

ENVI Tutorial: Linear Feature Extraction with Intelligent Digitizer

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Linear Feature Extraction with Intelligent Digitizer

This tutorial shows you how to use ENVI's Intelligent Digitizer to extract linear features, such as roads, coastlines, lake boundaries, and rivers as vector data.

Files Used in this Tutorial

ENVI Resource DVD: `Data\selmivis`

File	Description
<code>selinunte_rad.bil</code>	MIVIS Radiance Data, Selinunte, Italy, 92 bands
<code>selinunte_rad.hdr</code>	Header for the above file

ENVI Resource DVD: `Data\ortho`

File	Description
<code>po_101515_pan_0000000.tif</code>	Panchromatic IKONOS data of La Jolla, CA, one band
<code>po_101515_pan_0000000.hdr</code>	Header for the above file

About Intelligent Digitizer

With Intelligent Digitizer, you place seed points along the path of a feature and ENVI automatically finds the intermediate points. By using this method, Intelligent Digitizer reduces the number of mouse clicks you use to extract a feature, resulting in saved time and improved accuracy over traditional head-up digitization. You can also toggle between intelligent mode and ENVI's standard vector tool mode when needed, such as when contrast is low or there are big disturbances in the linear features, to ensure the feature selection is accurate. You can extract features using a single band or multiple bands. Using Intelligent Digitizer on properly-selected multiple bands increases the accuracy of your results.

With Intelligent Digitizer, you can perform automatic post-processing procedures to improve the quality of the feature extractions, and as with ENVI's standard vector tool, you can manually manage vectors, perform basic vector editing, and convert vectors to external formats such as shapefiles.

When extracting linear features, it is best to create separate layers for different feature types. The exercises that follow have you create one layer for coastline extraction from a multiband image, and another layer for road extraction from a single band image. Both examples extract the feature with a polyline. If you want to extract a feature such as a lake boundary, you use polygon mode.

Opening a File for Coastline Extraction

1. From the ENVI main menu bar, select **Vector > Intelligent Digitizer**. The Intelligent Digitizer Input File dialog appears.
2. Click **Open**, then select **New File**. The Please Select a File dialog appears.
3. Navigate to the `Data\selmivis` directory, select the file `selinunte_rad.bil`, and click **OK**. The File Spectral Subset dialog displays.
4. Click **OK** to accept the default bands to use for intelligent digitization (bands 6, 11, and 20). The image opens in a display group. The Vector Parameters dialog also opens, with menu options for

Intelligent Digitizer enabled. ENVI adds a new layer named Intelligent Digitizer: New Layer to the Available Vector Layers area of the Vector Parameters dialog.

A Note About Opening Multiband Files

If the image has three or fewer bands, the image opens in a display group, with all three bands selected for use in the Intelligent Digitizer.

If the image has more than three bands, the File Spectral Subset dialog appears with pre-selected bands. It is recommended that you select six or fewer bands. Using more than six bands slows system performance.

ENVI pre-selects bands as follows:

- If the image has four bands, ENVI selects bands 3 and 4, typically the red and near-infrared bands.
- If the image has more than four bands and also has wavelength information, ENVI selects a color-infrared combination of bands.
- If the image has more than four bands but does not have wavelength information, ENVI selects the bands as $[nb/3, nb/2, nb*2/3]$ for red, green, and blue, where nb is number of bands.

Extracting a Coastline

Using the layer named `Intelligent Digitizer: New Layer`, this exercise shows you how to select seed points that define the coastline, and how to rename the layer.

When extracting features such as coastlines or lake boundaries, you can change the extraction width in the Intelligent Digitizer Parameters dialog to 1.00. To do this, select **Mode > Intelligent Digitizer Parameters** to open the Intelligent Digitizer Parameters dialog. Change the **Linear Feature Width (Pixels)** value to **1.00**.

1. From the Display group menu bar, select **Tools > Pixel Locator**. The Pixel Locator dialog appears.
2. Enter the **Sample** as **1** and the **Line** as **501**, then click **Apply** to move to the beginning of the coastline shown in the image below.



3. In the Image window, begin left-clicking at intervals to add seed points that mark the coastline. ENVI automatically connects one seed point to the next seed point. The example above shows the seed points as solid black boxes and the nodes added by ENVI as white outlined boxes.

