Toward Preparing the Spectral Signature Library for the Ground Features Using Hyper-Spectral Remote Sensing Techniques

Nawal Kh. Ghazal

University of Baghdad, College of Science, Dep. of Remote Sensing and GIS

Abstract: ***The research represents the starting point in the preparation of the so-called spectral signature library of the ground features based on hyper-spectral satellite imaging techniques. This research represents a new approach (at the level of Iraq) for the study of the spectral signatures of different land cover types. From an experimental point of view, a satellite scene belongs to the Hyperion sensor (mounted on the EO-1 satellite) has been download via the official web site for the (USGS), this scene covers part of the city of Baghdad-Iraq with 242 spectral bands ranging from the ultraviolet region to the short infrared region of the electromagnetic spectrum. The specialized ERDAS Imagine 2014 software package was used to generate a unified stack image file of all of these 242 bands. This will be more easy in handling and processing of this huge bundle of bands, after then, the bad bands of the scene have been determined by indicating their spectral regions in the spectral signature plot. Finally, five samples of the some mainland covers have been taken with plotting the spectral signature for each one of them at different positions within the region study, these land covers are (vegetation, two types of bare soils , built-up and water). The general shape of the spectral signature for each sample represents the spectral behavior of the main land cover that clearly indicating and distinguishing all the other related secondary land cover classes.***

Keywords: Hyperspectral, Imagery Pre-processing, Hyperion, EO-1

1. Introduction

Multispectral image is one that captures image data within a specific wavelength ranges across the electromagnetic spectrum. Spectral imaging can allow extraction of additional information the human eye fails to capture with its receptors for red, green and blue. It was originally developed for space-based imaging, and has also found use in the document and painting analysis. The shortest wavelength region is the ultra-violet (wavelengths < 0.4 µm), followed by the visible (ranging from 0.4 µm to 0.7 µm). The others are the near-infrared with wavelengths from 0.7 µm to the thermal infrared 14 µm.Hyperspectral sensors typically collect hundreds of narrow (5-20 nm) contiguous bands. The name, hyperspectral, implies that the spectral sampling exceeds the spectral detail of the target (i.e., the individual peaks, troughs, and shoulders of the spectrum are resolvable). In practice, this is not always fully achieved, particularly for gaseous spectra. Spaceborne remote-sensing data have been widely used to obtain information regarding Earth surface properties [1,2].

The EO-1 satellite was launched into the same orbit as Landsat-7 and follows Landsat-7 by about 1 minute, which was launched by a Delta rocket from the Vandenburg Air Force Base in California on November 21, 2000. Following a three-month instrument and spacecraft checkout period of the instrument and operations teams, the data streams were judged to be operational and two years of evaluation started, and in this phase, a team of scientists (the Science Validation Team, SVT) examined the data and actively improved all aspects of data delivery and processing. These improvements resulted in advanced processing and many successful applications. Orbit: Sun-synchronous circular polar orbit, altitude = 705 km, inclination = 98.7º, period = 99 minutes, descending nodal crossing time of 10:15 AM. The orbit supports a 16 day repeat cycle. - A coordinated tandem orbit within a minute of Landsat-7 is prescribed for reasons of data calibration and synergetic use of data.

For this satellite spectral bands will allow researchers to better look for specific surface features or land characteristics based on scientific or commercial applications. These advanced imaging instruments will lead to a new generation of lighter weight, higher performance, and lower cost Landsat-type imaging instruments for NASA's Earth Science Enterprise [3,4].

The Hyperion sensor, carried by the EO-1 satellite, is the first space borne hyperspectral instrument to acquire spectral bands in the visible, near-infrared region (VNIR) and shortwave infrared region (SWIR).The performance characteristics of Hyperion sensor that has the SNR of the EO-1/Hyperion sensor is relatively low, between 40 and 190, which has a direct effect on spectral mineral mapping, resulting in extraction of less detail, while a cloud-free level 1R EO-1/ Hyperion imagery (EO1224064200920711OPF), obtained from the USGS-EROS, was acquired on July 26, 2009 during the dry season [5].Pre-processing can be done to eliminate noise for image before any image processing [6].

The device contains of two imaging spectrometers, and then two separate detectors with approximately 62,000 detector elements. The VNIR spectrometer registers 70 bands below 1058 nm and SWIR spectrometer can be record 172 bands above 852 nm. one scanning line records 256 pixels that covering about 7.7 km wide area on the ground and the length of scene varies among 42km and 185km.These data can be downloaded from USGS. The vertical bad lines on the image may be produced during the pushbroom scanner as a poorly calibrated detector. These bad lines have different values, some of these neighboring pixels are a constant value and other have a lower than the neighboring.

