

MODULE – 6 LECTURE NOTES – 1**IMAGE PROCESSING SOFTWARE****1. Introduction**

For effective data processing, various types of remote sensing software systems need to be applied reasonably and flexibly. This enables effective feature extraction useful for various applications. ERDAS, ENVI, ArcGIS are some of the professional and popular image processing software. They possess powerful image processing functions. These software are capable of manipulating the images in many ways. They are designed to provide comprehensive analysis of satellite and aircraft remote sensing data. They are not only innovative but very much user-friendly to display and analyze images. For example, ENVI allows user to work with multiple bands, to extract spectra, use spectral libraries, to process high spectral resolution datasets such as AVIRIS, hyperspectral analysis, specialized capabilities for analysis of advanced Synthetic Aperture Radar datasets like TOPSAR, AIRSAR etc. Similarly, the ArcGIS desktop applications provide a very high level of functionality like comprehensive mapping and analysis tools, geo processing tools, advanced editing capabilities that allow data to be integrated from a wide variety of formats including shape files, coverage tables, computed aided drafting drawings, triangulated irregular networks etc. ERDAS Imagine uses a comprehensive set of tools such as image orthorectifications, mosaicking, classification, reprojection, image enhancement techniques that enable an end user to analyze remotely sensed satellite imagery and present the same in various formats ranging from 2 dimensional maps to 3 dimensional models. These software find applications in varied fields of engineering and sciences. Archaeologists use image classification to identify features that cannot otherwise be observed visually by standing on the ground. Biologists use them for delineating wetlands, to identify vegetation species and land cover. Accurate estimates of slope, aspect and spot elevation can be ascertained. Hydrologists process satellite imageries for water quality management studies, land use classification, delineating watersheds etc. In geology, the image processing software can enable identification of fracture zones, deposition of ore minerals, oil and gas, identification of anomalies in the earth's magnetic field, electrical fields or radiation patterns, to identify geologic faults and folds, to study movement of crustal plates, disaster management study of

floods and landslides etc. This module will introduce the popular software explaining in detail one of their functionality.

2. ERDAS IMAGINE

ERDAS Imagine is raster based software that is specifically designed for information extraction from images. The product suite of ERDAS is designed to consist of three products for geographic imaging, remote sensing and GIS applications. The functions embedded involve importing, viewing, altering and analyzing both raster and vector data sets. This software is capable of handling an unlimited number of bands of image data in a single file. These bands imported into ERDAS IMAGINE are often treated as layers. Additional layers can be created and added to existing image file. It allows users to import a wide variety of remotely sensed imagery from satellite and aerial platforms. Depending on user requirements, this software is available in three levels namely: Essentials; Advantage and Professional. This software also has many add-on modules. The functionality includes a range of classification, feature extraction, change detection, georeferencing etc. The range of add on modules includes Virtual GIS, IMAGINE, Vector, Radar Mapping Suite etc. One functionality of this software is discussed in detail. More information regarding the product suite can be obtained at geospatial.intergraph.com/Libraries/Tech.../ERDAS_Field_Guide.sflb.ashx

2.1 Supervised classification



ERDAS IMAGINE allows an unlimited number of layers/ bands of data to be used for one classification. Usual practice is to reduce dimensionality of the data as much as possible as unnecessary data tend to consume disk space thereby slowing down the processing.

To perform supervised classification using ERDAS IMAGINE, open the image in a viewer.

- Select training signatures using the AOI tool [AOI>Tools]

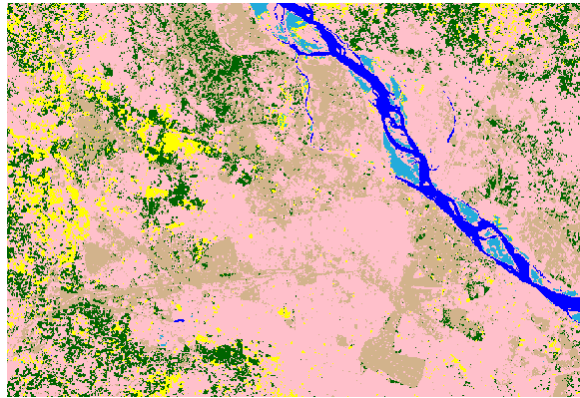
ERDAS IMAGINE enables users to identify training samples using one or more of the following methods:

a) using a vector layer b) defining a polygon in the image c) identifying a training sample of contiguous pixels with similar spectral characteristics d) identifying a training sample of contiguous pixels within a certain area, with or without similar spectral characteristics e) using a class from a thematic raster layer from an image file of the same area which is usually a result of an unsupervised classification.

