ENVI®

ENVI Tutorials

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Acknowledgments

Tutorial 4:

Image Georeferencing and Registration

The following topics are covered in this tutorial:

Overview of This Tutorial

This tutorial provides basic information about georeferenced images in ENVI and Image-to-Image and Image-to-Map Registration using ENVI. It covers step-by-step procedures for successful registration, discusses how to make image-maps using ENVI and illustrates the use of multi-resolution data for HSV Sharpening. It is designed to provide a starting point to users trying to conduct image registration. It assumes that you are already familiar with general image-registration and resampling concepts. This tutorial is designed to be completed in about 1 to 2 hours.

Files Used in This Tutorial

CD-ROM: *ENVI Tutorial and Data CD No. 1*

Path: `envidata/bldr_reg`

File	Description
Required Files	
`bldr_sp.img`	Boulder SPOT Georeferenced Image Subset
`bldr_sp.hdr`	ENVI Header for Above
`bldr_sp.grd`	Boulder SPOT Map Grid Parameters
`bldr_sp.ann`	Boulder SPOT Map Annotation
`bldr_tm.img`	Non-Georeferenced Boulder TM Data
`bldr_tm.hdr`	ENVI Header for Above
`bldr_tm.pts`	GCPs for TM-SPOT Image-to-Image Registration
`bldrtm_m.pts`	GCPs for TM-Map Registration
`bldr_rd.dlg`	Boulder Roads DLG
`bldrtmsp.grd`	Merged TM-SPOT Map Grids
`bldrtmsp.ann`	Merged TM-SPOT Annotation
Generated Files	
`bldr_tm1.wrp`	Image-to-Image Result Using RST and Nearest Neighbor
`bldr_tm1.hdr`	ENVI Header for Above

File	Description
bldr_tm2.wrp	Image-to-Image Result Using RST and Bilinear Interpolation
bldr_tm2.hdr	ENVI Header for Above
bldr_tm3.wrp	Image-to-Image Result Using RST and Cubic Convolution
bldr_tm3.hdr	ENVI Header for Above
bldr_tm4.wrp	Image-to-Image Result Using 1st degree polynomial and Cubic Convolution
bldr_tm4.hdr	ENVI Header for Above
bldr_tm5.wrp	Image-to-Image Result Using Delaunay Triangulation and Cubic Convolution
bldr_tm5.hdr	ENVI Header for Above
bldr_tm5.hdr	ENVI Header for Above
bldrtm_m.img	Image-to-Map Result using RST and Cubic Convolution for the Boulder TM data
bldrtm_m.hdr	ENVI Header for Above
bldrtmsp.img	Boulder TM/SPOT sharpening result using HSV sharpening, 10 meter pixels
bldrtmsp.hdr	ENVI Header for Above

Georeferenced Images in ENVI

ENVI provides full support for georeferenced images in numerous predefined map projections including UTM and State Plane. In addition, ENVI's user-configurable map projections allow construction of custom map projections utilizing 6 basic projection types, over 35 different ellipsoids and more than 100 datums to suit most map requirements.

ENVI map projection parameters are stored in an ASCII text file `map_proj.txt` that can be modified by ENVI map projection utilities or edited directly by the user. The information in this file is used in the ENVI Header files associated with each image and allows simple association of a Magic Pixel location with known map projection coordinates. Selected ENVI functions can then use this information to work with the image in georeferenced data space.

ENVI's image registration and geometric correction utilities allow you to reference pixel-based images to geographic coordinates and/or correct them to match base image geometry. Ground control points (GCPs) are selected using the full resolution (Main Image) and Zoom windows for both image-to-image and image-to-map registration. Coordinates are displayed for both base and uncorrected image GCPs, along with error terms for specific warping algorithms. Next GCP point prediction allows simplified selection of GCPs.

Warping is performed using resampling, scaling and translation (RST), polynomial functions (of order 1 through *n*), or Delaunay triangulation. Resampling methods supported include nearest-neighbor, bilinear interpolation, and cubic convolution. Comparison of the base and warped images using ENVI's multiple Dynamic Overlay capabilities allows quick assessment of registration accuracy.

The following sections provide examples of some of the map-based capabilities built into ENVI. Consult the *ENVI 3.5 User's Guide* for additional information.

Georeferenced Data and Image-Map

This portion of the exercise will familiarize you with the use of georeferenced data in ENVI, allow you to construct an image-map complete with map grids and annotation, and produce an output image.

Start ENVI

Before attempting to start the program, ensure that ENVI is properly installed as described in the installation guide.

- To open ENVI in UNIX, enter `envi` at the UNIX command line.
- To open ENVI from a Windows or Macintosh system, double-click on the ENVI icon.

The ENVI main menu appears when the program has loaded and executed.

Open and Display SPOT Data

To open the Georeferenced SPOT data:

1. Select **File** → **Open Image File** on the ENVI main menu.

Note

On some platforms you must hold the left mouse button down to display the submenus from the menu bar.

