

ENVI Tutorial: Landsat TM and SAR Data Fusion

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Landsat TM and SAR Data Fusion

This tutorial is designed to demonstrate selected ENVI data fusion capabilities. You will co-register Landsat Thematic Mapper (TM) data and ERS-2 synthetic aperture radar (SAR) data of Rome, Italy using image-to-image registration. You will fuse the two datasets using a hue-saturation-intensity (HSI) color transform, and you will compare the fused data to the individual datasets.

ERS-2 and Landsat images used in this tutorial are provided courtesy of the European Space Agency (ESA) and Eurimage (used with permission) and may not be redistributed without explicit permission from these organizations.

For additional data fusion details, please see ENVI Help.

Files Used in this Tutorial

ENVI Resource DVD: `Data/rometm_ers`

File	Description
<code>rome_tm (.hdr)</code>	Landsat TM data of Rome, Italy
<code>rome_ers2 (.hdr)</code>	ERS-2 SAR data of Rome Italy
<code>romr_tm.pts</code>	Ground control points (GCPs) for image-to-image registration

Background

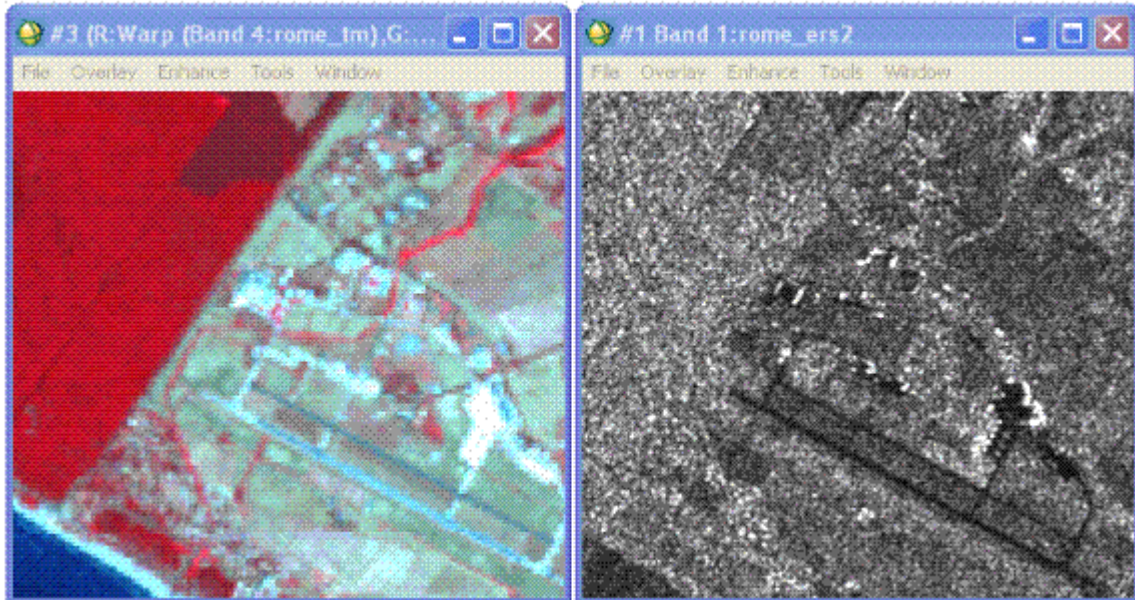
Data fusion is the process of combining multiple image layers into a single composite image. It is commonly used to enhance the spatial resolution of multispectral datasets using high spatial resolution panchromatic or single-band SAR data.

To perform data fusion in ENVI, the files must either be georeferenced (in which case spatial resampling is performed on the fly), or, if not georeferenced, cover the same geographic area, have the same pixel size, have the same image size, and have the same orientation. The files used in this exercise are not georeferenced. Therefore, the low spatial resolution images must be resampled to have the same pixel size as the high spatial resolution image (using nearest-neighbor resampling).

Read and Display Images

1. From the ENVI main menu bar, select **File > Open Image File**. Navigate to `Data\rometm_ers` and select `rome_ers2`. Click **Open**. This file contains ERS-2 SAR data.
2. In the Available Bands List, select the **Gray Scale** radio button. Select **Band 1** under `rome_ers2` and click **Load Band**.
3. From the ENVI main menu bar, select **File > Open Image File**. Select `rome_tm`. Click **Open**. This file contains Landsat TM data.
4. In the Available Bands List, click **Display #1** and select **New Display**.
5. Select the **RGB Color** radio button. Select **Band 4**, **Band 3**, and **Band 2** in sequential order. Click **Load RGB** to display `rome_tm` as a false-color composite into Display #2.