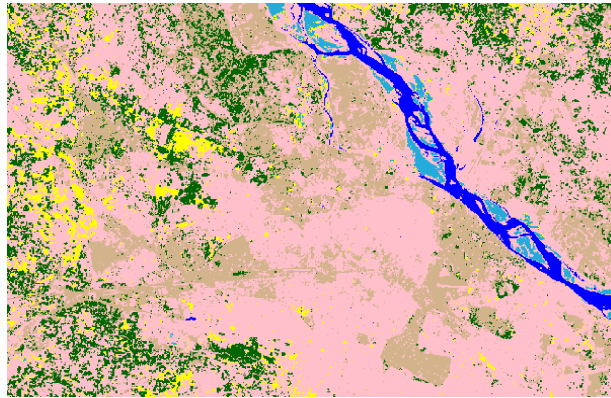
Select Signature Editor using the Classifier button. Select signatures representing each land cover class in the viewer. Use the Create Polygon AOI button  from the AOI tools. After selecting a polygonal area, double click when finished. The polygon should completely be located within a homogeneous part of the land cover which is focused. Now use the 'Create New Signature' button from the AOI button  in the Signature Editor tool in order to add the sample. Polygons representing the areas selected using AOI tool are stored as vector layers which can be used as input to the AOI tool to create signatures. Training area can also be selected using user defined polygons or using seed pixel approach. Selecting training samples being a crucial step in supervised classification, is an iterative process. In order to identify signatures that accurately represent the classes, repeated selection may be required. These need to be evaluated and manipulated as necessary. Signature manipulation involves merging, deleting, appending etc. Three or more signatures need to be collected for each land cover type classified. Once this procedure is complete, save the signature file.

- Use the 'Classifier' button from menu and go for 'Supervised Classification'
- Select the satellite imagery and enter in the 'Input Raster File'. Similarly, load the file created using the signature editor in the box showing 'Input Signature File'. Enter a new file name for the classified image. Press OK.

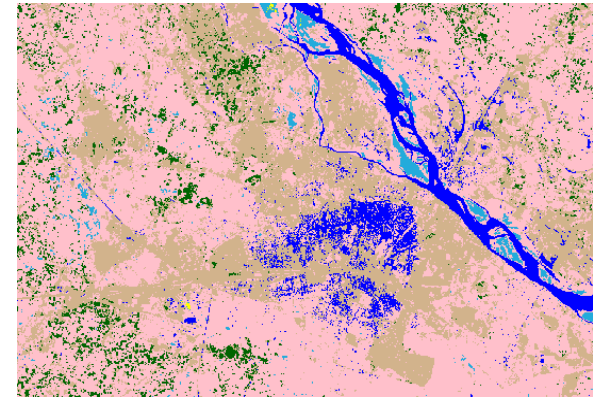
This procedure can be followed for performing supervised classifications like maximum likelihood, minimum distance to means, etc. Shown in Figure 1, shows the results of Mahalanobis, maximum likelihood and minimum distance classifier. The signature file created is also shown in Figure 1 d.



(a)



(b)



(c)

Class #	>	Signature Name	Color	Red	Green	Blue	Value	Order	Count	Prob.	P	I	H	A	FS
1	>	Deep water	Blue	0.000	0.000	1.000	3	3	64	1.000	X	X	X	X	
2		Shallow water	Light Blue	0.138	0.673	0.862	5	7	148	1.000	X	X	X	X	
3		Forest	Green	0.000	0.392	0.000	6	11	52	1.000	X	X	X	X	
4		Urban	Pink	1.000	0.753	0.796	4	14	252	1.000	X	X	X	X	
5		Mixed urban and forest	Brown	0.824	0.706	0.549	8	18	54	1.000	X	X	X	X	
6		Barren land	Yellow	1.000	1.000	0.000	9	22	61	1.000	X	X	X	X	

(d)

Figure 2.1: Thematic map obtained after performing supervised classification in ERDAS IMAGINE using methods of (a) Mahalanobis (b) minimum distance to means (c) maximum likelihood classification and (d) Signature file used

3. ENVI

ENVI employs a graphical user interface (GUI) in order to select image processing functions. ENVI uses a generalized raster data format to use nearly any image file including those which contain their own embedded header information. Generalized raster information is stored in either band sequential (BSQ), band interleaved by pixel (BIP) or band interleaved by line (BIL) format. When using ENVI, a number of windows (like main, scroll and zoom windows) and dialog boxes will appear on the screen. These allow an end user to manipulate and analyze the image. The display menu provides access to interactive display and analysis functions.



Figure 3.1: Main, scroll and zoom windows of ENVI showing image displayed

[Source: ENVI version 3 Tutorial]

Mosaicing

This module provides a working knowledge regarding ENVI image mosaicing capabilities. Basically, mosaicing refers to combining multiple images into a single composite image. ENVI provides users with the ability of placing non georeferenced images (i.e., images with no coordinate system attached to it) within a mosaic. The software allows creating and displaying mosaics without the creation of large files. Most of the mosaics require contrast stretching and histogram matching in order to minimize the image differences in the resulting output mosaic. Hence, the first step in a mosaic using ENVI is to contrast stretch the images.