They can be corrected by changing the DN values with the average DN values of the left and right neighboring pixels.

The detector of Hyperion records image column inside of a particular spectral band and the amount of striping changing as the wavelength. The column amount of the image is a function of the wavelength and records the values of the positions with two dimensions. The effect of uncorrected striping will represent to faulty interpretation results of the data [7].

The radiation of electromagnetic causes radiometric effects as it passes through the atmosphere due to its disturbances, and this affects on the measurements, such as absorption and scattering and this signal can be modified. The atmosphere contains varying materials which absorb different wavelengths. Also the effect of radiation relative to the earth's surface, Like (reflection angles and shadow), and surface features can be effected by the spectral signature [8].

2. Region study and the used data

A Satellite Scene of EO-1 Hyperion for a region near Baghdad-Iraq city has been selected in this research (fig.1) , table-1 illustrates the specification details for this scene.

Figure 1: The gray region is the used satellite image (EO-1 Hyperion) and its spatial extent

Table 1: Specification of the EO-1 Hyperion scene

Acquisition date	2005-04-07	
Acquisition Time (GMT)	Start Time	07:23:41
	END Time	07:24:51
Product of Samples	1031	
Product of Lines	3391	
Grid Cell Size (meter)	30	
Spatial Extent Coordinates	Upper Left Corner Latitude	33.692652
	Upper Left Corner Longitude	44.409610
	Upper Right Corner Latitude	33.678409
	Upper Right Corner Longitude	44.491508
	Lower Left Corner Latitude	32.779358
	Lower Left Corner Longitude	44.251541
	Lower Right Corner Latitude	32.792921
	Lower Right Corner Latitude	44.171408
Reference Ellipsoid	WGS 84	
Reference Datum	WGS 84	
Sun Azimuth (deg.)	132.812259	
Sun Elevation (deg.)	54.860678	
Number of Spectral Bands	242	

3. Processing steps and the Results

From a practical point of view, the following processing steps have been performed

- Image downloading the above mentioned EO-1 Hyperion Scene (fig.2)

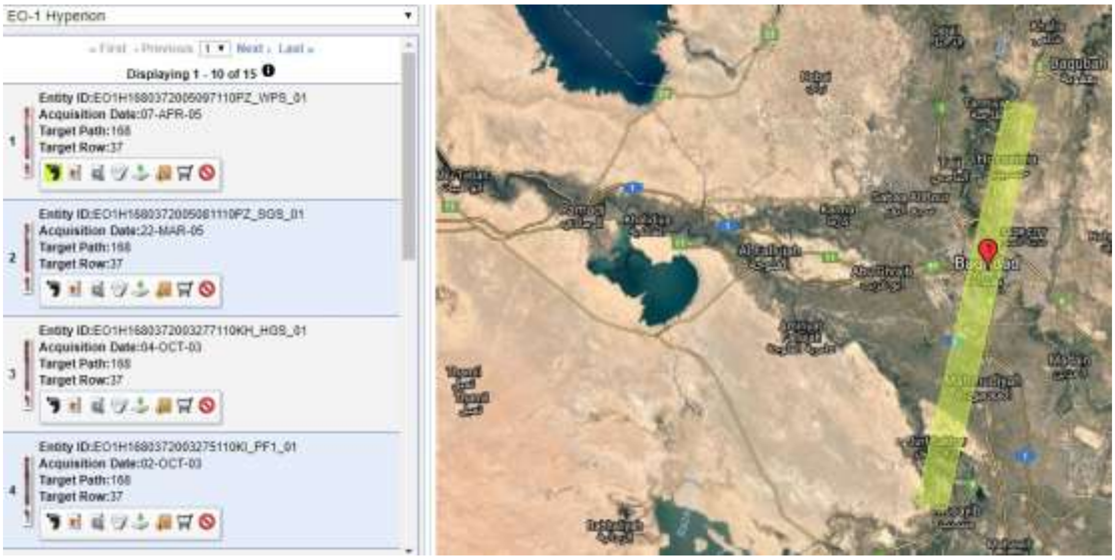

Figure 2: Downloading the EO-1 Hyperion scene using an Earth explorer portal

- Adopting the main module of ERDAS Imagine 2014, in performing the stacking of all the 242 bands into a single imagine format image file, this will introduce more speed and compactness in the processing.
- Using the spectral workstation application (within the ERDAS Imagine software) , for creation of the new project including the stacked 242 image bands (fig.3)

