



# **Using ENVI and Geographic Information Systems (GIS)**

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## I. Introduction

ENVI is the premier application for extracting geospatial information from remotely-sensed imagery. Developed by ITT Visual Information Solutions, ENVI has long been recognized as a leader in the data access, analysis, and sharing of all imagery and data formats. ENVI's complete image analysis platform includes robust yet easy-to-use tools for users with all levels of image processing experience, in order to enhance the GIS workflow with all types of imagery.

A major focus of recent and future ENVI development is providing tools to integrate information derived from imagery into Geographic Information System (GIS) databases. ENVI currently has many tools to help prepare raster data for updating GIS databases, including extracting relevant information and converting to common vector data formats. Moreover, upcoming releases will improve and add to these capabilities.

Many GIS users face the problem of acquiring accurate and timely data at a cost effective price. GIS data may be outdated, inaccurate, prohibitively expensive, or all three. Image analysis applications such as ENVI, along with recently acquired satellite imagery, provide the ideal, cost-effective, solution for updating GIS databases with accurate layers such as roads, parcels, and natural phenomena including wetlands, land-cover, and invasive species.

## II. Classification

Finding features in remotely sensed imagery can be a time-saving way to define and update GIS layers. Locating features and converting them to vector coverages is often accomplished via heads-up digitizing, which is the process of tracing on-screen the outlines of features of interest from a raster image. Heads-up digitizing is often extremely labor intensive and time consuming.

When raster images with spectral information are available (i.e., images with multiple wavelength bands), ENVI's methods for automatically categorizing pixels into specific classes can be used. Raster data classified in this way can then be converted to vector layers, and output to a variety of vector formats, including ESRI shapefiles. This process is usually much faster and easier than manually digitizing from the raster image, providing GIS users with a cost effective way to update their GIS with accurate and timely layers.

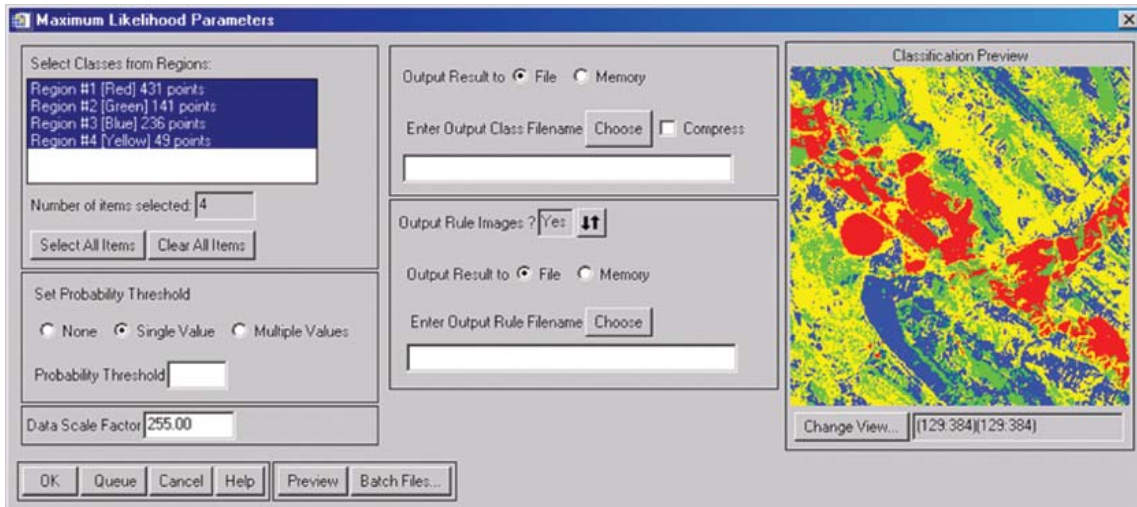


Figure 1: ENVI's classification tools allow you to easily adjust classification parameters to get a quick view of results.

ENVI's raster classifiers include standard approaches such as maximum likelihood and minimum distance classifiers. ENVI also has a suite of more sophisticated classification methods, including neural net and decision tree classifiers. Neural networks use algorithms suggestive of connections between neurons and can learn by trial and error. A decision tree is a predictive model employing a branching series of decisions. In a decision tree, all of the decisions to which a given pixel is subject eventually determine the class to which that pixel is assigned.

