Remote Sensing in Geosciences
GEOG 361
Department of Geography
Texas A&M University

Course Instructor: Dr. Anthony M. Filippi

LABORATORY 1

Measurement and Analysis of Target Reflectance

Points Possible: 10

Objectives

- To determine the most useful/optimal bands for target discrimination.
- To identify features based on spectral reflectance curves.

As humans, the colors we see are made up of combinations of reflected wavelengths throughout the visible portion of the electromagnetic spectrum. Each object that we see, or can visually perceive, has its own unique ***spectral reflectance curve*** (e.g., grass, water, gravel, etc). These curves are defined by the varying percent of reflectance as a function of wavelength. The color we see comes from the wavelengths that are reflected the most relative to other wavelengths. For example, a green object will be highly reflective in the green portion of the spectrum, but exhibit low reflectivity in blue and red portion of the electromagnetic spectrum. Graphs of spectral reflectance curves help us better understand the reflectance nature of an object.

In remote sensing, one must understand the reflectance nature of an object if it is going to be identified on an image. ***In-situ*** or reference data are often collected at the time of image acquisition. One form of reference data is the ground-based measurement of the reflectance of surface features to determine their spectral response patterns. This might be done in the laboratory or in the field using a ***spectroradiometer.*** This device measures, as a function of wavelength, the energy coming from an object within its view. It is used primarily to prepare spectral reflectance curves for various objects.

In this lab, we will use a multiband ***radiometer*** that measures radiation in a series of discrete spectral bands, rather than over a continuous range. The one of interest in this exercise operates in four spectral bands, or channels (blue, green, red, and near infrared). These bands are similar to the bands used by the Thematic Mapper (TM) sensor onboard the Landsat satellites and the high resolution visible (HRV) sensor onboard the SPOT satellites.

In this lab, you are to compute radiometric data from previously obtained instrumentation readings and then plot the spectral reflectance curves in graphic format. This will allow you to determine which bands are most useful for target discrimination from experimental radiometric data. Reflectance curves such as these have already been generated for a number of surface types. It is up to you to examine these curves and predict the contrast relationship between various targets. By analysis of experimental results such as these, the scientist may be able to choose the proper spectral band combinations for a given remote sensing task. Theoretically, the higher the reflectance contrast between any two imaged objects, the easier it should be to distinguish them. The easier an object is to distinguish, the greater the potential is for fast, accurate image interpretation.

Determining the Most Useful Bands for Target Discrimination

For Table 1, determine the percent hemispherical target reflectance for each of the four bands (blue, green, red, and near-infrared) based on the following equations:

