Object Based Classification Based on Hyperspectral AVIRIS Data

1.Purpose: In my project, I evaluate the performance of the AVIRIS sensor using object based classification for delineating landcover to a specific thematic map using a set of classes. Validation of the classification map from object based algorithms was performed through error matrix statistics which are used for evaluating the assessment accuracy using the values of overall accuracy, user's accuracy, producer's accuracy and Kappa statistic.

2.Data: the remote sensing data I use is collected from the AVIRIS hyperspectral sensor which has nearly the highest spectral resolution and spatial resolution, acquiring spectral information of Earth's surface objects in **224** spectral bands in an extremely high spatial resolution of **0.8** m. the original data (Fig.1, Left) was captured in Galveston, Huston, TX at 16:46, 9/2/2010.

3.Methodology

3.1Data preprocessing

All of preprocessing of the AVIRIS imagery was carried out using ENVI (v. 5.1) image processing software. Hyperspectral sensors should be spectrally and radiometrically calibrated before you analyze their data. NASA/JPL has already processed the AVIRIS data to remove geometric and radiometric errors associated with the motion of the aircraft used during data collection. However, the data should be further corrected using FLAASH (Fig.1 Mid) for atmospheric effects and converted to surface reflectance prior to scientific analysis. (Fig.2) After this process, the available bands of AVIRIS reduced to 170 and we will get a corrected

image(subset) using MNF transformation both forwardly and inversely. The inverse transformation will get a final imagery containing 170 bands. (Fig.1 Right)

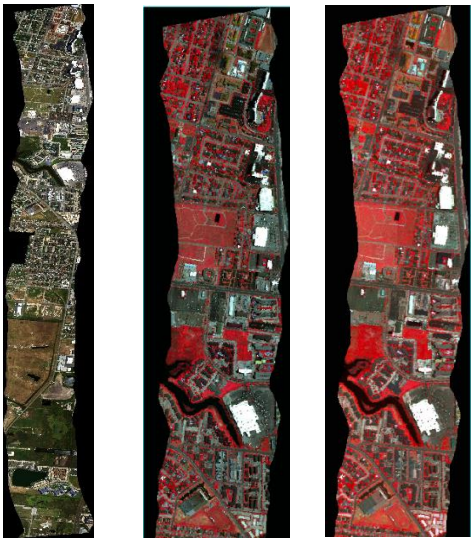

Fig.1 Original AVIRIS data (left), FLAASH correction result(mid), Inverse MNF result(right)

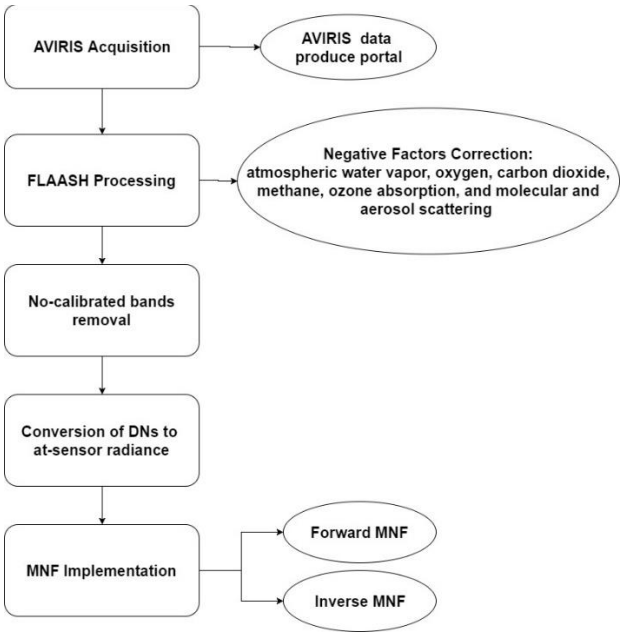

Fig.2 Workflow of preprocessing AVIRIS data

3.2. Object based classification

In my study, the software I use for object based classification is e-cognition. After trying different criterions, finally my AVIRIS image was segmented using all 170 bands with equal weighting, shape parameter of 0.1, compactness of 0.8 and scale of 15. The specific object features I use for my classification are brightness value, band1 value, band12 value, band21 value, band31 value, band52 value, max_difference, area, border length, length, number of pixels, width, asymmetry, compactness, rectangular fit, perimeter, relation border to neighbor objects and distance to neighbor objects. The specific class types for my classification are **avenue**, **brown facilities**, **healthy trees**, **shrub/grass**, **parking lot**, **river**, **soil/cement**, **house**, **swimming pool**, **street/ground**, **wetland** and white facilities (12 in total). The workflow (Fig.3, Fig.4) contains all the feature extraction methods. And the result of object based classification (Fig.5, Fig.6) will get.