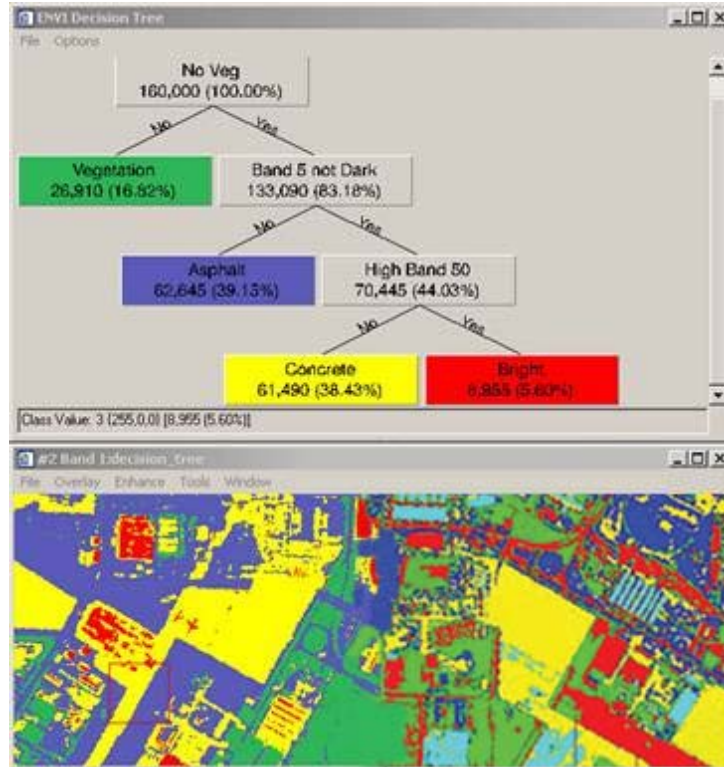


Figure 2. ENVI's Decision Tree uses predictive models to classify each pixel in an image.

## A. Spectral Angle Mapper (SAM)

The most popular of ENVI's classification tools for use with spectral imagery is the Spectral Angle Mapper (SAM). SAM is a method to compare known spectral target properties to every pixel in the scene. When looking for a single target, the result is a grayscale image where the pixels that best match the target properties are the darkest. If multiple targets are identified at input, then a color image is automatically generated, in which each pixel has a color corresponding to the target to which that pixel is most similar. An example application for SAM would be locating a vehicle via literal analysis. The analyst could "paint" the target with a region of interest (ROI), and then use SAM to find everywhere else in the scene that the target is present. An alternative application would be to select known targets from some pre-defined spectral library to find within the image.

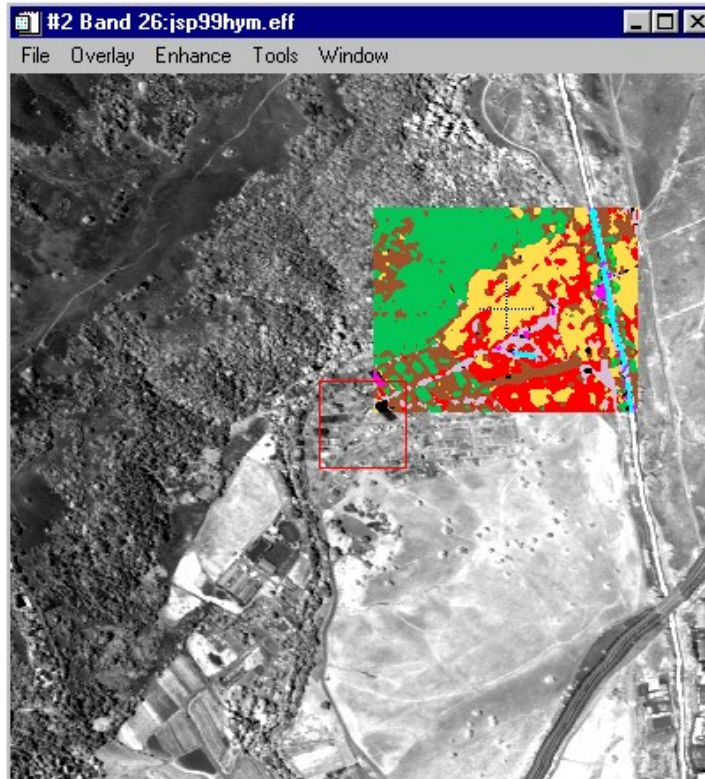


Figure 3. ENVI's Spectral Angle Mapper (SAM) classifies an input image based on the spectral properties of the target classes.

### III. Post Classification

After pixels in a raster dataset have been assigned to categories, post-classification methods can clean up the resulting raster class image in preparation for conversion to vector data. Raster classification results often contain scattered individual pixels of one class surrounded by a larger area of another class (i.e., islands). ENVI provides a number of tools, including clumping, sieving, and majority analysis, for minimizing this type of clutter in classification results, providing smoother results for improved GIS analysis.

Finally, the cleaned-up classification results can be converted from raster class images to vector layers. ENVI supports output of vector data to its own vector format (ENVI Vector Format or EVF), as well as to ESRI shapefiles and other formats.