Here are some tips for extraction:

- For sharp curves along the coastline, select seed points at the sharp curves.
 - If the placement of a seed point does not extract the feature as desired, middle-click to remove the last seed point, then select a new seed point closer to the seed point you removed. You can middle-click more than once to remove seed points in reverse order, one at a time.
 - If the spectrum of the coastline changes abruptly, select a seed point a few pixels beyond the surface change.
4. Continue adding seed points until you define the entire coastline. After you add the final seed point, right-click to set the point, then right-click again and select **Accept New Polyline**.



5. From the Vector Parameters dialog menu bar, select **Edit > Save Changes Made to Layer** to save the layer to memory, then close the Vector Parameters dialog. The remaining steps show you how to rename your layer and save it to a file.
6. From the ENVI main menu bar, select **Vector > Available Vectors List**. The Available Vectors List displays, with the layer named Intelligent Digitizer: New Layer in the Available Vector Layers area.
7. From the Available Vectors List menu bar, select **Options > Edit Layer Names**. The Edit Layer Names dialog appears.

8. Select the layer named Intelligent Digitizer: New Layer, type the name `Selinunte_Coastline` in the **Edit Selected Item** field, then click **OK**. The new layer name appears in the Available Vector Layers area of the Available Vectors List.
9. Select the `Selinunte_Coastline` layer, then from the Available Vectors List menu bar select **File > Save Memory Layers to File**. The Save Memory Layer to File dialog appears.
10. Enter the filename `Selinunte_Coastline.evf` in the **Enter Output Filename [.evf]** field, then click **OK**.
11. In the Available Vectors List, select the layer name in the Available Vector Layers area and click **Load Selected**. The Load Vectors dialog displays.
12. Select **Display #1** and click **OK**. ENVI overlays the vector on the image. The Vector Parameters dialog appears, with the new layer name in the Available Vector Layers area.

Opening a File for Road Extraction

1. From the ENVI main menu bar, select **Vector > Intelligent Digitizer**. The Intelligent Digitizer Input File dialog appears.
2. Click **Open**, then select **New File**. The Please Select a File dialog appears.
3. Navigate to the `Data\ortho` directory, select the file `po_010515_pan_00000000.tif`, and click **OK**. The image opens in a display group. The Vector Parameters dialog also opens, with menu options for Intelligent Digitizer enabled. ENVI adds a new layer named Intelligent Digitizer: New Layer added to the Available Vector Layers area of the Vector Parameters dialog.

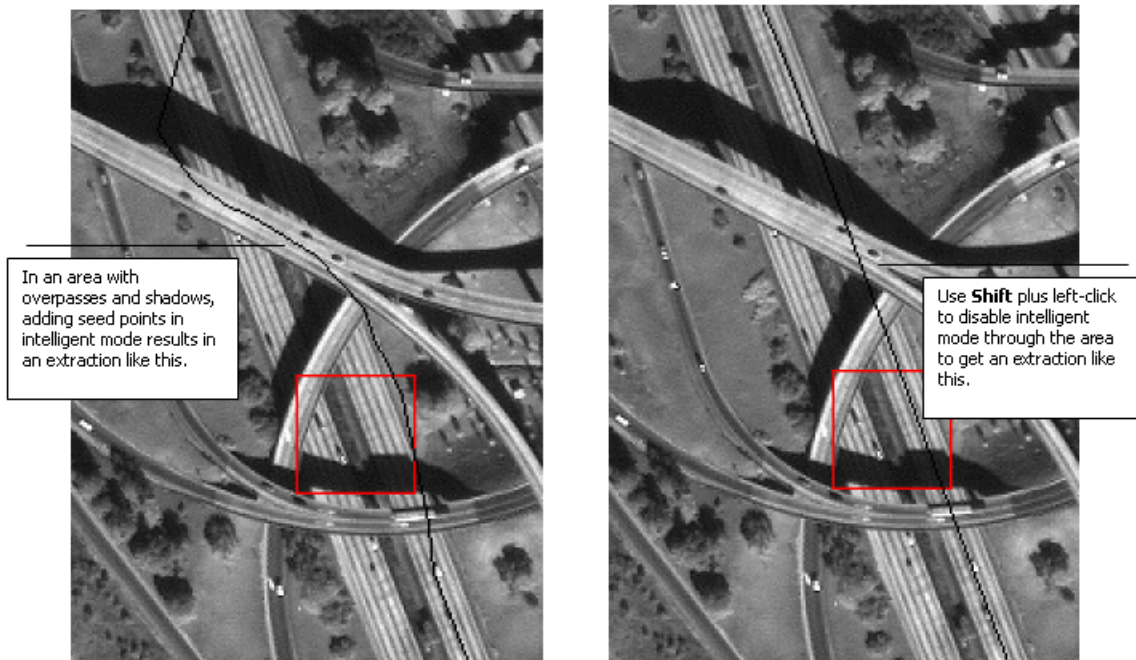
Extracting Roads

This exercise shows you how to create a new layer and extract roads with intersections and a highway with overpasses.