- Open the image files
- Display the images by selecting the desired bands in the Available bands list
- Select Functions < Display Enhancements < Default stretches < the desired stretch type or Functions < Display Enhancements < Interactive Stretching
- Stretch the image and save the output in a new file by selecting Functions < Output Display < Image file

3.1 Histogram Matching

This technique is used such that the grayscales of images are matched with the base image. ENVI's interactive contrast stretching function can be used to perform this procedure. The steps are:

- Display the two images which are to be subjected to histogram matching in two separate display windows
- Identify the overlap areas and place the zoom windows of both the images within the overlap
- Select Functions< Display Enhancements < Interactive Stretching
- A dialog will appear for contrast stretching. Now stretch the base image
- Choose Histogram_Source< Zoom.
- In the second contrast stretch dialog also select the Histogram_Source < Zoom
- In the second dialog select Stretch_type< Arbitracy

- Apply the output histogram from the base image to the histogram of the second image
- Save both the images and repeat for additional overlapping images as required.

3.2 Feathering

ENVI provides the functionality of feathering that is used to blend or blur the scenes between mosaiced images using either edge feathering or cutline feathering.

a) Edge Feathering

This function requires the user to provide the edge feathering distance. This is blended using a linear ramp that averages the two images across that distance. For example, if the specified distance is 30 pixels, 0% of the top image is used in the blending at the edge and 100 % of the bottom image is used to make the output image. At the specified distance of 30 pixels, 100% of the top image is used to make the output image, 0% of the bottom image is used. 50% of each image is used to make the output at 15 pixels from the edge.

b) Cutline Feathering

This functionality uses the distance specified in the cutline feathering distance. For example, if the specified distance is 20 pixels, 100% of the top image is used in the blending at the cutline and 0% of the bottom image is used to make the output image. At the specified distance of 20 pixels out from the cutline, 0% of the top image is used to make the output image and 100% of the bottom image is used. 50% of each image is then used to make the output at 10 pixels out from the cutline.

4. ARCGIS

ArcGIS represents a collection of software products created by Environmental Systems Research Institute (ESRI). The Desktop GIS products allow users to integrate and edit data to create new map layers and maps.

ArcView: It is the desktop version of ArcGIS which is the most popular of the GIS software programs.

ArcEditor: This includes all the functionalities of ArcGIS which include the ability to edit features in a multiuser geodatabase,

ArcInfo: This is Esri's professional GIS software which includes functions of ArcGIS and ArcEditor.

ArcReader: This is a free product to view maps.

The basic ArcGIS desktop products include an enormous amount of functionality and extensions that can be integrated with the existing functions . Hence, a comprehensive review of these can be obtained at: <http://webhelp.esri.com/arcgisdesktop>

Some of the more frequently used extensions are:

Tools	Use
Spatial Analyst	Enables modeling and analysis with raster data.
3D Analyst	Allows users to visualize and analyze spatial data in 3D This includes draping surfaces to create ortho photos on elevation models, extruding polygons, creating animations that simulate a fly through over the study area considered.
Geostatistical Analyst	This tool enables users to analyze raster and point data using advanced statistical methods like kriging and inverse distance weighting methods etc.
Network Analyst	Allows to determine closest facility/service areas, provides useful information about traffic flow, least travel time etc.

a) Triangular Irregular Network (TIN)

Triangular Irregular Networks (TIN) have been used to represent surface morphology. These are constructed by triangulating a set of vertices which can be interpolated using different methods. ArcGIS supports the Delaunay triangulation method for creating DEM (Digital Elevation Model) using TIN. In TIN, the elevations are represented at the vertices of irregularly shaped triangles which may be small in number when the surface is flat and may be numerous for a surface with steep slope. TIN is created by running an algorithm over a

raster to capture the nodes required for TIN. A TIN surface can be created using features of either point, line or polygon that contain elevation information. It can also be generated from raster data sets. For conversion of raster dataset to TIN, the Raster to TIN geoprocessing tool can be used. This procedure by itself does not guarantee a better result unless accompanied by ancillary data which is compatible with the surface definition.

Similarly, TIN surface can also be generated using a terrain dataset using the following steps:

- *3D Analyst Toolbox > Terrain to TIN* geoprocessing tool
- Select input terrain dataset and browse the dataset which is to be converted to TIN
- Provide locations for saving the output TIN file
- Select a *Pyramid Level Resolution* from terrain as it is known to improve efficiency taking advantage from the fact that accuracy requirements diminish with scale.
- Provide the *Maximum number of nodes* value which is to be used to create TIN surface. Default is 5 million
- Select *Clip to Extent*
- Click *OK*

Similar operations can be performed for creating TIN surface from raster data. TIN for Krishna basin in India created using USGS DEM data (<http://www.usgs.gov>) is shown in Figure 4.5. It can be observed from this figure how the topographical variations are depicted with the use of large triangles where change in slope is small and small triangles of different shapes and sizes where there are large fluctuations in slope.

