TEXAS A&M UNIVERSITY

Lab Exercise

GEOG 361 / 651
Lab Exercise 1 ***Introduction to ENVI***

I. Introduction

This lab exercise aims to introduce you to the basics of the ENVI image processing software and to help you begin to understand the nature and statistical properties of digital remote sensing images.

By the end of this lab you should have a working knowledge of basic image operations in ENVI and have a basic understanding of digital images. The teaching assistant will guide you through this assignment. The learning objective of this lab assignment is to understand the user interface of ENVI and ENVI help well enough to complete the following basic image processing tasks:

- Load and open image data;
- Label and comment the image data;
- Display images in gray-scale, pseudo color or RGB mode;
- Zoom and pan images;
- View and record the digital number (DN) values of image pixels;
- View the geolocation information about the image and individual pixels;
- Enhance image brightness and contrast.

II. Overview of ENVI Software Features

ENVI (*The Environment for Visualizing Images*) is one of several commonly used image commercial processing packages. Others you may have heard about include ERDAS Imagine, ERMapper and PCI. Each of these packages has its own strengths and weaknesses. ENVIs strengths lie in well-developed algorithms for hyperspectral and SAR data. In addition, it is built upon the IDL (Interactive Data Language) platform which enables ENVI functionality to be available in IDL and IDL functionality in ENVI. It also makes development, customization and extension of ENVI easier than other software packages. While this class uses ENVI, proficiency in using one image processing package should make it easy to translate this skills to another image processing package.

ENVI can directly read image data in ENVI Standard image file or External files including:

Landsat	Radar (SAR)	ArcView Raster
SPOT	AVHRR	Mr. SID
IKONOS	MODIS	TIFF/GeoTIFF
Quickbird	USGS DOQ	JPEG
ASTER	Thermal	ASCII

However, only ENVI raster datasets accommodate the full functionalities of ENVI. An ENVI raster data set consists of two component files:

- A binary data file containing the raster data in one of three formats: Band Sequential (BSQ), Band Interleaved by Pixel (BIP), or Band Interleaved by Line (BIL) format.
- A corresponding ASCII header file with an ".hdr" file extension

Vector information containing lines, points, and polygons can be also loaded and displayed in ENVI. For example, overlay a network of known roads (vector data) on a satellite image backdrop. An ENVI Vector data set consists of one data file with an ".evf" file extension. ENVI can also open numerous vector formats including: Shapefiles, ARC/INFO Interchange files, DXF files, USGS Digital Line Graphs (DLG), and USGS DLGs in Spatial Data Transfer Standard (SDTS) format, *etc.*

Statistical information about the images, indicating image quality and characteristics, can be calculated and viewed in a tabular or graphical format using histograms and scatter plots.

You can directly save raster images in ENVI in a number of formats including:

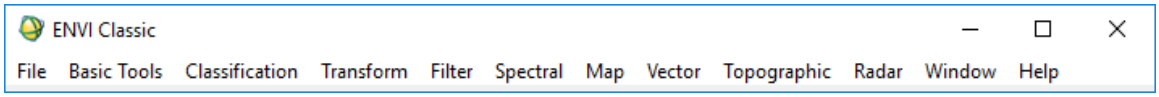
• ENVI Standard Raster Dataset	• ASCII (.txt)
• ArcView Raster (.bil)	• ER Mapper File (.ers)
• ERDAS File (.lan)	• JPEG (.jpg)
• NITF (.ntf)	• PCI File (.pix)
• TIFF/GeoTIFF (.tif)	• ESRI GRID

The following is a brief tutorial and exercises that are aimed at helping you learn the basics of the ENVI image processing system. As the menus change somewhat between versions the exact menu options you may see on your computer may differ slightly from those shown in the screenshots here, but you should be able to easily identify the basic functionality discussed in this lab.

My advice here is to spend some time this week simply playing with ENVI and trying out its features, there is no substitute for learning how to use an image processing system other than exploring its features – remember you cannot break anything – so do not be fearful from playing. Also, it is a good skill to learn how to find information in help if you have a problem.

A) Starting ENVI

To Start ENVI, you need to locate the ENVI Software just like you would any other software. Push the Windows start menu (bottom left of screen) and type "ENVI Classic" and select "ENVI Classic 5.5 (64 bit)". After starting ENVI, the main menu, which should be similar to what is shown below, should appear. Most of the main image processing functionality can be found under the options on this menu and are grouped by task.