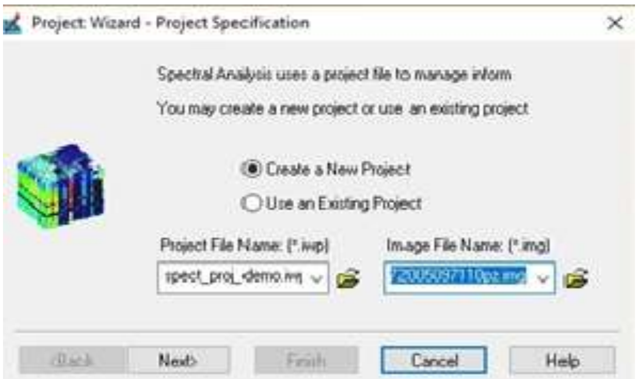

Figure 3: Creation the project for EO-1 Hyperion spectral processing

- Selecting the bad bands of the 242 bands (fig. 4), these bands were: bands 1-8, bands 58-76, bands 165-181 and bands 223-242.

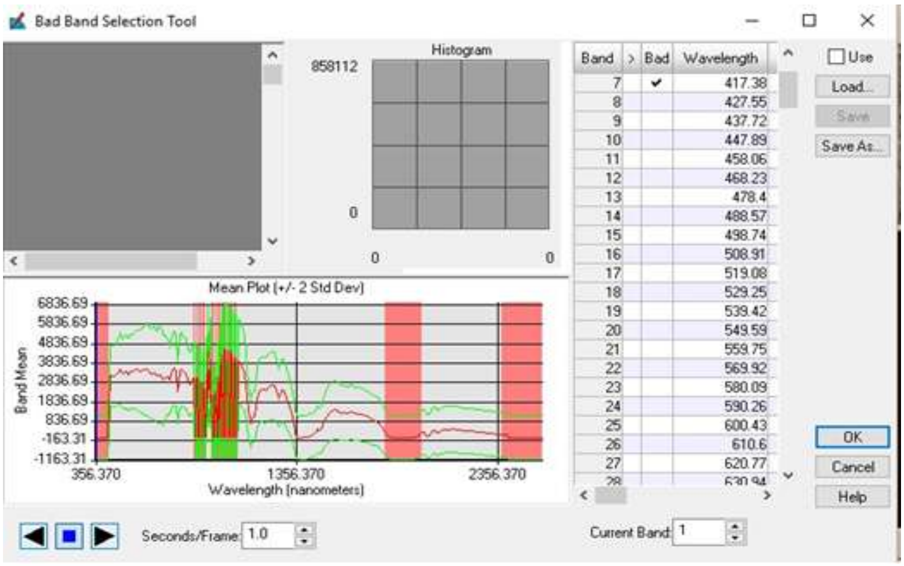

Figure 4: Bad band selection panel within Spectral Analysis Workstation-ERDAS Imagine 2014

- Positioning the sites for some typical ground features (main land covers) , these land covers are : vegetation, bare soil (with two species), built up and water with plotting the spectral signature for each one of them as illustrated in fig.5.