2. When the **Enter Data Filename** file-selection dialog appears, navigate to the `bldr_reg` subdirectory of the `envidata` directory and select the file `bldr_sp.img` from the list.
3. Click **OK**.
4. When the **Available Bands List** dialog appears, click on the **Gray Scale** radio button and select the SPOT band listed at the top of the dialog by clicking on the band with the left mouse button.

   The band you have chosen will be displayed in the field marked **Selected Band:**.
5. Click the **Load Band** button to load the image into a new display.

Edit Map Info in ENVI Header

1. From the ENVI main menu, select **File** → **Edit ENVI Header**.

2. When the **Edit Header Input File** dialog appears, select the file `bldr_sp.img` and click **OK**.
3. The **Header Info:** ***[filename]*** dialog opens. In this dialog, select the **Edit Attributes** button and *Map Info* from the pull-down menu to start the **Map Information** dialog.

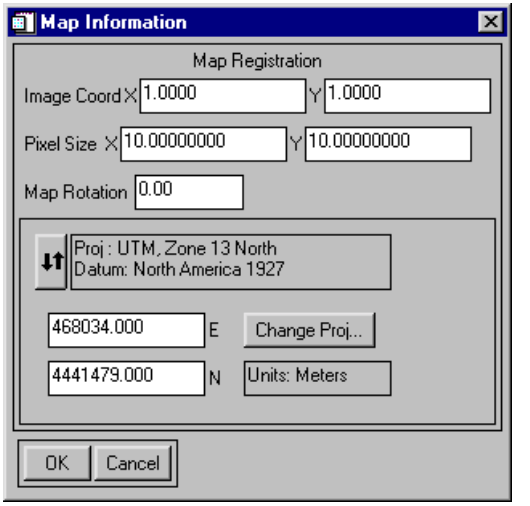

Figure 4-1: The Map Information Dialog.

This dialog lists the basic map information used by ENVI in georeferencing. The image coordinates correspond to the Magic Pixel used by ENVI as the starting point for the map coordinate system. Because ENVI knows the map projection, pixel size, and map projection parameters based on this header information and the map projection text file, it is able to calculate the geographic coordinates of any pixel in the image. Coordinates can be entered in either map coordinates or geographic coordinates.

4. Click on the spin box arrow next to the **Projection/Datum** field to see the latitude/longitude coordinates for the UTM Zone 13 North map projection.

   ENVI makes this conversion on-the-fly.
5. Click on the active **DMS** or **DDEG** button to toggle between Degrees-Minutes- Seconds, and Decimal Degrees, respectively.
6. Click **Cancel** to exit the **Map Information** dialog.

7. Click **Cancel** to exit the **Header Info: *[filename]*** dialog.

Cursor Location/Value

To open a dialog box that displays the location of the cursor in the Main Image, Scroll, or Zoom windows, do the following.

1. From the Main Image window menu bar, select **Tools** → **Cursor** *Location/Value*.

   You can also open this dialog from both the ENVI main menu and the Main Image window menu bar, by selecting **Window** → **Cursor Location/Value**.

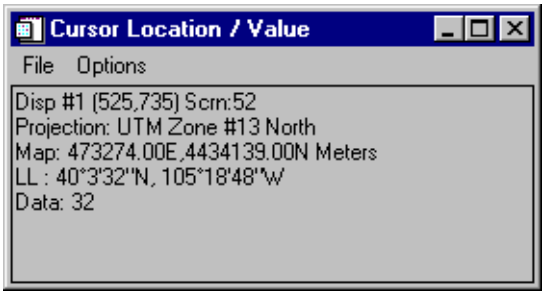

Figure 4-2: The Cursor Location dialog displays the pixel and georeferenced coordinates for georeferenced images.

   Note that the coordinates are given in both pixels and georeferenced coordinates for this georeferenced image.

2. Move the cursor around the image and examine the coordinates for specific locations and note the relation between map coordinates and latitude/longitude.
3. Select **File** → **Cancel** to dismiss the dialog when finished.

Overlay Map Grids

1. From the Main Image window menu bar, select **Overlay** → **Grid Lines**.

   The **#1 Grid Line Parameters** dialog appears and a virtual border is added to the image to allow display of map grid labels exterior to the image.

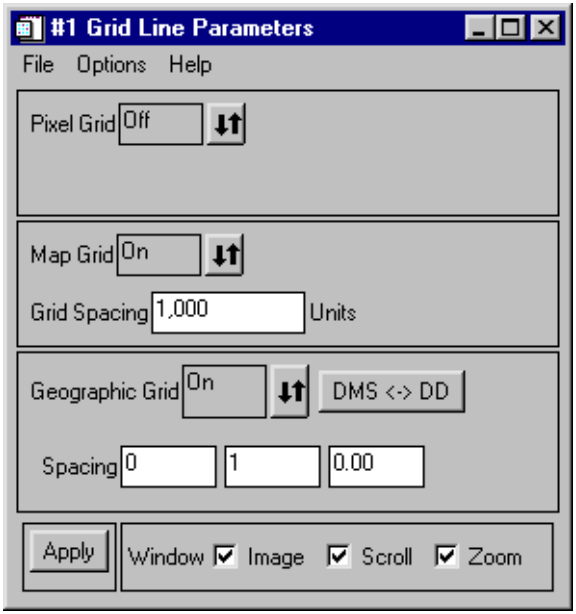

Figure 4-3: The Grid Line Parameters dialog.