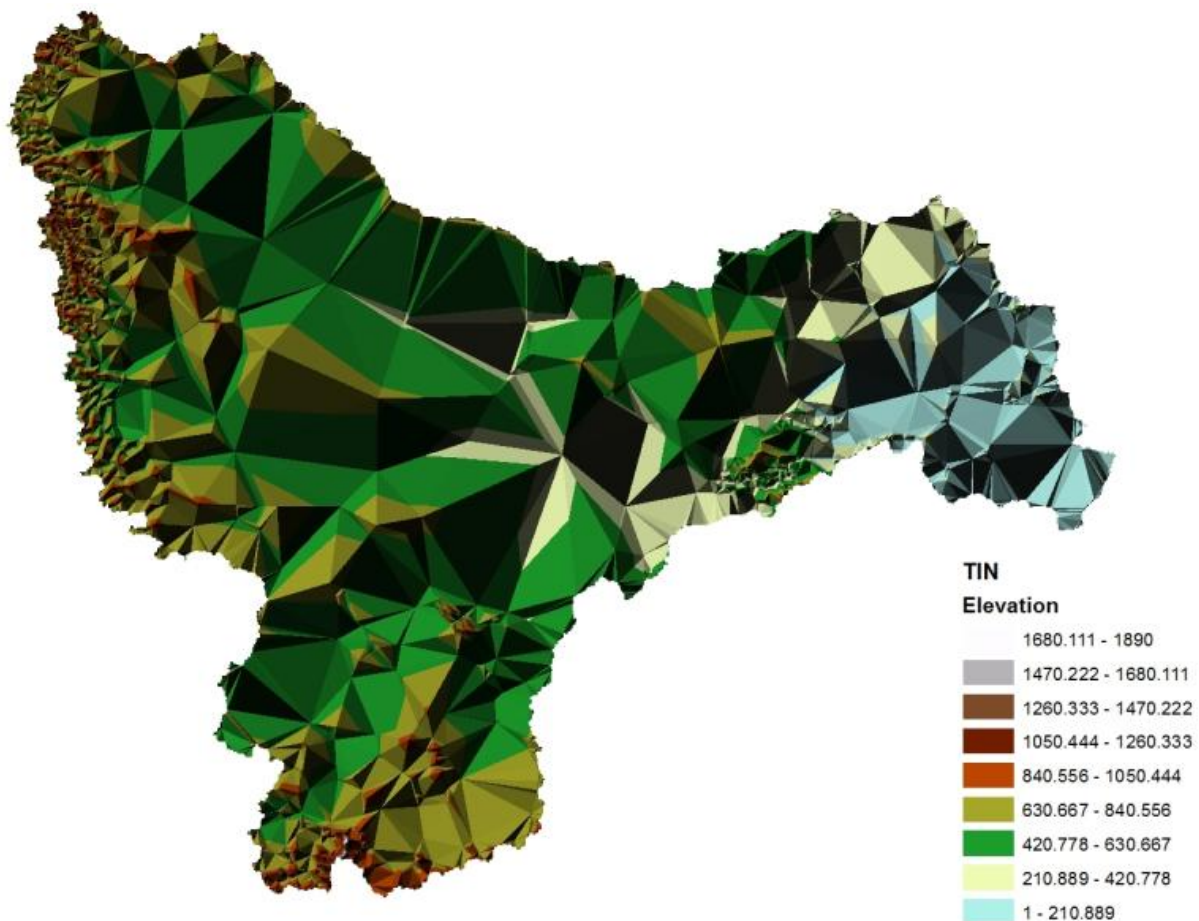


Figure 4.1: TIN image of Krishna river basin, India.

5. Map Projections

Maps are representation of all or any part of the earth in a 2 dimensional flat surface at a specific scale. Map projections are relied to transfer the features of a globe onto the flat surface of a map. The three types of map projections originally developed are cylindrical, planar and conic. It is essential to note that while these map projections try to outlay the globe as accurately as possible, the globe is the only true representation of the spherical earth and therefore any attempt to represent it on a flat surface will definitely result in some form of distortion. The basic knowledge of datums and coordinate systems are expected before user tries to understand a suitable map projection system. However, these will not be covered in this material. Extensive information regarding the same can be obtained from the following link : <http://kartoweb.itc.nl/geometrics/map%20projections/understanding%20map%20projections.pdf>