ENVI

ENVI Tutorial: Landsat TM and SPOT Data Fusion

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Overview of This Tutorial

This tutorial is designed to demonstrate selected ENVI data fusion capabilities. For additional data fusion details, please see *ENVI Help*. Two examples are provided for this tutorial.

The first uses Landsat TM and SPOT data from London, UK (Data Courtesy of ITT Visual Information Solutions International UK, Ltd). The TM data are Copyright, European Space Agency, and distributed by Eurimage/NRSC. The SPOT data are Copyright CNES, 1994, distributed by Spot Image/NRSC. Both datasets are used with permission (NRSC, 1999).

The second example uses multispectral and panchromatic SPOT data from Brest, France (Data Courtesy of ITT Visual Information Solutions International, France, Copyright CNES-Spot image, 1998. Used with permission of SPOT, 1999. These data may not be used for commercial purposes).

Files Used in This Tutorial
CD-ROM: Tutorial Data CD #1
Path: `envidata/lontmsp` (London, UK example)
`envidata/brestsp` (Brest, France example)

File	Description
TM/SPOT example	
`lon_spot`	London SPOT data
`lon_spot.ers`	ER Mapper header for above
`lon_tm`	London Landsat TM data
`lon_tm.ers`	ER Mapper header for above
SPOT example	
`s_0417_1.bil (.hdr)`	Brest SPOT panchromatic data
`s_0417_2.bil (.hdr)`	Brest SPOT-XS multispectral data
`copyright.txt`	Data copyright statement

Data Fusion

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 higher spatial resolution panchromatic data or single-band SAR data.

The following sections demonstrate the preparation required to fuse image datasets in ENVI, and how to perform data fusion.

Preparing Images

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).

London, UK, Data Fusion Example

Read and Display ER Mapper Images

The London data consist of TM and SPOT data binary files with ER Mapper header files. ENVI has ER Mapper routines to automatically read the data.

1. From the ENVI main menu bar, select **File → Open External File → IP Software → ER Mapper**. A file selection dialog appears.

2. Navigate to `envidata\lontmsp` and use the **<Shift>** key to select `lon_tm.ers` and `lon_spot.ers`. Click **Open**.

3. In the Available Bands List, select the **RGB Color** radio button, then click **Load RGB** to display the true-color Landsat TM image (`lon_tm`).

4. In the Available Bands List, click **Display #1** and select **New Display**.

5. Select the **Gray Scale** radio button. Under `lon_spot`, select the **Pseudo Layer** band and click **Load Band** to display the gray scale SPOT image.

Resize Images to the Same Pixel Size

The Dims field of the Available Bands List shows that the spatial dimensions of the SPOT image are 2820 x 1569, and those of the Landsat TM are 1007 x 560. The Landsat data have 28 m spatial resolution, while the SPOT data have 10 m spatial resolution. You will need to resize the Landsat image by a factor of 2.8 to create 10 m data that match the SPOT data.

1. From the ENVI main menu bar, select **Basic Tools → Resize Data (Spatial/Spectral)**. A Resize Data Input File dialog appears.

2. Select `lon_tm` and click **OK**. A Resize Data Parameters dialog appears.

3. In the **xfac** field, enter **2.8**. In the **yfac** field, enter **2.8009**. You must use a value of 2.8009 rather than 2.8 to add an extra pixel to the y dimension, so the images will exactly match. This difference is insignificant for the purposes of this exercise.

4. In the **Enter Output Filename** field, enter `resize_lon_tm` and click **OK**.

5. In the Available Bands List, click **Display #2** and select **Display #1**.

6. Select the **RGB Color** radio button. Load `resize_lon_tm` as an RGB composite into Display #1.

7. From a Display group menu bar, select **Tools → Link → Link Displays**. A Link Displays dialog appears. Click **OK** to link the resized image (Display #1) to the SPOT panchromatic image (Display #2). Compare the two images.