2. In the new dialog, select **File** → **Restore Setup**. A file selection dialog opens.
3. In the **Enter Grid Parameters Filename** dialog, select the file `bldr_sp.grd` and click **Open**.

   Previously saved grid parameters are loaded into the dialog.
4. In the **#1 Grid Line Parameters** dialog you can examine the map parameters by selecting **Options** → **Edit Map Grid Attributes** from the dialog menu bar. An **Edit Map Attributes** dialog opens.
5. In the **Edit Map Attributes** dialog, note the grid spacing and the parameters that control the color and other characteristics of the lines, labels, corners, and the box (outlining box).
6. Click **File** → **Cancel** to close the dialog when you are finished.
7. Now in the **#1 Grid Line Parameters** dialog you can examine the geographic parameters by selecting **Options** → **Edit Geographic Grid Attributes** from the menu bar. This opens the **Edit Grid Attributes** dialog.

Note again the parameters for the geographic (latitude/longitude) grid. Click **Cancel** to close the dialog when you are finished.

8. Click **Apply** in the **Grid Line Parameters** dialog to put the grids on the image.

   ENVI allows simultaneous pixel, map, and geographic coordinate grids.

Overlay Map Annotation

1. In the Main Image display, select **Overlay** → **Annotation**. This opens the **#1 Annotation: Text** dialog.
2. In the new dialog, select **File** → **Restore Annotation**. Doing this opens a standard file selection dialog.
3. In the **Enter Annotation Filename** dialog, choose the file `bldr_sp.ann` from the file list and click **OK**.

   The pre-saved map annotation is loaded onto the image.
4. Enlarge the Scroll window by grabbing one of the corners and dragging. Reposition the resized Scroll window so you can see the Main Image window simultaneously.
5. In the resized Scroll window, move the main image indicator box using the left mouse button and examine the map elements which appear in the Main Image window.
6. In the **#1 Annotation: Text** dialog, click and hold the *Object* menu to examine the objects you can use to annotate the map.

Output to Image or Postscript

ENVI gives you several options for saving and outputting your image-maps. You can save your work in ENVI's image file format, or in several popular graphics formats (including Postscript) for printing or importing into other software packages.

Saving Your Image in ENVI Image Format

To save your work in ENVI's native format (as an RGB file) do the following.

1. In the Main Image window, select **File** → **Save Image As** → **Image File**.
2. When the **Output Display to Image File** dialog appears, select the Output File Type button pull-down menu (default file type setting is ENVI) to see the different formats available.

The **Change Graphics Overlay Selections** button opens a dialog of the same name which allows you to add or delete many graphics overlay options, including annotations and gridlines.

The **Change Image Border Size** button also opens a dialog of the same name. This dialog allows you to change the top, bottom, left, and right border widths and also the border color if desired.

If you have left your annotated and gridded color image on the display, both the annotation and grid lines will be automatically listed in the graphics options. You can also select other annotation files to be layered onto the output image.

3. You can choose whether you want your result to be saved to a file on disk or to memory by selecting either the radio button labeled **Memory**, or the **File** radio button. This time, select **Memory** and click **OK** to output the image.
4. The Available Bands List now has the new image available. Open another display by clicking on the **Display #1** button pull-down menu in the **Available Bands List** and choosing *New Display* from the menu.
5. Select the **RGB Color** radio button and load the image in from memory by selecting the **R**, **G**, and **B** (Georeferenced SPOT) data bands successively.
6. Then select the **Load RGB** button to display the results of the annotation as a raster image.

Saving your Image to Postscript

To save your work to a Postscript file perform the following.

1. In the Main Image window, select **File** → **Save Image As** → **Postscript File**.

   The **Output Display to Postscript File** dialog appears. Both the annotation and grid lines will be automatically listed in the graphics options. A graphical representation of the output page appears at the right top of the dialog.