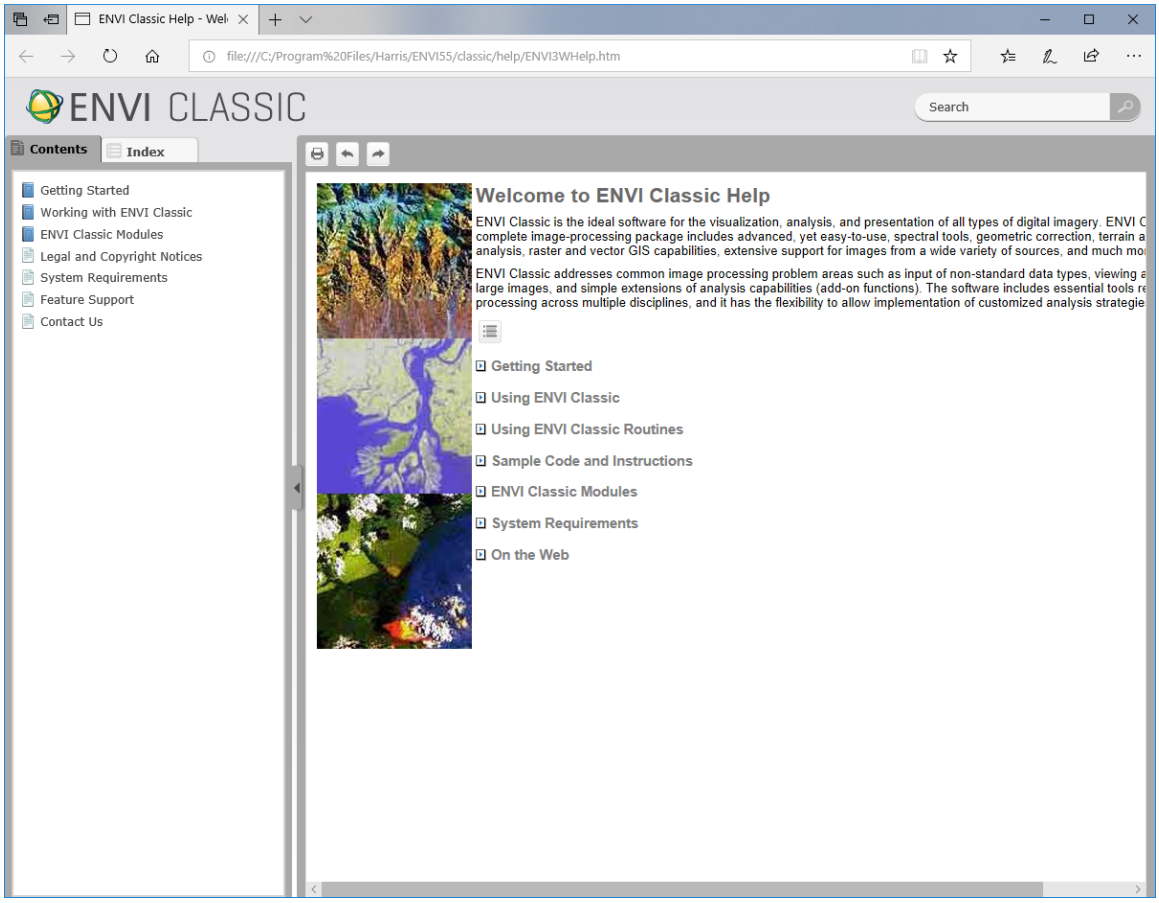
ENVI Main Menu Bar

B) ENVI Tutorials

However, before we begin using ENVI it is necessary to introduce the ENVI help system that if used properly during this course can help answer many of your questions and problems. ENVI provides an extensive on-line help system with both simple overviews and detailed descriptions of its features and functions as well as PDF tutorials which can walk you through the specifics of certain tasks. The tutorial included in ENVI software provides simple step-by-step lessons that give you hands-on practice using the basic features of the software. **It is imperative that you learn to use the available help system.**

To start the **online help system**, simply click on **Help** in the main ENVI Menu Bar simply select Help from the Main ENVI Menu *(it is typically the rightmost option as shown above*) and select "Start ENVI Classic Help". An example of the ENVI help system is shown in the screen capture below.

ENVI PDF tutorials are available online from Harris Geospatial Solutions – the company that produces ENVI and IDL. These online tutorials can be reached from the main ENVI online help page.