If you changed the Linear Feature Width (Pixels) value to 1.00 in the previous exercise to extract the coastline, reset the value to **15.00** before you extract roads.

1. In the Scroll window, move the Image box to an area containing roads, preferably roads that intersect. You can use the Pixel Locator tool to find areas for extraction. Some suggested areas to extract include the following:
 - Sample = 4532, Line = 2479, for an area of highway that contains overpasses
 - Sample = 1301, Line = 3349, for an area of streets and intersections
 - Sample = 3263, Line = 4470, for an area of streets and intersections
 - Sample = 2863, Line = 1631, for an area of streets and intersections
2. Click the **Maximize** button in the Image window title bar to enlarge the Image window.
3. From the Vector Parameters dialog menu bar, select **File > Create New Layer**. The New Vector Layer Parameters dialog appears.
4. Type the name `LaJolla_CA_Roads` in the **Layer Name** field.

5. Select output to **File** and enter the filename `LaJolla_CA_Roads.evf` in the **Enter Output Filename [.evf]** field. If needed, click **Choose** to change the directory to which to save the file.
6. Click **OK**. The new layer appears in the Vector Parameters dialog.
7. In the Image window, begin left-clicking at intervals to add seed points that mark the roads you want to extract. ENVI automatically connects one seed point to the next seed point. Here are some tips for extraction:
 - For road centerline extraction, select seed points near the road centerline.
 - For sharp curves in the road, select seed points at the sharp curves.
 - If the placement of a seed point does not extract the feature as desired, middle-click to remove the last seed point, then select a new seed point closer to the seed point you removed. Clicking on a location closer to the previous seed point will likely give a better result. You can middle-click more than once to remove seed points in reverse order, one at a time.
 - At intersections, extend the start or end node beyond the point where the two roads intersect. You will use automatic post-processing in a later step to remove dangling lines.
 - In areas that do not provide sufficient contrast between the feature and its background, or in areas of roadways with overpasses, press and hold the **Shift** key to temporarily disable intelligent mode, then left-click to define the feature through the area. When you are past the area, release the **Shift** key to resume using intelligent mode. For example:



8. When you have enough seed points added to define a road, right-click to set the final seed point, then right-click again and select **Accept New Polyline**. Optionally, if you are extracting a road that is near another road (or roads) that is already extracted, you can snap the node(s) to the

, **Snap End Node to Nearest Polyline**, or **Snap Both Ends to Nearest Polylines** from the right-click menu.

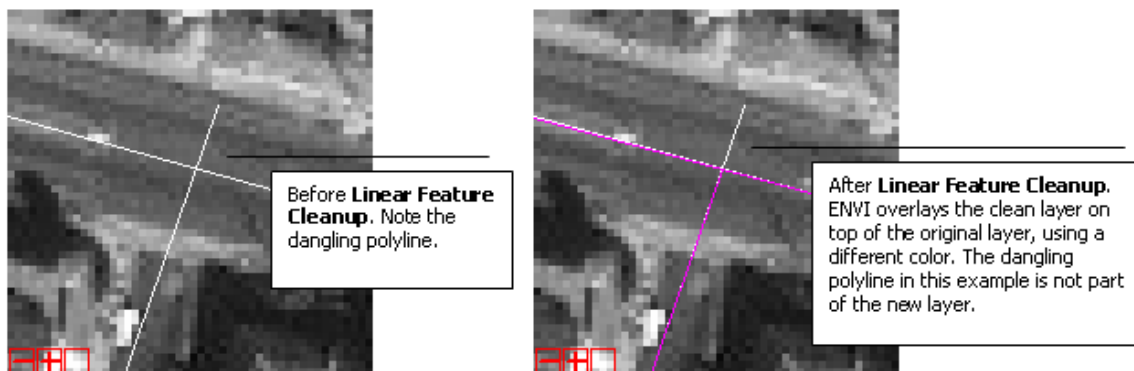
9. Repeat adding seed points for each road you want to extract.
10. From the Vector Parameters dialog menu bar, select **Edit > Save Changes Made to Layer**.