ENVI also provides the ability to create new vector layers via heads-up digitizing from raster data. ENVI's vector tools also enable editing of existing vector layers, and vector attribute querying.

### More ENVI Raster GIS Tools

ENVI's raster GIS tools include a buffer zone tool to calculate distances from a vector or class boundary. A line-of-sight tool can help identify areas that are visible from a given

location. Vector elevation contours and point elevation data can be converted to raster DEM images, and vice versa. ENVI can read popular vector formats such as ArcView Shapefiles, ARC/INFO interchange files, DXF files, Microstation or Intergraph DGN files, USGS DLG files and more. Vector layers can be overlain onto image data, to easily compare raster and vector information.

### III. Feature Extraction

Today's GIS and Imagery analysts increasingly need to find and identify features of interest within geospatial imagery. But, the process of manually locating and digitizing these features is often complex and time consuming, and spectral content is often limited, reducing the accuracy of standard classification methods.

The new ENVI Feature Extraction Module will provide a significant time savings over traditional feature extraction methods. Users will be able to segment an image and quickly view the results in a Preview Window to assess the accuracy of the segmentation and classification, rather than having to wait for the full image to be processed. The segmentation scale can be quickly adjusted and previewed as many times as needed prior to full image processing. Once accurate parameters have been established, the process can be automatically repeated on a collection of imagery.

Traditional pixel-based approaches to feature extraction use the spectra of each pixel to classify imagery. The accuracy of this approach typically depends upon the availability of a large number of spectral bands, limiting the types of imagery that can be used. The ENVI Feature Extraction Module uses an object-based approach to identify and define features, allowing users to get accurate results even with limited bands. This method makes it an accurate tool for use with all kinds of imagery and data types, particularly pan and multi-spectral imagery.

The new module will provide intuitive workflows and preview screens that allow users to ingest images, perform segmentations and initiate processing. The new Preview Window will also allow users to quickly see the results of the processing and readily allow for adjustments and changes. In most cases the analyst will only need to interact with a single parameter and the tool will automatically take care of the rest.

The ENVI Feature Extraction Module will allow analysts to extract features from pan and multi-spectral imagery - the most widely available imagery today. In addition, because it is an add-on module to the ENVI product, users can perform all feature extraction, image processing, analysis and visualization tasks in a single product.

The ENVI Feature Extraction Module will be ideal for:

- Finding and counting particular features across large images
- Adding new vector layers to geodatabases
- Classifying images as outputs to be used in reports or analyses
- Replacing or accelerating manual digitization processes

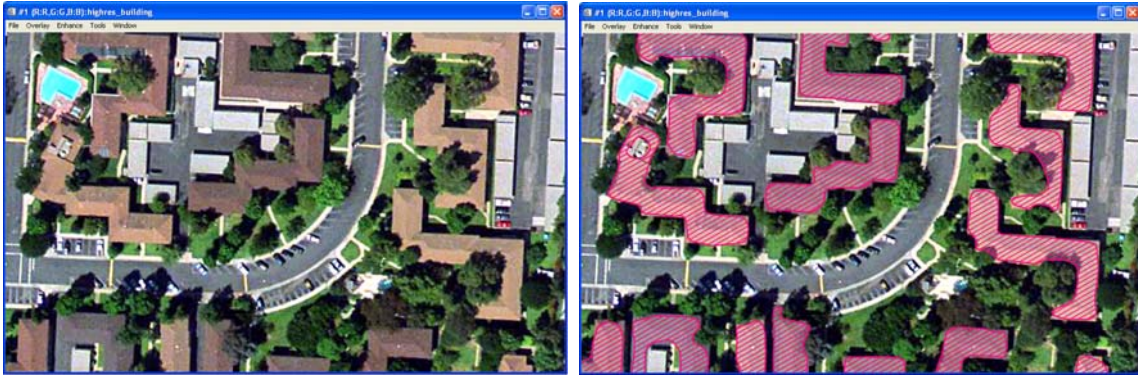


Figure 4: ENVI's Spatial Feature Extraction Module includes tools to automatically extract area-based features from geospatial imagery. The figure above shows the original geospatial image on the left, courtesy of DigitalGlobe, and the vector overlay showing building rooftops extracted using the ENVI Feature Extraction Module.

### A. Intelligent Linear Feature Extraction

ENVI's intelligent linear feature extraction tool automatically defines nodes between user-specified seed points along linear features. As you identify seed points, the intelligent linear feature extractor automatically digitizes everything between the seed points, faithfully following curves, jumping gaps, and snapping vectors if desired. This tool can be used on any linear feature, from roads to coastlines, and saves large amounts of time over traditional point-by-point digitizing.

