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

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LABORATORY 2

Interpretation and Analysis of Aerial and Satellite Imagery

Points Possible: 10

Objectives

- To introduce fundamental image-interpretation techniques.
- To introduce basic ENVI remote-sensing digital image processing system display and screen cursor control procedures.
- To analyze and understand basic characteristics of various remote-sensing multispectral systems.

Part I. Image Interpretation

All remote-sensing scientists require fundamental image-interpretation skills to detect, identify, measure, and solve problems. Eleven fundamental image-interpretation skills are listed in Table 1 below:

Table 1. Fundamental elements of image interpretation.

Primary Elements	1. Black & White Tone
	2. Color
	3. Stereoscopic Parallax
Spatial arrangement of tone and color	4. Size
	5. Shape
	6. Texture
	7. Pattern
Based on analysis of primary elements	8. Height
	9. Shadow
Contextual elements	10. Site
	11. Association

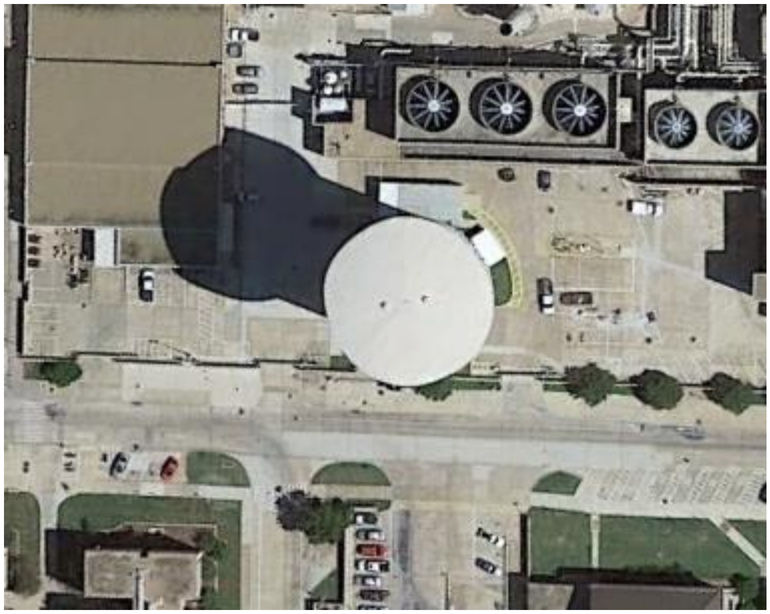
As humans, we process profile views of the Earth everyday and are very adept at incorporating all of our knowledge for the interpretation of an image. Our minds might be able to recognize a feature on an image that a computer would have problems identifying due to our powerful visual-processing capabilities and our experience. There has recently been a resurgence in the art and science of visual photointerpretation due to new digital remote-sensing systems providing progressively higher spatial resolution images. For example, IRS-C (5 × 5 m) and IKONOS (1 × 1 m) panchromatic images are often photointerpreted and used as base maps for GIS projects. Even higher spatial resolution imagery is also commercially available (e.g., WorldView-3 (0.31 × 0.31 m panchromatic)). The demand for experienced photointerpreters will only increase as next-generation satellite systems proliferate.

1. Photointerpret the following images and identify the type of location for each image. Which fundamental image-interpretation skills are you using to properly identify these locations?

A

B

C



D

E

F

G

2. List the advantages and disadvantages of vertical vs. oblique photography.

3. Describe how f-stop and shutter speed work and why these are important considerations in capturing aerial photography.

4. Describe three important mission planning considerations when acquiring aerial photography.

5. How often and at what scale are National Aerial Photography Program (NAPP) data collected for each state? A 9 × 9 inch photo at this scale represents how much area on the ground? For what types of applications are these data useful?