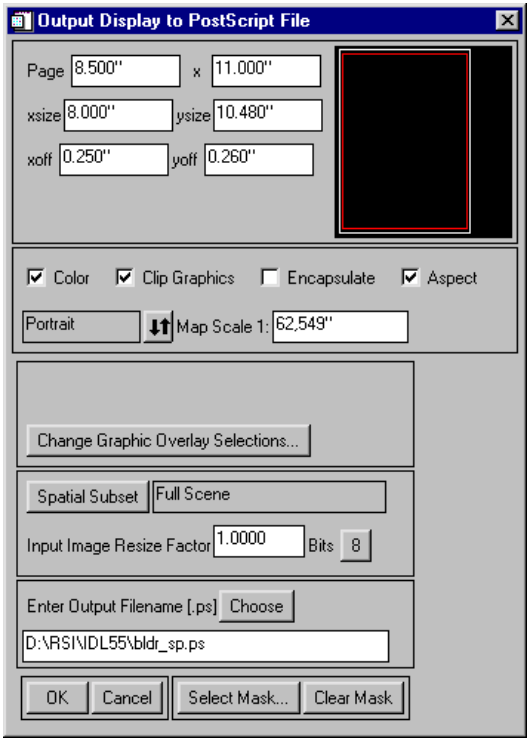

Figure 4-4: The Display to Postscript dialog for output of the above image map.

2. Enter the desired size of the output image in the **xsize** and **ysize** parameter text fields. By clicking the left mouse button in the representational graphic you can see the new image size outline and position in the graphical representation of the output page in the dialog.
3. Click the right mouse button in the graphic to center the image on the page.
   - If you'd like scaled map output, enter the desired map scale in the **Map Scale** text box, and then click the left mouse button in the graphic representation to see the result.

     If the scale makes the image larger than the available page size, ENVI automatically creates a multi-page Postscript document.

4. If you have a large-scale plotter, change the **Page** size to the plot size and the scaled image will be output to a Postscript file that can be plotted to scale directly on the plotter.

Note

Create the Postscript file only if you can print color output and print the file using your standard operating system procedures for printing Postscript output.

5. Save the postscript print settings by clicking **OK**.

   If you can't print color output, click **Cancel** to cancel the output operation.

Direct Printing

ENVI also allows direct printing to devices supported by your operating system.

1. From the Main Image window, select **File** → **Print**. This opens your operating systems standard **Print** dialog, and you can now follow your standard printing procedures.
2. Once you have selected all of the parameters in the operating system's standard **Print** dialog and clicked **OK**, ENVI opens an **Output Display to Printer** dialog to allow you to set additional basic ENVI printing parameters similar to those used for postscript output procedure (see above). Adjust these print settings as desired and click **OK** to begin printing.

Image to Image Registration

This section of the tutorial takes you step-by-step through an Image to Image registration. The georeferenced SPOT image will be used as the Base image, and a pixel-based Landsat TM image will be warped to match the SPOT.

Open and Display Landsat TM Image File

1. From the ENVI main menu, select **File** → **Open Image File**.
2. When the **Enter Data Filenames** dialog appears, navigate to the `bldr_reg` subdirectory of the `envidata` directory and select the file `bldr_tm.img` from the list.
3. Click **Open** (**OK** on UNIX) in the file selection dialog to load the TM image bands into the **Available Bands List**.
4. Click on Band 3 in the list, select the **No Display** button menu and **New Display** from the pull-down menu.
5. Then click on the **Load Band** button to load the TM band 3 image into a new display.

Display the Cursor Location/Value

To bring up a dialog box that displays the location of the cursor in the Main, Scroll, or Zoom windows do the following.

1. From the Main Image display menu bar, select **Tools** → **Cursor Location/Value**.
2. Move the cursor around the TM image in the Main Image, Scroll, and Zoom windows.

   Note that the coordinates are given in pixels since this is a pixel-based rather than georeferenced image like the SPOT data above.
3. Select **File** → **Cancel** to dismiss the **Cursor Location/Value** dialog.

Start Image Registration and Load GCPs

1. From the ENVI main menu bar, select **Map** → **Registration** → **Select GCPs: Image to Image**.

2. The **Image to Image Registration** dialog appears. For the **Base Image**, click on **Display #1** (the SPOT image) to select it. For the **Warp Image** select **Display #2** (the TM image).
3. Click **OK** to start the registration. This opens the **Ground Control Points Selection** dialog.

   Individual ground control points (GCPs) are added by positioning the cursor position in the two images to the same ground location.

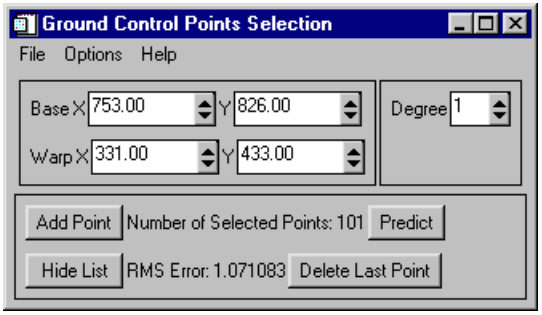

Figure 4-5: The Ground Control Points Selection dialog used for image to image registration.

4. Move the cursor in the SPOT image to 753, 826 by entering the values into the **Ground Control Points Selection** dialog in the **Base X** and **Y** text boxes.
5. Move the cursor in the TM image to 331, 433 by entering the values in the same way into the dialog in the **Warp X** and **Y** text boxes.
6. Examine the locations in the two Zoom windows and adjust the locations if necessary by clicking the left mouse button in each Zoom window at the desired locations.