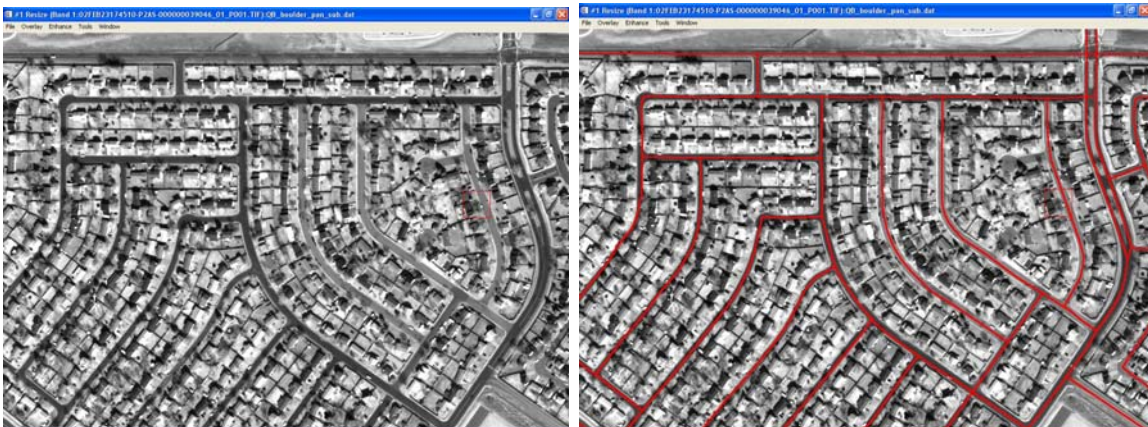


Figure 5: ENVI's includes tools to automatically extract linear features from geospatial imagery. The figure above shows the original geospatial image on the left, courtesy of DigitalGlobe, and the vector overlay showing roads extracted using the ENVI Intelligent Digitizer.

## IV. ENVI Zoom Interface

ENVI 4.3 introduced a new interface for ENVI that is designed to be more intuitive to users familiar with popular GIS software. ENVI Zoom is an optional interface for ENVI that allows you to view and explore your images in an intuitive and familiar environment. Users of any experience level can use ENVI Zoom to easily view images and perform anomaly detection. In future releases, you will be able to access additional components of the ENVI suite of tools from the ENVI Zoom interface.

This first release of the new ENVI interface provides a new image viewer with a set of graphical tools and performance enhancements that make image exploration fast and easy. The new viewer also introduces a layer concept, to facilitate working with multiple raster datasets. All displays and display tools are contained within one window by default, limiting desktop clutter and keeping projects organized.

Benefits of the optional ENVI Zoom interface include:

- Easily view and explore images without extensive ENVI experience
- Work in a familiar Windows®-type environment
- Access helpful tools from a new toolbar that includes buttons, sliders, undo/redo, tool tips, and more
- Display layers and stack multiple images with on-the-fly reprojection
- Access a new portal feature that allows you to look through one image layer to another image layer
- Detect anomalous features in images

## V. Geodatabase Support

Geodatabase and enterprise connectivity is important for ENVI, as more and more companies and organizations are providing their image data to constituents by setting up databases on centralized server machines. For the members of the enterprise to access these images across the internet or other network, they need appropriate software on their local (client) machines. Making ENVI a client to these remote databases allows the enterprise members to use ENVI to smoothly access the imagery that they need as part of their normal image analysis workflow.

Many users of remotely sensed imagery and geographic information systems are moving to geodatabases to organize and provide access to large amounts of data. We recognize this important development in the industry, and plan to add support for geodatabases to ENVI. The first step was to enable ENVI as a client to Open Geospatial Consortium (OGC) compliant servers. This functionality was released with ENVI version 4.3.1.

The two main OGC service standards addressed with the ENVI 4.3.1 release are:

**WMS (Web Map Service)** – WMS serves “maps,” which are static pictures.

**WCS (Web Coverage Service)** –WCS serves “coverages”, which are raw images.

Future plans include direct support for raster and vector data stored in Oracle 10g and ArcSDE databases.

## **VI. Conclusion**

ITT Visual Information Solutions recognizes the growing importance of raster imagery for geographic information system users. ENVI currently provides a number of tools that can help integrate raster imagery with geographic information systems. Moreover, development plans for ENVI include many new tools that will make working with raster imagery even easier for GIS specialists.

To learn more about ENVI features and functionality, and how it integrates with GIS applications, visit [www.itvis.com/ENVI/GIS](http://www.itvis.com/ENVI/GIS), or contact your ENVI sales representative at 303-786-9900.

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