ENVI Help Screen

C) ENVI Tutorials

The easiest way to learn about ENVI is to work your way through some of the tutorials that have been produced Harris Geospatial Solutions. They can be found at https://www.harrisgeospatial.com/Support/SelfHelpTools/Tutorials.aspx and later in this lab, I will suggest working through several of these. Both the data and instructions can be downloaded from the site and they will also be made available on the class Google Drive. Your Teaching Assistant can also assist if you have problems.

III. Understanding the Nature and Characteristics of a Digital Image

A remotely sensed image is a pictorial rendition, or model, of target features described through the use of spectral reflectance. A digital image is stored as a two-dimensional array (or grid) of small areas called *pixels* (picture elements). Each pixel corresponds spatially to an area on the earth's surface. This array or grid structure is also called a *raster*, so image data is often referred to as a raster image. The raster image is arranged in horizontal rows called *lines*, and vertical columns called *samples*. Each pixel in the image raster is represented by a digital number (DN) or a brightness value (BV).

The image DNs can represent many different types of information depending on the data source. For satellite data such as LANDSAT and SPOT, the DNs represent the intensity of reflected light in the visible, infrared, or other wavelengths. For imaging radar (Synthetic Aperture Radar - SAR) data, the DNs represent the strength of a radar pulse returned to the antenna.

A single band (channel) image has only one data layer (matrix) and is often rendered in gray scale or in color mode. Many image datasets have multiple bands (or layers) of data covering the same geographic area, each containing a different type of information. For example, a LANDSAT ETM+ satellite image has eight bands of data, each recording reflectance from the earth's surface in a different wavelength of light. Since each band records reflectance in a different part of the spectrum, this type of data is often called multispectral data. A mutli-spectral image has a number of data layers (matrices), and can be readily rendered using RGB (Red Green Blue) or HSI (Hue Saturation Intensity) color modes.

A multi-spectral digital image can be organized and stored by ENVI in one of three basic formats: Band Interleaved by Pixel (BIP), Band Interleaved by Line (BIL), and Band Sequential (BSQ).

ENVI adopted these three formats as its internal raster data format. The header file ".hdr" is an ASCII file. It contains the metadata about the image, often including the information about the number of rows (lines), the number of columns (samples), the pixel depth (how many bytes for each pixel), the number of bands, geolocation (coordinates), map projection, the pixel size (spatial resolution), etc. The mean, standard deviation, minimum value, maximum value, and histogram of the image DNs are often used to statistically characterize digital images.

IV. Exercises and Questions

Before you begin on work on your lab, here are a few introductory comments about the lab component of this course. First, labs are an integral part of educational experience of this remote sensing course. The labs are designed to reinforce theoretical concepts presented in lecture through a hands-on experience. In addition they are designed to introduce students to a modern image processing software package providing skills that are directly transferable to the workplace. To accomplish these dual tasks requires time and you should anticipate spending more time working on labs outside of scheduled lab times than during them. Completion of the labs typically requires 4-6 hours outside of lab time.

Lab Report

For each lab in the course you will be responsible for producing a report. The report's cover information should also include your name, student ID, and lab session number. Your lab report should contain:

1) Short answers in your own words to each of the questions asked above;

2) The required figures and maps

Often an easy way to put images into your lab report is to select a window and then press Alt-PrintScreen to copy the histogram window onto the clipboard, then click Paste icon in your Word file.

Lab reports are uploaded to eCampus before the beginning of the next lab. You are not to spend lab time working on the previous week's lab.

Structure of the Exercise and Question portion of the labs

To make the lab assignment as easy to understand as possible and to provide some guidance on common questions, the assignment portion of each lab handout is structured to highlight what tasks you are required to perform, specific questions you will be asked to answer, and what maps and figures you will be expected to produce. In addition, tips are provided as guidance with some of the more common, or occasionally tricky, technical issues that may arise. To highlight these various components, typically tasks will be presented in light brown boxes, questions with a light yellow background and tips as small inset gray boxes.

TASK 1. Learn to use the ENVI help system

You will find it beneficial to read the following ENVI help information. The idea is not to read all the information in the online help, but simply to understand help well enough so you can locate information if you get stuck. As you begin to use ENVI to examine satellite images of Houston, the following portions of ENVI help may prove useful:

1. Getting Started with ENVI Classic
2. In the ENVI User's Guide the following subsections may be helpful *Interactive Displays*, *File Management* and *Basic Tools*

As we have learned from experience and much to student's detriment, many students will simply refuse to use help unless absolutely required to so just to make sure you do use help, please briefly answer the following questions to enable us to assess whether you understand the basics of ENVI. *Your answers should be typewritten.*

Question 1. What is an ENVI Header File and what is its purpose?