6. Discuss some of the advantages/disadvantages of using satellite verses aircraft remotely sensed data.

Part II. Analysis of Aerial and Satellite Data

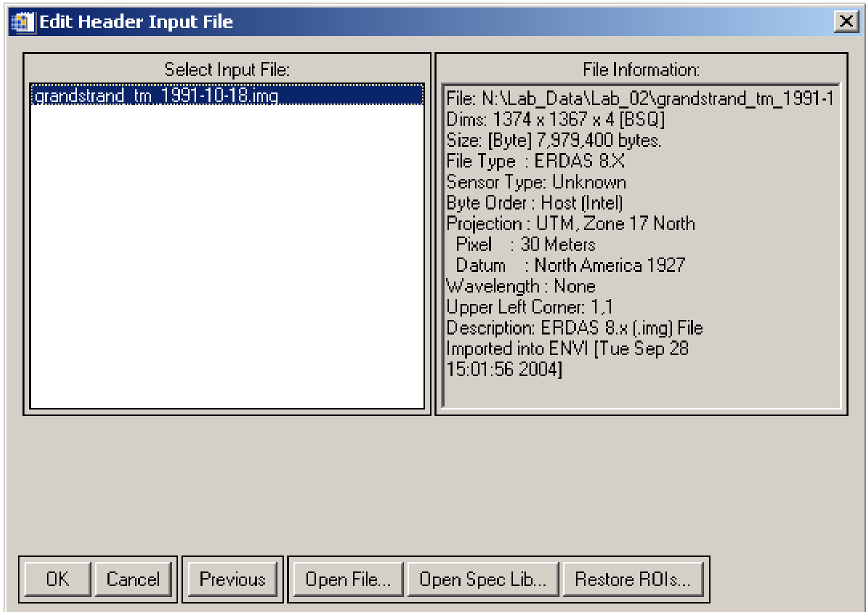
There is an abundance of digital images available in the remote-sensing market today. This market is expected to grow substantially in the next few years with many new platforms being developed. This exercise will introduce you to some of the most common forms of airborne and satellite sensor data available. Examples of airborne data include aerial photography data such as the National Aerial Photography Program (NAPP) and airborne multispectral scanning systems, such as the Airborne Terrestrial Applications Sensor (ATLAS). Examples of common satellite-based platforms include the multispectral scanning systems in Landsat Multispectral Scanner (MSS) and Thematic Mapper (TM) and the linear array sensors systems in SPOT Image XS (multispectral) High Resolution Visible (HRV).

In order to view the data for this exercise, we will be using the ENVI software package. Once you have successfully logged-on to your computer account, start ENVI. (**NOTE: The ENVI instructions provided below are for ENVI Classic; however, one can work with the data of interest in a similar manner using ENVI 5x.**) From the ENVI main menu, we can open a particular ENVI image file by navigating: **File | Open Image File**. However, the files that we are going to be using in this lab are native ERDAS Imagine files, which is a proprietary data format from another remote-sensing digital image processing software package (i.e., ERDAS Imagine). Imagine files (version 8.x or newer) will always have a *.img file extension. (Note: sometimes the ENVI files used in this course may have a *.img file extension, so in the future, if the file type you are working with is not an ENVI file, this will be specified in the instructions. Note further that the ENVI image files used in this course will also have an associated header file (*.hdr) with the same base name as the image file.) To open an ERDAS Imagine file, we will use a slightly different procedure. We will instead navigate: **File | Open External File | IP Software | ERDAS IMAGINE**. In general, the files that we will be using in lab are located on your class shared drive, located at **\\vh2stor.geos.tamu.edu\geogclass\geog361filippi**. You should have already mapped this network drive previously (see Lab 0 instructions). Within the “Lab_Data” directory, the files for each lab will be in the directory for the respective lab (e.g., Lab_02, Lab_03, etc.). To open a file, position the cursor (pointer) over the file to be displayed and press the left mouse button (lmb). The file name should appear in the file name dialog, located at the bottom of the window. If you do not see a list of the files with a *.img extension, you are not looking in the correct directory. Navigate to and select the following file in the Lab_02 subdirectory: **charleston_napp_1994-02-14.img**. Then click the "Open" button in the dialog box.

The image file and its associated bands should then appear in the **Available Bands List** window. To open up a new image display window, click on the Display button at the bottom of the Available Bands List window; since you have not yet opened any image displays yet, the Display button currently reads "No Display." Once you click this button, click the "New Display" option to open the display window. Using the "Gray Scale" and "RGB Color" radio buttons, you can choose to view a gray scale image (i.e., viewing one band at a time) or a true- or false-color composite, where we assign the spectral bands of the image to the color planes, or color guns, red, green, and blue (RGB). These spectral band assignments for each image to-be-analyzed will be given to you (see below). In addition, once you choose a viewing option (gray scale or RGB Color) and the bands in the associated color guns, click the button in the lower-left corner of the Available Bands List window; it will be labeled either as "Load Band" (for gray scale) or "Load RGB" for RGB color. An image display group (comprised of the main image display window, the scroll window, and the zoom window) will appear with the image loaded.

To stop displaying a particular image, you can quit out by navigating in the main image display window menu: **File | Cancel**, or you can click the "x" button in the upper-right corner of the main image display window (an operation common to most Windows-based programs). If you would rather load successive image bands—from the same file or from other files—you can simply select new band combinations in the Available Bands List, and click "Load RGB" or "Load Band" again. This overwrites the previous band combinations in the same image window. Alternatively, if you want to load image bands in a new image display group, click the Display button again in the Available Bands List, and select the "New Display" option from the drop-down list.

Additional information about each image can be found by examining the ENVI header information, located in the associated *.hdr text file. This can be viewed using any text editor or word processor, but it will likely be more intelligible and more convenient to navigate from the main ENVI menu: **File | Edit ENVI Header**.