   Note that sub-pixel positioning is supported in the Zoom windows. The larger the zoom factor, the finer the positioning capabilities.
7. In the **Ground Control Points Selection** dialog, click **Add Point** to add the GCP to the list. Click **Show List** to view the GCP list. Try this for a few points to get the feel of selecting GCPs.

   Note the list of actual and predicted points in the dialog. Once you have at least 4 points, the RMS error is reported.

8. In the **Ground Control Points Selection** dialog, select **Options → Clear All Points** to clear all of your points.
9. In the **Ground Control Points Selection** dialog, choose **File → Restore GCPs from ASCII**.
10. In the **Enter Ground Control Points Filename** dialog, select the file name `bldr_tm.pts`, and click **OK** to load a list of pre-saved GCPs.
11. Click on individual GCPs in the **Image to Image GCP List** dialog and examine the locations of the points in the two images, the actual and predicted coordinates, and the RMS error. Resize the dialog to observe the total RMS Error listed in the **Ground Control Points Selection** dialog.

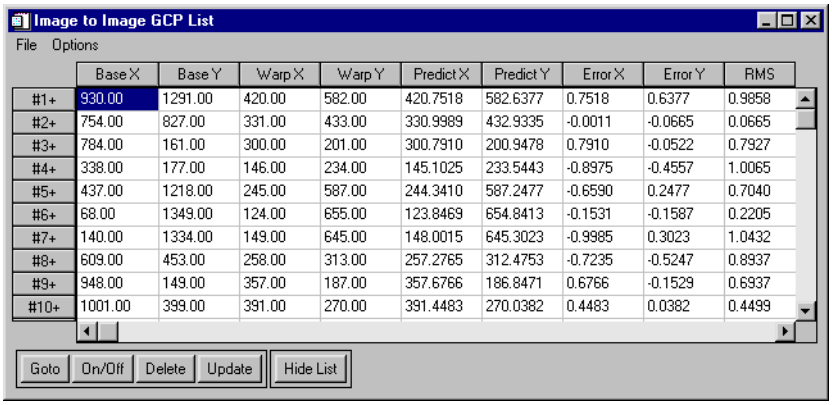

Figure 4-6: Image to Image GCP LIst dialog for image to image registration.

Working with GCPs

The following descriptions are provided for information only. **Perform only the numbered Predict GCP button functions.**

- The position of individual GCPs can be edited by selecting the appropriate GCP in the **Image to Image GCP List** dialog and editing in the **Ground Control Points Selection** dialog. Either enter a new pixel location, or move the position pixel-by-pixel using the direction arrows in the dialog.
- Clicking on the **On/Off** button in the **Image to Image GCP List** dialog removes selected GCPs from consideration in the Warp model and RMS calculations. These GCPs aren't actually deleted, just disregarded, and can be toggled back on using the **On/Off** button.

- In the **Image to Image GCP List** dialog, clicking on the **Delete** button removes a GCP from the list.
- Positioning the cursor location in the two Zoom windows and clicking the **Update** button in the **Image to Image GCP List** dialog updates the selected GCP to the current cursor locations.
- The **Predict** button in the **Image to Image GCP List** dialog allows prediction of new GCPs based on the current warp model.

1. Try positioning the cursor at a new location in the Main Image containing the SPOT image. Click on the **Predict** button and the cursor position in the TM image will be moved to match its predicted location based on the warp model.
2. The exact position can then be interactively refined by moving the pixel location slightly in the TM data.
3. In the **Ground Control Points Selection** dialog, click **Add Point** to add the new GCP to the list.

Warp Images

Images can be warped from the displayed band, or multiband images can be warped all bands at once. We will warp only the displayed band.

1. In the **Ground Control Points Selection** dialog, select **Options** → **Warp Displayed Band**.
2. The **Registration Parameters** dialog appears. Use the **Warp Method** button menu to select *RST*, and the **Resampling** button menu to select *Nearest Neighbor* resampling.

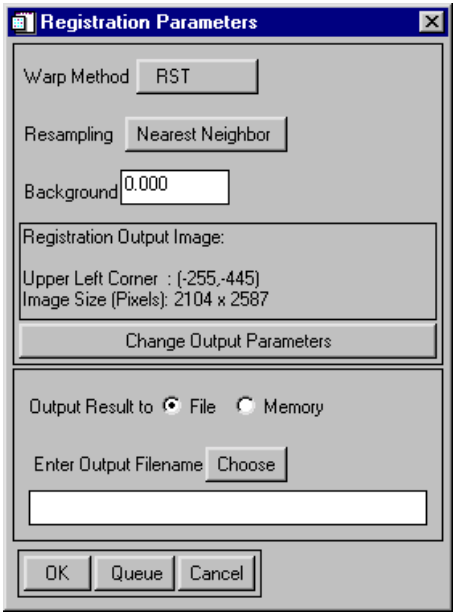

Figure 4-7: The Registration Parameters dialog.