Question 2. What is the required and optional information in an ENVI header file?

Question 3. What are the ENVI directly supported output file formats – e.g., in what data formats can ENVI directly save data. Which of these are raster and which of these are vector?

TASK 2. Learn the basics of image manipulation using ENVI.

Every image processing package provides the user with a suite of basic image manipulation functionality that is typically needed all the time. A main point of this lab is to provide you the opportunity to learn this basic functionality as it will be required for successful completion of later labs. The skills you use here are also transferable to manipulating images within other image processing and GIS packages. While the implementation of the functions may vary, techniques such as contrast stretching, zooming, filtering etc. are common to all image processing software packages.

In order to accomplish this, two data sets for Downtown Houston are provided in the lab share /lab01 folder. One data set, consisting of "downtown.img" and "downtown.hdr", is the Landsat ETM+ multi-spectral data for Houston. It contains three bands: band 2 (green), band 3 (red) and band 4 (near infrared). The other data set, consisting of "houston_pan.img" and "houston_pan.hdr", is the panchromatic image of Landsat ETM+. These two data sets are a subset of the original full scene of the Landsat ETM+ image. The original panchromatic Landsat image for Houston has 14166 rows and 15078 columns, and the original multi-spectral Landsat image has 7083 rows and 7539 columns, covering about 185 km by 185 km ground area. The image was acquired on September 20, 1999.

Please explore these two data sets in ENVI, and answer the following multipart questions:

To begin learning about ENVI, you might find it very useful to use some of the ENVI tutorials that are available on the ENVI website. To be able to answer the questions about the Houston images, the skills presented in the following two tutorials may be useful – and you will use it nearly every time you use ENVI.

1. A Quick Start to ENVI Classic.pdf
2. Introduction to ENVI Classic.pdf
3. Google Search

Question 4. Display the Landsat ETM+ image (downtown.img) of Houston, Texas a as False Color composite image by using the RGB color display and displaying band 4 as red, band 3 as green and band 2 as blue. You should demonstrate your success with this by pasting the downtown Houston portion of the image into your lab report.

To display an image in ENVI, simply **Open Image File** to load an image file in the **Available Bands List** window where you build your image display by creating one or more 'layers' of data. The various data layers combine to create a final image on your screen display or output to your hardcopy device. The way in which you choose to display your raster data is called the "Color Mode" in ENVI. There are several ways in which raster data can be viewed, including gray scale or pseudocolor displays, and Red-Green-Blue (RGB) displays.

Use **the Available Bands List** window, RGB color mode, add "downtown.img" as three data layers, then set them respectively as red, green, blue, select correct band for red, green, blue.

There are also many different ways to enhance the contrast of your image in ENVI. These are found under the **Enhance** menu located on the main image display window.

To insert the result into your lab report, click on the scroll or main image window and press **Alt-PrintScreen** to copy the selected window into clipboard, then click Paste icon in your Word file. *You will use this trick a lot during the class.*

Question 5. How many bands, rows (lines) and columns (samples) does the multi-spectral data set "downtown.img" have? What are the pixel depth (bits or byte per pixel) and spatial resolution (cell size)? What is the band label for each data layer?

Click **File** on the main menu to invoke **Open Image File** window, navigate to the data folder and highlight "downtown.img" and open it; then click **File** again and select **Edit ENVI Header**, highlight "downdown.img". The basic information is on the right side of the window. Continue to click **OK** button to enter the **Header Info** editing window. Click **Edit Attributes**, click **Map Info…**

Alternatively, open the ASCII file "downtown.hdr" using a text editor such as NotePad or WordPad to view the content and find the answers.

Question 6. What is the datum and map projection of the panchromatic Landsat image "houston_pan.img"? What is the geographic location of the top left corner of this image? What is the total geographic area covered by this image in square kilometers?

To find information about an image Click **File** on the main menu to invoke **Open Image File** window, navigate to the data folder and highlight "houston_pan.img" and open it; then click **File** again and select **Edit ENVI Header**, highlight "houston_pan.img". The basic information is on the right side of the window. Continue to click **OK** button to enter the **Header Info** editing window. Click **Edit Attributes**, click **Map Info…**, **Geographic Corners…**.

Have fun and please do not hesitate to ask questions!