By clicking-on the filename with your left mouse button (lmb), the basic file information is automatically displayed on the right side of the dialog box. The information given includes the file path and the dimensions of the image file (# samples (i.e., image columns), # lines (i.e., image rows), and the number of image channels (i.e., bands)). The abbreviation that follows in brackets is the band interleave, which refers to the data storage format. Also, given are the size of the image (in bytes), sensor type (if known and if entered), byte order (for viewing on specific computing platforms (e.g., Windows versus UNIX workstations, etc.)), projection information (including projection, pixel size and units, and datum), wavelength (if specified), etc. Although you will not typically have an occasion to edit, or change, this information, if you do have a need to do this, once the file is selected in the Edit Header Input File dialog, you can click OK, and you would then be given options to edit the header information. *Do **not** do this now*.

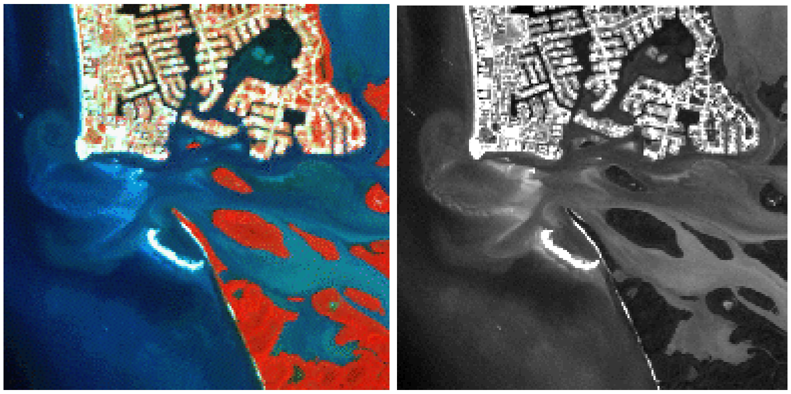
Task: Open and browse the following files and answer the questions that follow:

NAPP 1 × 1 m
File: *charleston_napp_1994-02-14.img*
Color Infrared Composite RGB = Bands 3,2,1

Landsat MSS 80 × 80 m
File: *south-florida_mss_1982-10-17.img*
Color Infrared Composite RGB = Bands 4,2,1

Landsat TM 30 × 30 m
File: *charleston_tm_1990-12-08.img*
Color Infrared Composite RGB = Bands 4,3,2
Natural Color Composite RGB = Bands 3,2,1

Landsat TM 30 × 30 m
File: *grandstrand_tm_1991-10-18.img*
Color Infrared Composite RGB = Bands 4,2,1
Natural Color Composite RGB = Bands 3,2,1



SPOT XS HRV 20 × 20 m
SPOT Pan HRV 10 × 10 m
File: *marco-island_spot_1988-10-21.img*
Color Infrared Composite RGB = Bands 4,3,2
Panchromatic RGB = Bands 1,1,1

QUESTIONS*

*(Note: In order to answer some of the following questions, you may need to consult your Jensen (2007) textbook, chapter 7).

7. Which Landsat platforms have the Multispectral Scanner (MSS), which have the Thematic Mapper (TM), and which have the Enhanced Thematic Mapper plus (ETM^+)?

8. Study the differences between the MSS and TM bands. How are the TM bands an improvement over the MSS bands? Why do the TM bands offer improved vegetation discrimination over those of the MSS? How does Landsat 7 offer more in mapping capabilities?

9. Using the TM bands, how could one distinguish between clouds and snow?

10. For each of the following, choose one or more TM bands and explain why you think it should be used for the following feature discrimination:

Vegetation moisture content?

Soil moisture content?

Water body penetration?

Mineral and rock types?

11. Explain the primary difference between energy sensed with TM band 6, and the energy collected by the other sensors aboard TM.

12. In the color infrared composites, what do the red hues indicate? Be specific.

13. Of the satellites considered in this lab, which satellite has off-nadir viewing capabilities? How can this characteristic be useful in acquiring data?

14. Notice the difference between spatial resolution on the SPOT panchromatic (pan) and multispectral mode (1, 2, 3). Discuss some advantages/disadvantages of varying spatial resolutions and what platform would you use for each of the following applications. Justify your responses.

> **1. Cadastral mapping**
> **2. Precision agricultural**
> **3. Urban and regional planning**
> **4. Forestry inventory**
> **5. Sea surface temperature mapping**
> **6. Telecommunications (cellular antennae suitability)**
> **7. 3-Dimensional visualization and simulation**
> **8. Tourism and leisure**

15. Complete the following table:

	Landsat MSS		**Landsat TM**		**SPOT HRV**	
	Band	**Micrometers**	**Band**	**Micrometers**	**Band**	**Micrometers**
	4		1		1	
	5		2		2	
	6		3		3	
	7		4		Pan	
	8		5			
			6			
			7			
IFOV at nadir						
Quantization levels						
Earth coverage						
Altitude						
Swath width						

DELIVERABLES:

Your write-up should be typed and coherent. Turn in the answers to the questions posed.

Acknowledgement: This lab was modified from an exercise written by Dr. John R. Jensen, USC.