Following is a comparison of the Landsat TM false-color composite (left) and the ERS-2 SAR gray scale image (right):



Register the TM image to the ERS-2 image

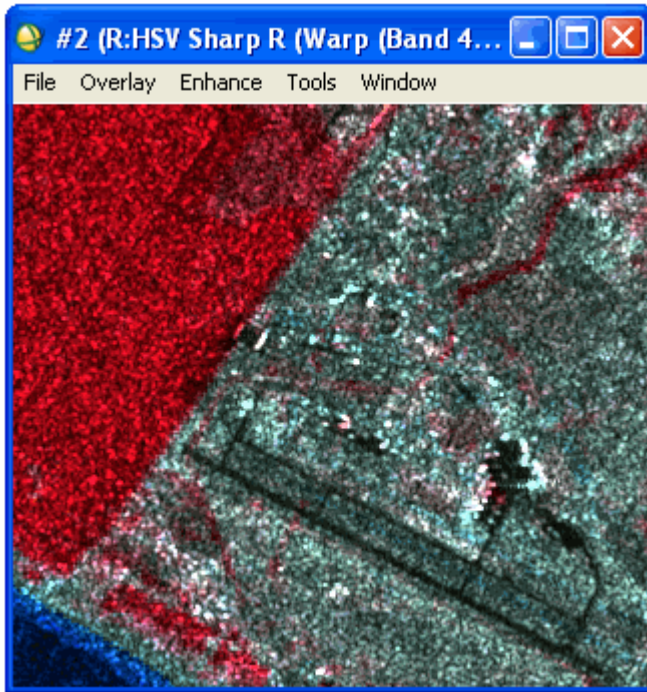
1. From the ENVI main menu bar, select **Map > Registration > Select GCPs: Image-to-Image**. An Image to Image Registration dialog appears.
2. Under **Base Image**, select **Display #1** (ERS-2 data). Under **Warp Image**, select **Display #2** (TM data). Click **OK**. A Ground Control Points Selection dialog appears.
3. From the Ground Control Points Selection dialog menu bar, select **File > Restore GCPs from ASCII**. A file selection dialog appears.
4. Select `rome_tm.pts` and click **Open**.
5. Pre-selected GCPs are loaded into both the TM and ERS-2 display groups. Review the positions of these points in both images for accuracy, and observe the total RMS error listed at the bottom of the Ground Control Points Selection dialog.
6. Click **Show List**. In the Image to Image GCP List that appears, scroll to the right and review the RMS values for each GCP. These GCPs are sufficient for a quick registration and for this exercise; however, adding more GCPs will improve the match between images. See the tutorial Image Georeferencing and Registration for additional details about performing image-to-image registration. From the Ground Control Points Selection dialog menu bar, select **File > Cancel**.
7. From the Ground Control Points Selection dialog menu bar, select **Options > Warp File**. A file selection dialog appears. Select `rome_tm` and click **OK** to warp all seven TM bands to match the ERS-2 data. A Registration Parameters dialog appears.
8. Enter the following values for Output Image Extent:
Upper Left X: **1**
Upper Left Y: **1**
Output Samples: **5134**
Output Lines: **5549**
9. Accept the default values for the remaining fields. In the **Enter Output Filename** field, enter `register_tm`. Click **OK** to perform the image-to-image registration.
10. In the Available Bands List, click **Display #2** and select **New Display**.
11. In the Available Bands List, select the **RGB Color** radio button. Select **Warp** bands **4, 3, and 2** under `register_tm` and click **Load RGB** to display the registered TM image as a false-color composite in Display #3.

Perform HSI Transform to Fuse Data

1. From the ENVI main menu bar, select **Transform > Image Sharpening > HSV**. A Select Input RGB dialog appears.
2. Select **Display #3** (which contains `register_tm`) and click **OK**. A High Resolution Input File appears.
3. Select **Band 1** under `rome_ers2` and click **OK**. An HSV Sharpening Parameters dialog appears.
4. In the **Enter Output Filename** field, enter `rome_fused.img` and click **OK**.

Display and Compare Results

1. In the Available Bands List, select the **RGB Color** radio button. Click **Display #2**.
2. Select the **HSV Sharp R, G, and B** bands under `rome_fused.img` in sequential order. Click **Load RGB** to load the HSV-sharpened, fused, color image into Display #2, replacing the original TM image. Following is a subset of the fused image:



3. From a Display group menu bar, select **Tools > Link > Link Displays**. A Link Displays dialog appears.
4. Click **OK** to link Display #1 (original ERS-2 image), Display #2 (fused image), and Display #3 (registered TM image). Compare these three images.
5. Try fusing other color composites with the ERS-2 data as above and compare the results.
6. When you are finished, exit ENVI.