using machine learning techniques	52