4. Object based classification accuracy assessment

After classification process, the result was evaluated using accuracy assessment methods such as overall accuracy, user's accuracy, producer's accuracy and Kappa statistic using error matrix based on TTA masks. The assessment accuracy(Fig.7) indicates that object based classification has a higher overall accuracy (89%) and a higher Kappa value (0.86).

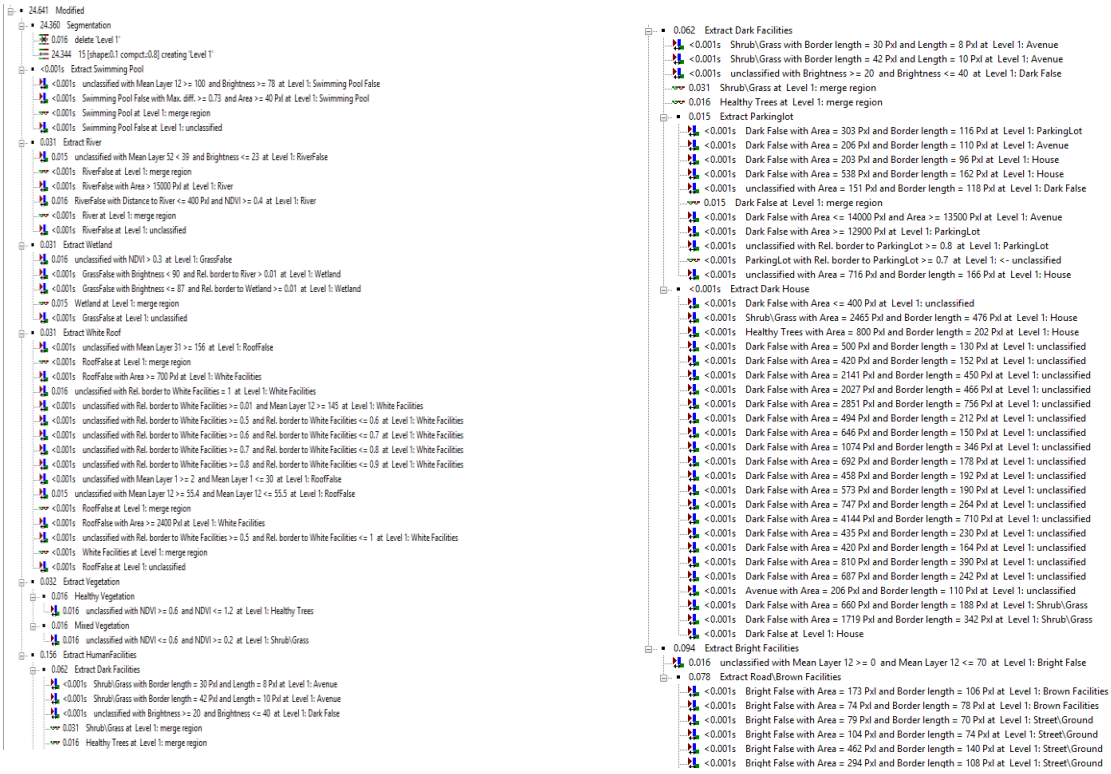

Fig.3 Workflow of object based classification

Feature	Value
Image Object Related Features	
Object features	**Customized**
NDVI	-0.017571
Layer Values	**Mean**
Brightness	63.38
Layer 1	-0.5188
Layer 12	58.17
Layer 21	72.54
Layer 31	77.43
Layer 52	74.76
Max. diff.	0.5633
Geometry	**Extent**
Area	72062 Pxl
Border length	10188 Pxl
Length	601 Pxl
Length/Width	1.611
Number of pixels	72062
Volume	72062 Pxl
Width	373 Pxl
Geometry	**Shape**
Asymmetry	0.6364
Border index	9.212
Compactness	3.111
Density	1.403
Elliptic Fit	0
Rectangular Fit	0.3880
Roundness	2.131
Geometry	**Based on Polyg...**
Area (excluding inner polygons)	71907.50 Pxl
Perimeter (polygon)	5322.27 Pxl
Object features	**Hierarchy**
Level	Level 1
Relations to neighbor objects	**Rel. border to**
House	0.1409
ParkingLot	0.056439
River	0
Wetland	0
White Roof	0.054967
Relations to neighbor objects	**Distance to**
ParkingLot	186.17 Pxl
River	388.21 Pxl
White Roof	182.17 Pxl

Fig.4 Workflow of object based classification & object feature(cont.)