1. Gray Card Incident Radiant Flux =

(radiometer gray card reflectance / radiometer instrument gain) / 0.18

2. Target Reflected Radiant Flux =

radiometer target reflectance / radiometer instrument gain

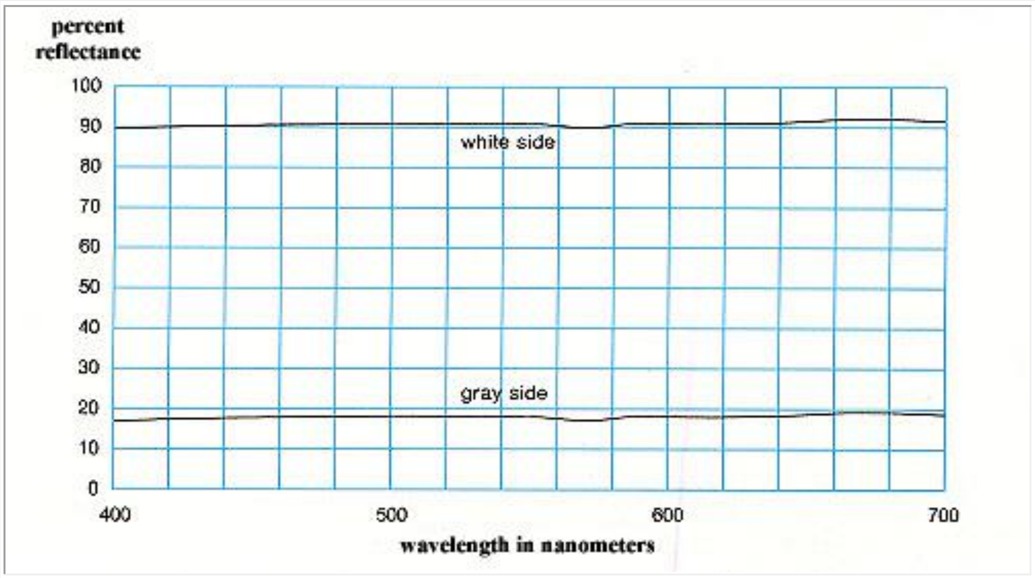
3. Hemispherical Target Reflectance =

(target reflected radiant flux / gray card incident radiant flux) × 100

Please note the following constants:

Radiometer instrument gain = 125

Gray card percent reflectance throughout the spectrum = 0.18



This graph shows the percent reflectance of a KODAK Gray Card in relation to light wavelength in nanometers.

Table 1. Computation of Hemispherical Target Reflectance

TM Band	Radiometer Gray Card Reflectance	Gray Card Incident Radiant Flux	Radiometer Target Reflectance	Target Reflected Radiant Flux	Hemispherical Target Reflectance
Green Sweetgum					
1 BLUE	0.13		0.05		
2 GREEN	0.15		0.1		
3 RED	0.12		0.05		
4 NIR	0.17		0.4		
Yellow Sweetgum					
1 BLUE	0.13		0.09		
2 GREEN	0.15		0.19		
3 RED	0.12		0.19		
4 NIR	0.18		0.32		
Red Sweetgum					
1 BLUE	0.13		0.05		
2 GREEN	0.15		0.08		
3 RED	0.12		0.15		
4 NIR	0.18		0.3		
Brown Sweetgum					
1 BLUE	0.13		0.04		
2 GREEN	0.15		0.09		
3 RED	0.12		0.12		
4 NIR	0.18		0.28		
Grass					
1 BLUE	0.12		0.04		
2 GREEN	0.16		0.08		
3 RED	0.11		0.04		
4 NIR	0.16		0.4		

Concrete					
1 BLUE	0.12		0.1		
2 GREEN	0.16		0.16		
3 RED	0.11		0.12		
4 NIR	0.16		0.2		
Laterite Soil					
1 BLUE	0.12		0.05		
2 GREEN	0.16		0.08		
3 RED	0.11		0.07		
4 NIR	0.16		0.15		
Water					
1 BLUE	0.28		0.03		
2 GREEN	0.30		0.02		
3 RED	0.22		0.01		
4 NIR	0.32		0.005		

Once you have completed Table 1, create a graph of spectral reflectance curves for each of the targets listed in the table. Plot the target hemispherical reflectance percentages (*y*-axis) in each of the four bands (*x*-axis). Use different colors and/or line patterns (dashes, dots, symbols, etc.) to distinguish each of the individual target reflectance curves on the plot. Once you have completed the graph, answer the following questions:

1. Determine which of the bands available to you is best for discriminating between the following target classes:

A. Green Sweetgum and Red Sweetgum

B. Yellow Sweetgum and Green Sweetgum

C. Brown Sweetgum and Red Sweetgum

D. Brown Sweetgum and Grass

E. Grass and Soil

F. Concrete and Soil

G. Water and Soil

2. In which of the four bands is Yellow Sweetgum the lightest tone (highest reflectance)? The darkest tone (lowest reflectance)?

3. If you were to choose only two spectral bands to discriminate between *all* targets, which bands would you select and why?

4. Why does the human visual system (i.e., our eyes, etc.) perceive healthy vegetation as green in color? What is the standard spectral reflectance curve for almost all healthy green vegetation? (Give a verbal description and graphically draw an example vegetation spectral reflectance curve.)

5. How do you think the presence of moisture in soil will affect its reflectance?

6. What are some of the factors that affect the reflective nature of water?

7. Why is it important to investigate the nature of spectral reflectance curves from targets prior to planning a remote sensing project?

DELIVERABLES:

Your write-up should be typed and coherent. Turn in the completed table, spectral plots (graph), and the answers to the questions posed.

Acknowledgement: This lab is derived from an exercise written by Dr. John R. Jensen.