3. Enter the filename `bldr_tm1.wrp` and click **OK**.

   The warped image will be listed in the **Available Bands List** when the warp is completed.

4. Now repeat steps 1 and 2 still using *RST* warping but with both *Bilinear*, and *Cubic Convolution* resampling methods.

5. Output the results to `bldr_tm2.wrp` and `bldr_tm3.wrp`, respectively.

6. Repeat steps 1 and 2 twice more, this time performing a 1st degree *Polynomial* warp using *Cubic Convolution* resampling, and again using a Delaunay *Triangulation* warp with *Cubic Convolution* resampling.

7. Output the results to `bldr_tm4.wrp` and `bldr_tm5.wrp`, respectively.

Compare Warp Results

Use Dynamic Overlays to compare your warp results:

1. In the **Available Bands List**, click on the original TM Band 3 image name `bldr_tm.img` and select **File** → **Close Selected File** from the menu bar.
2. In the subsequent ENVI Warning dialog, click **Yes** to close the associated image file.
3. In the **Available Bands List**, select the `BLDRTM_1.WRP` file and click on the **Display #** button pull-down menu. Select *New Display* and choose **Load Band** to load the file into the new display.
4. Click the right mouse button in the Main Image window and select **Tools** → **Link** → **Link Displays**.
5. Click **OK** in the **Link Displays** dialog to link the SPOT and the registered TM image.
6. Now compare the SPOT and the TM images using the dynamic overlay by clicking the left mouse button in the Main Image display.
7. Load `bldr_tm2.wrp` and `bldr_tm3.wrp` into new displays and use the image linking and dynamic overlays to compare the effect of the three different resampling methods: nearest neighbor, bilinear interpolation, and cubic convolution.

   Note how jagged the pixels appear in the nearest neighbor resampled image. The bilinear interpolation image looks much smoother, but the cubic convolution image is the best result, smoother, but retaining fine detail.
8. Close the displays containing `bldr_tm1.wrp` (RST warp, Nearest Neighbor resampling) and `bldr_tm2.wrp` (RST, Bilinear interpolation) by clicking the right mouse button in the appropriate Main Image display and selecting **File** → **Cancel**.
9. Load `bldr_tm4.wrp` and `bldr_tm5.wrp` into two new displays and use the image linking and dynamic overlays to compare to `bldr_tm3.wrp` (RST Warp).

   Note the effect of the three different warping methods, RST, 1st degree Polynomial, and Delaunay Triangulation on the image geometry.
10. Use dynamic overlay to compare to the georeferenced SPOT data.

Examine Map Coordinates

To bring up the **Cursor Location/Value** dialog:

1. Select **Tools** → **Cursor Location/Value** from the Main Image window menu bar.
2. Browse the georeferenced data sets and note the effect of the different resampling and warp methods on the data values.
3. Select **File** → **Cancel** to close the dialog.

Close All Files

You can close all of the data files by selecting **File** → **Close All Files** from the ENVI main menu.

Image to Map Registration

This section of the tutorial will take you step-by-step through an Image to Map registration. Many of the procedures are similar to image to image and will not be discussed in detail. The map coordinates picked from the georeferenced SPOT image and a vector Digital Line Graph (DLG) will be used as the Base, and the pixel-based Landsat TM image will be warped to match the map data.

Open and Display Landsat TM Image File

1. From the ENVI main menu, select **File** → **Open Image File**.
2. When the **Enter Data Filenames** dialog appears, navigate to the `bldr_reg` subdirectory of the `envidata` directory and select the file `bldr_tm.img` from the list.
3. Click **OK** to load the TM image bands into the **Available Bands List**.
4. Select **Gray Scale** in the **Available Bands List** and click on Band 3. Then from the **Display #1** pull-down menu button select the *New Display* button at the bottom of the dialog.
5. Click the **Load Band** button to load the TM band 3 image into a new display.

Select Image-to-Map Registration and Restore GCPs

1. From the ENVI main menu, select **Map** → **Registration** → **Select GCPS: Image to Map**. The **Image to Map Registration** dialog appears.
2. In the **Image to Map Registration** dialog select Display #1.
3. Then select **UTM** from the list of projections and enter 13 in the **Zone** text field.
4. Leave the pixel size at 30 m and click **OK** to start the registration.

   The **Ground Control Points Selection** dialog appears.

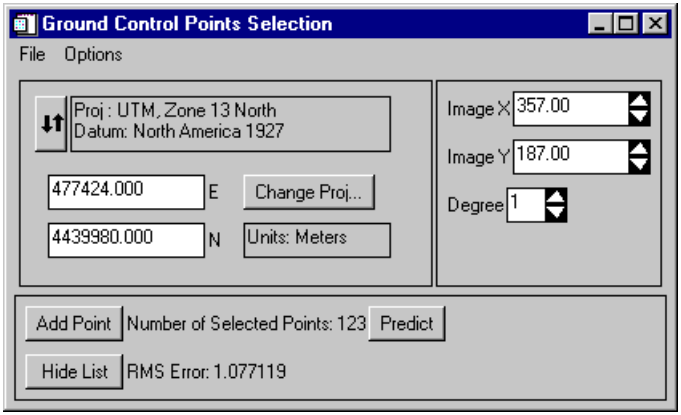

Figure 4-8: Ground Control Points Selection dialog for Image to Map Registration.