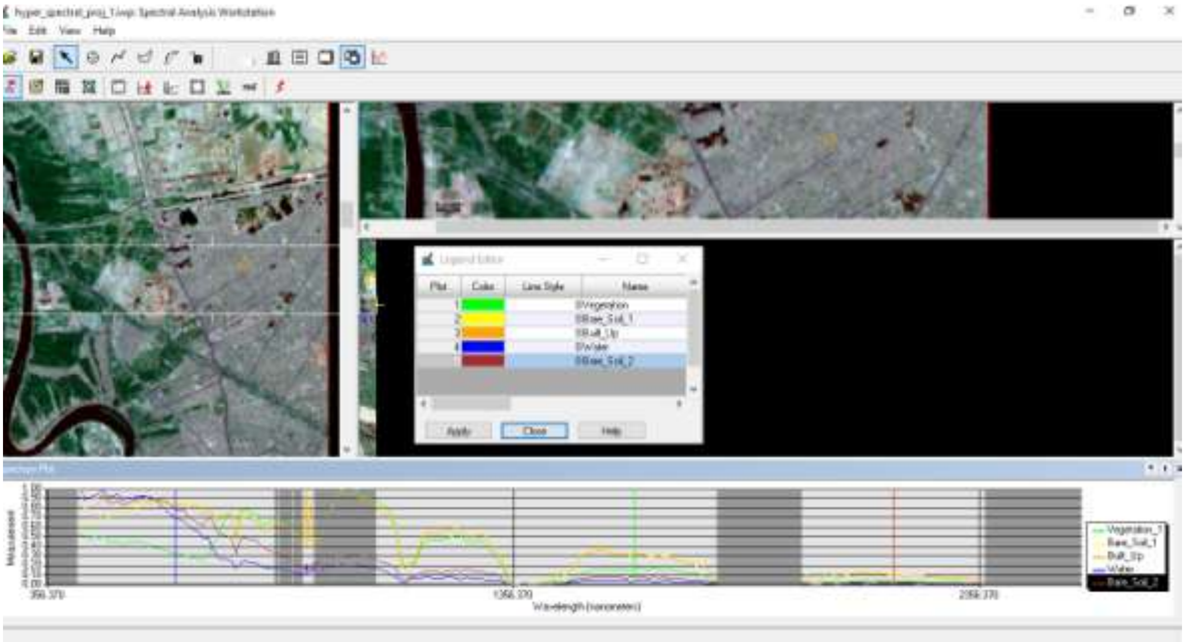

Figure 5: Positioning the site of some mainland covers with plotting their corresponding spectral signature

4. Conclusions

From the theoretical and practical investigation of the EO-1 Hyperion scene with its hyperspectral bands it is concluded the following:

- There are a lot of scenes of this sensor covers different regions of Iraq, these scenes could be utilized for more investigation and analysis of hyperspectral remote sensing.
- The spectral signature of the ground features (whether they were main or secondary) is highly affected by the radiometric distortion due to the atmosphere of the Earth, so that the using of radiometric calibration and correction should be taken in considerations.
- Some bands of the Eo-1 Hyperion are not bad, but they are corrupted with stripes, due to acquisition conditions, the process of de-striping could be necessary as pre-processing operation.
- Other activities related to Hyperspectral remote sensing and spectral signature collecting for the ground features, these activities like, terrestrial spectral signature preparing with using hand held spectro-radiometer , as well as utilizing the ready spectral signature library that have been previously established by different specialized direct rates such USGS, JPL,..etc.

References

[1] D.L.B. Gupp & Bisun Datt (Eds), " Evaluation of the EO-1 Hyperion Hyperspectral Instrument & its Applications at Australian Validation Sites 2001-2003", CSIRO Earth Observation Centre Report 2004/05 , Australia.

[2] B. Emison, Merrick & Company," LiDAR & Hyperspectral Data Fusion Analysis from Simultaneous, Multi-Sensor Collection Project", Civil Commercial Imagery Evaluation Workshop,2009

[3] P.Dong,"Fractal signatures for multiscale processing of hyperspectral image data", Department of Geography, University of North Texas, P.O. Box 305279, Denton, TX 76203, USA,2007.

[4] Fred A. Kruse1," Comparison of AVIRIS and Hyperion for Hyperspectral Mineral Mapping",

[5] B. Zheng," Using Satellite Hyperspectral Imagery To Map Soil Organic Matter, Total Nitrogen And Total Osphorus", Submitted to the faculty of the University Graduate School in partial fulfillment of the requirements for the degree Master of Science in the Department of Earth Sciences, Indiana University ,August 2008.

[6] D.Scheffler[a], P. Karrasch[b],"Preprocessing of Hyperspectral Images -a omparative Study of Destriping Algorithms for EO-1 Hyperion", [a]GFZ German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, Germany,[b] Professorship of Geoinformation Systems, Technische Universität Dresden, Helmholtzstraße 10.01069 Dresden, Germany.

[7] Fred A.Kruse[1],"Comparison of AVIRIS and Hyperion for Hyperspectral Mineral Mapping",[2] Presented at the 11th JPL Airborne Geoscience Workshop, 4-8 March 2002, Pasadena, California,[1] Analytical Imaging and Geophysics LLC, Boulder, Colorado, USA, E-mail: kruse@aigllc.com

[8] D. Scheffler[a], P. Karrasch[b],"Preprocessing of Hyperspectral Images -a Comparative Study of Destriping Algorithms for EO-1 Hyperion",GFZ German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, [b]Professorship of Geoinformation Systems, Technische Universität Dresden, Helmholtzstraße 10. 01069 Dresden, Germany.