8. When you are finished, select **Tools → Link → Unlink Displays** from a Display group menu bar.

Manual HSV Data Fusion

Manually performing data fusion may help you better understand the data fusion process. First, transform the color TM image into hue-saturation-value (HSV) color space. Replace the value band with the higher resolution SPOT data and stretch the value band from 0 to 1 to fill the correct data range. Then transform the TM hue and saturation data and SPOT data values back to RGB color space. This produces an output image that contains the colors from the TM data with the spatial resolution of the SPOT data.

Forward HSV Transform

1. From the ENVI main menu bar, select **Transform** → **Color Transforms** → **RGB to HSV**. An RGB to HSV Input dialog appears.
2. Select **Display #1** (which contains `resize_lon_tm`) and click **OK**. An RGB to HSV Parameters dialog appears.
3. In the **Enter Output Filename** field, enter `out_hsv` and click **OK** to perform the transform.
4. In the Available Bands List, under `out_hsv`, display the resulting **Hue**, **Sat**, and **Val** bands as individual gray scale images or as an RGB composite in Display #1.

Create a Stretched SPOT Image to Replace TM "Value" Band

1. From the ENVI main menu bar, select **Basic Tools** → **Stretch Data**. A Data Stretch Input File dialog appears.
2. Select `lon_spot` and click **OK**. A Data Stretching dialog appears.
3. In the Output Data section of the Data Stretching dialog, enter **0** in the **Min** field and **1.0** in the **Max** field.
4. In the **Enter Output Filename** field, enter `stretch_lon_spot` and click **OK** to stretch the SPOT data to floating-point data with a range of 0 to 1.0.

Inverse HSV Transform

1. From the ENVI main menu bar, select **Transform** → **Color Transforms** → **HSV to RGB**. An HSV to RGB Input Bands dialog appears.
2. Select the **Hue** and **Sat** bands under `out_hsv` as the H and S bands for the transform. Select the **Stretch** band under `stretch_lon_spot` as the V band. Click **OK**. An HSV to RGB Parameters dialog appears.
3. In the Enter Output Filename field, enter `fused_london` and click **OK** to perform the inverse transform.

Display Results

1. In the Available Bands List, load `fused_london` as an RGB composite into Display #1.
2. In the Available Bands List, click **Display #1** and select **New Display**.
3. Load `resize_lon_tm` as an RGB composite into Display #3. Following is a summary of what each display group contains at this point:

   Display #1: Fused TM/SPOT image (`fused_london`)
   Display #2: SPOT panchromatic image (`lon_spot`)
   Display #3: Resized TM image (`resize_lon_tm`)

4. From a Display group menu bar, select **Tools** → **Link** → **Link Displays**. A Link Displays dialog appears.
5. Click **OK** to link all three display groups. Click in the Image window to use dynamic overlay to compare the images.

Automated HSV Data Fusion

1. From the ENVI main menu bar, select **Transform** → **Image Sharpening** → **HSV**. A Select Input RGB dialog appears.