5. Add Individual GCPs by moving the cursor position in the warp image to a ground location for which you know the map coordinate (either read from a map or ENVI vector file (see below)).
6. Enter the known map coordinates manually into the **E** (Easting) and **N** (Northing) text boxes and click **Add Point** to add the new GCP.
7. Select **File** → **Restore GCPs from ASCII** in the dialog and open the file `bldrtm_m.pts`.
8. In the **Ground Control Points Selection** dialog, click the **Show List** button. The **Image to Map GCP List** dialog appears. Examine the base map coordinates, the actual and predicted image coordinates, and the RMS error. Resize the dialog to see the RMS error.

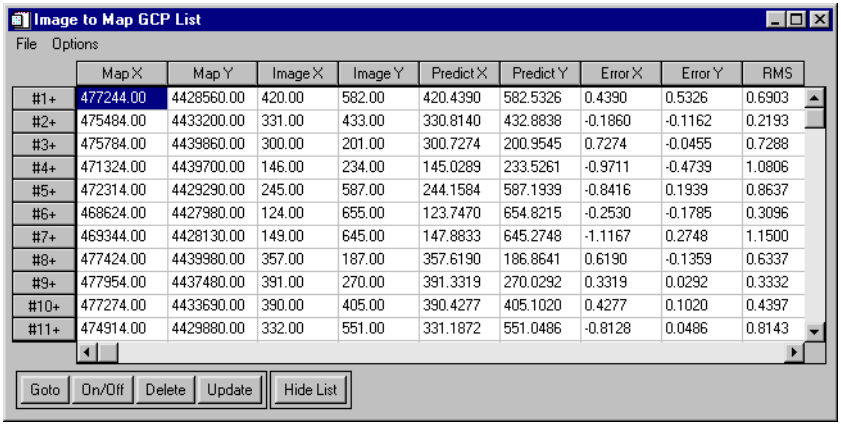

Figure 4-9: Image to Map GCP LIst dialog for image to map registration.

Add Map GCPs Using Vector Display of DLGs

1. From the ENVI main menu, select **File** → **Open Vector File** → **USGS DLG**.
2. In the **Enter Optional USGS DLG Filenames** dialog, choose the file `bldr_rd.dlg` and click **OK** to open the file. This opens the **Import Optional DLG File Parameters** dialog.
3. In the **Import Optional DLG File Parameters** dialog, select the **Memory** radio button and click **OK** to read the DLG data.
4. The **Available Vectors List** appears. Highlight the ROADS AND TRAILS: BOULDER, CO file in the **Available Vectors Layers:** list, and then click on the **Load Selected** button.
5. In the **Load Vector** dialog, click **New Vector Window**. This opens the **Vector Window Parameters** dialog and a new Vector Window.
6. Click **Apply** in the **Vector Window Parameters** dialog to plot the vectors in the vector window.
7. Click and drag the left mouse button in the Vector window to activate a crosshair cursor.

The map coordinates of the cursor will be listed in the **Location** field of the **Vector Window Parameters** dialog.

Figure 4-10: Vector Window Parameters dialog showing cursor location.

8. Position the image cursor on the road intersection at 402, 418 in the Main Image display by selecting **Tools** → **Pixel Locator**, entering the values, and clicking **Apply**.

   Note that sub-pixel positioning accuracy is again available in the Zoom window.

9. In the Vector window, position the vector cursor at the road intersection at 477593.74, 4433240.0 (40d 3m 3s N, -105d 15m 45s W) by clicking and dragging with the left mouse button and releasing when the circle at the crosshair intersection overlays the intersection of interest.

10. Click **Export** in the **Vector Window Parameters #1** dialog. The new map coordinates will appear in the **Ground Control Points Selection** dialog.

11. In the **Ground Control Points Selection** dialog, click **Add Point** to add the map-coordinate/image pixel pair and observe the change in RMS error.