Using Automatic Post-Processing Tools

After you extract polyline features, you can apply ENVI's automatic post-processing cleanup tool to create intersections between polylines that cross one another, and to correct overshooting (dangling) polylines.

1. Right-click on the `LaJolla_CA_Roads` layer in the Vector Parameters dialog and select **Linear Feature Cleanup**. The Linear Feature Cleanup Parameters dialog appears.
2. The **Dangle Length Tolerance (Pixels)** default value is 20.00. ENVI removes any dangling polylines shorter than this value during automatic linear feature cleanup. You can change this value in the dialog, if needed.
3. Click **OK**. ENVI removes any dangling polylines and creates intersections between crossing polylines. When complete, ENVI overlays the modified layer on the original layer (using a different **Current Layer** color). In the Vector Parameters dialog, ENVI adds the new layer named `LaJolla_CA_Roads_clean` to the Available Vector Layers list.

The next figures show an example of before and after using Linear Feature Cleanup.



4. The following figure shows a large scene with an extracted road network after automatic post-processing is complete. The original extraction contained dangles, which were removed during the Linear Feature Cleanup step.



5. If desired, you can close the original layer (LaJolla_CA_Roads) by right-clicking on the layer name in the Vector Parameters dialog box and selecting **Remove Active Layer**.

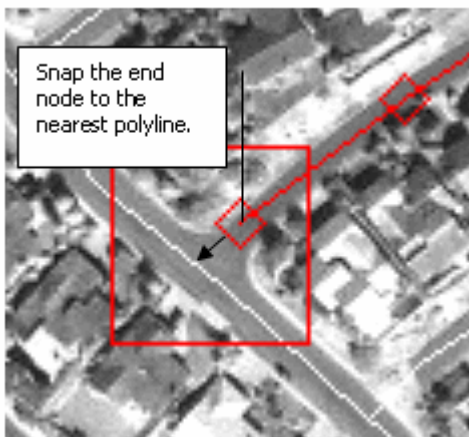
Using Manual Post-Processing Tools

You can further clean up your extraction using manual post-processing features. You can snap one polyline to one another, and you can extend polylines that you previously extracted. You can also use ENVI's standard vector tools to adjust nodes.

Snapping Nodes to Polylines

ENVI uses a default setting of 30.00 pixels to snap nodes to polylines. When you select a node that is 30.00 or fewer pixels away from a polyline, ENVI snaps that node to the polyline when you select the menu option described in the steps below. You can modify the snap setting by selecting **Mode > Intelligent Digitizer Parameters** from the Vector Parameters menu bar and editing the **Snap Tolerance (Pixels)** field. You can also disable snapping by setting **Snap Tolerance (Pixels)** to 0.0.

1. From the Vector Parameters dialog menu bar, select **Mode > Edit Existing Vectors**.
2. Select the layer to edit from the Available Vector Layers area.
3. In the Image window, find an area where extracted polylines do not quite meet. Select the polyline you want to join with a nearby polyline. The polyline nodes appear and the polyline color changes to red.
4. Right-click and select **Snap End Node to the Nearest Polyline**. ENVI connects the end node to the nearest polyline.



Extending Polylines

1. From the Vector Parameters dialog menu bar, select **Mode > Edit Existing Vectors**.
2. Select the layer to edit from the Available Vector Layers area.
3. In the Image window, select the polyline you want to extend. The polyline nodes appear and the polyline color changes.
4. Right-click on the end node you want to extend and select **Extend Selected Vector**. The polyline nodes disappear and the polyline color returns to the current layer color. ENVI automatically changes to Add New Vectors mode. Verify that **Intelligent Digitizer** is enabled in the **Mode** menu of the ENVI main menu bar. If it is disabled, then enable it.
5. Add new seed points as you do when you extract a feature. ENVI automatically continues the vector from the end node and treats the vector as one continuous polyline.
6. After you select the last seed point, right-click to set it, then right-click again and select **Accept New Polyline**.

Calculating Extracted Feature Length

You can calculate the length of extracted features and include the results as the attribute `evf_length` in the Layer Attributes table. The default units for the `evf_length` attribute are meters.

1. Right-click on the `LaJolla_CA_Roads_clean` layer in the Vector Parameters dialog and select **Calculate Length Attribute**.
2. ENVI calculates the EVF length of the features, then displays the results in the `evf_length` field of the Layer Attributes table.