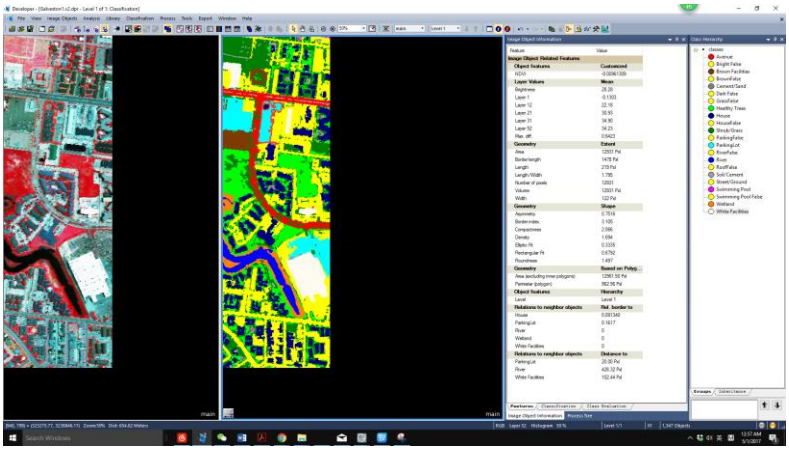

Fig.5 Overview of the original data (False Color Display) and classification result.

Fig.6 Zoomed original data and classification result (above part/ below part)

User Class \ Sample	River	Wetland	White Roof	ParkingLot	House	Healthy Vegetation	Shurb/Grass	Avenue	Brown Facilities	Swimming Pool	Street	Soil/Cement	Sum
River	5	1	0	0	0	0	0	0	0	0	0	0	6
Wetland	0	4	0	0	0	0	0	0	0	0	0	0	4
White Roof	0	0	3	0	0	0	0	0	0	0	0	0	3
ParkingLot	0	0	0	6	0	0	0	0	0	0	0	0	6
House	0	0	0	0	63	0	0	0	0	0	1	0	64
Healthy Vegetation	0	0	0	0	0	15	1	0	0	0	0	0	16
Shurb/Grass	0	0	0	0	1	1	7	0	0	0	0	0	9
Avenue	0	0	0	0	0	0	0	2	0	0	0	0	2
Brown Facilities	0	0	0	0	0	0	0	0	2	0	0	0	2
Swimming Pool	0	0	0	0	0	0	0	0	0	4	0	0	4
Street	0	0	0	0	0	0	0	0	0	0	10	0	10
Soil/Cement	0	0	0	0	5	1	0	1	0	1	1	3	12
unclassified	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	5	5	3	6	69	17	8	3	2	5	12	3	
Producer	1.00	0.80	1.00	1.00	0.91	0.88	0.88	0.67	1.00	0.80	0.83	1.00	
User	0.83	1.00	1.00	1.00	0.98	0.94	0.78	1.00	1.00	1.00	1.00	0.25	
Hellden	0.91	0.89	1.00	1.00	0.95	0.91	0.82	0.80	1.00	0.89	0.91	0.40	
Short	0.83	0.80	1.00	1.00	0.90	0.83	0.70	0.67	1.00	0.80	0.83	0.25	
KIA Per Class	1.00	0.79	1.00	1.00	0.84	0.87	0.87	0.66	1.00	0.79	0.82	1.00	
Overall Accuracy	0.90												
KIA	0.86												

Fig.7 Accuracy assessment of object based classification

5. Reference

Due to the reason that most of my reference sources are from videos, labs and data website, the reference below may not be as formal as paper format.

1-4 Lab7,lab8,lab10,lab11

5.harrisgeospatial.com

6.youtube.com.ecognition

7.https://aviris.jpl.nasa.gov/

8.http://www.harrisgeospatial.com/docs/PreprocessAVIRIS.html

9.Dimensionality Reduction and Classification of Hyperspectral Image Data Using Sequences of Extended Morphological Transformations Antonio Plaza, Member, IEEE, Pablo Martínez, Javier Plaza, and Rosa Pérez

10.Hyperspectral Image Classification and Dimensionality Reduction: An Orthogonal Subspace Projection Approach Joseph C. Harsanyi, Member, IEEE, and Chein-I Chang, Senior Member, IEEE

11.Support vector machines and object-based classification for obtaining land-use/cover cartography from Hyperion hyperspectral imagery