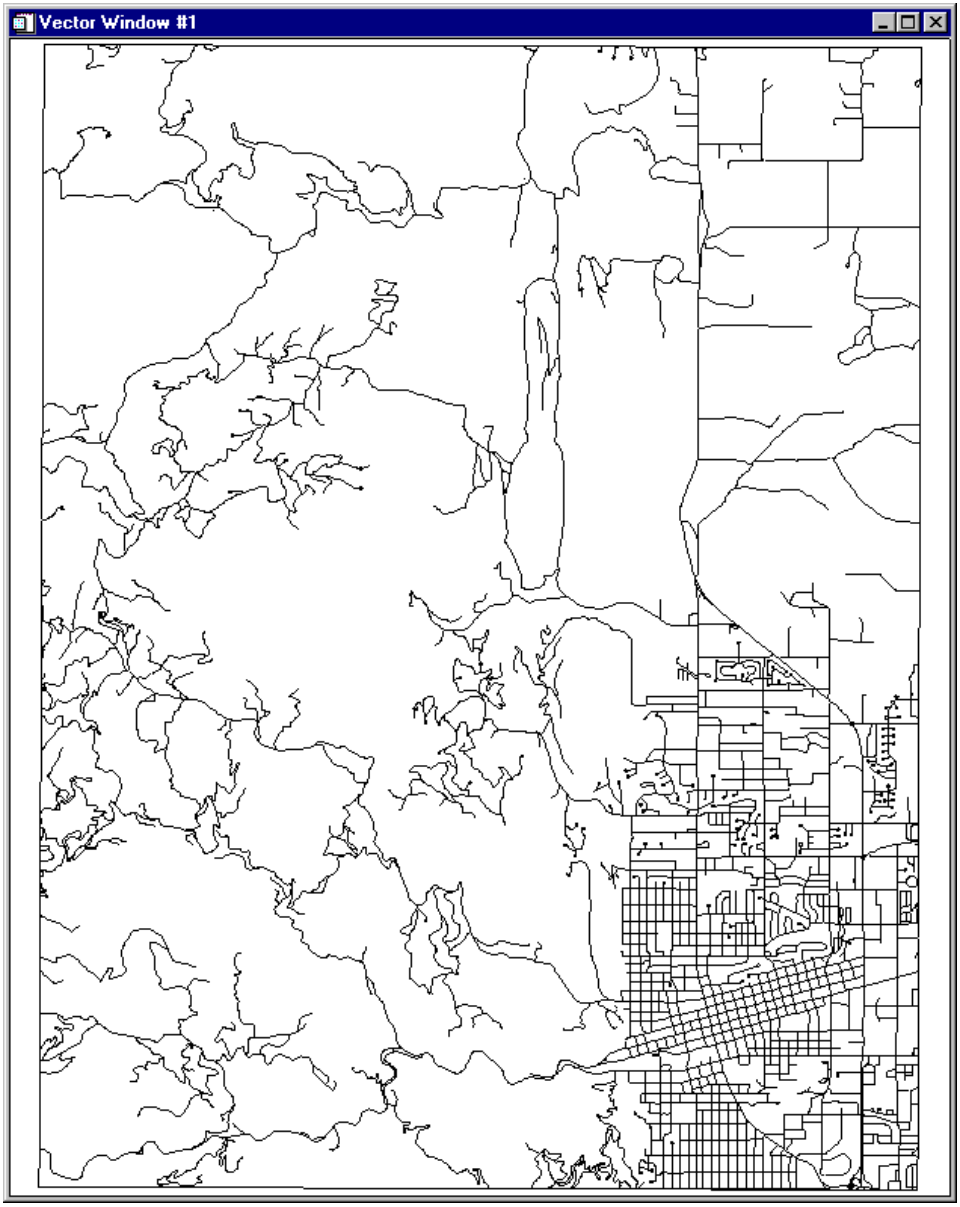

Figure 4-11: The Vector Window display.

RST and Cubic Convolution Warp

1. In the **Ground Control Points Selection** dialog, select **Options** → **Warp File**.
2. In the Input Warp Image dialog, highlight the file name `bldr_tm.img` and click **OK** to select all 6 TM bands for warping.
3. The Registration Parameters dialog appears. Choose *RST* for the **Warp Method**, and set **Resampling** to *Cubic Convolution* in the **Registration Parameters** dialog.
4. Change the background value to 255.
5. Enter the output file name `bldrtm_m.img` in the output file text box.
6. Click **OK** to start the image to map warp.

Display Result and Evaluate

Use Cursor Location/Value to evaluate the resulting warped color image.

1. Click on the RGB radio button in the **Available Bands List** followed by clicking on bands 4, 3, and 2 (RGB) of the warped image.
2. Select *New Display* from the **Display #** button pull-down menu. Click on **Load RGB** to load the TM warped color image.

   Note the skew of the image resulting from removal of the Landsat TM orbit direction. This image is georeferenced, but at 30 meter resolution versus the 10 meter resolution provided by the SPOT image.

   - If desired, load the SPOT image into a new display window and compare the image geometries and scale.

Close Selected Files

You can leave `bldrtm_m.img` and `bldr_sp.img` open as you will use these files in the next exercise.

1. Click on any other file names in the **Available Bands List** and select **File** → **Close Selected File** to close these images.
2. Click **Cancel** in the **Vector Window Parameters #1** dialog to close the Vector window.
3. Select **File** → **Cancel** in the **Available Vectors List** to close that dialog.

4. Select **File** → **Cancel** in the **Ground Control Points Selection** dialog to close that dialog. Save the GCPs if desired.