2. Select **Display #3** (the resized TM image) and click **OK**. A High Resolution Input File dialog appears.

3. Select the **Pseudo Layer** band under `lon_spot` and click **OK**. An HSV Sharpening Parameters dialog appears.

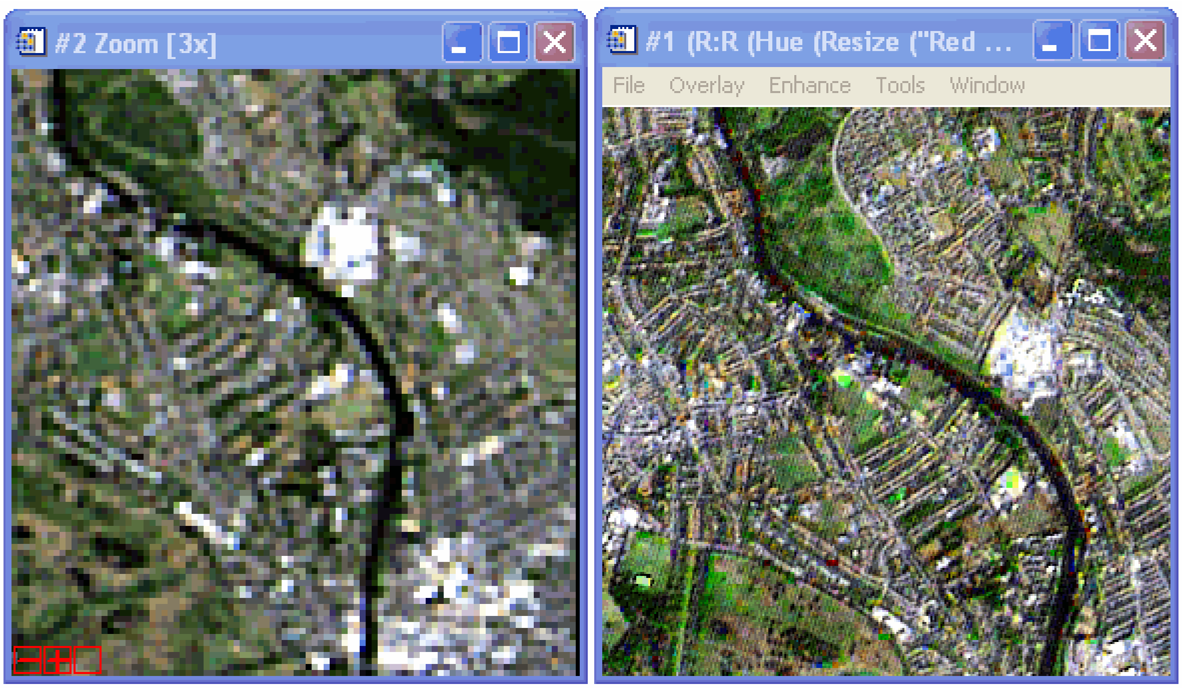
4. In the **Enter Output Filename** field, enter `lontmsp.img` and click **OK**.

5. In the Available Bands List, click **Display #3** and select **New Display**.

6. Load `lontmsp.img` as an RGB composite into Display #4.

7. From a Display group menu bar, select **Tools** → **Link** → **Link Displays**. A Link Displays dialog appears. Click **OK** to link all four display groups.

   Below is a comparison between the original TM image (left) and the fused TM/SPOT image (right) for approximately the same area.



8. Try the same process using the Color Normalized (Brovey) Transform by selecting **Transform** → **Image Sharpening** → **Color Normalized (Brovey)** from the ENVI main menu bar.

9. When you are finished comparing images, close all files and display groups.

Brest, France, Data Fusion Example

Open and Display Images

1. From the ENVI main menu bar, select **File → Open Image File**. Navigate to `envidata\brestsp` and select `s_0417_2.bil`. Click **Open**. This is a SPOT-XS multispectral data file.

2. In the Available Bands List, select the **RGB Color** radio button. Click **Load RGB** to display `s_0417_2.bil` as a false-color infrared composite.

3. From the ENVI main menu bar, select **File → Open Image File**. Select `s_0417_1.bil`. Click **Open**. This is a SPOT panchromatic data file.

4. In the Available Bands List, select the **Gray Scale** radio button. Select **Band 1** under `s_0417_1.bil`, and click **Load Band** to display the SPOT panchromatic data.

Resize Images to Same Pixel Size

1. The Dims field of the Available Bands List shows that the spatial dimensions of the panchromatic image are 2835 x 2227, and those of the SPOT-XS image are 1418 x 1114. The SPOT-XS data have 20 m spatial resolution, while the SPOT panchromatic data have 10 m spatial resolution. You will need to resize the SPOT-XS image by a factor of 2.0 to create 10 m data that match the SPOT data.

2. From the ENVI main menu bar, select **Basic Tools → Resize Data (Spatial/Spectral)**. A Resize Data Input File dialog appears.

3. Select `s_0417_2.bil` (the SPOT-XS image) and click **OK**. A Resize Data Parameters dialog appears.

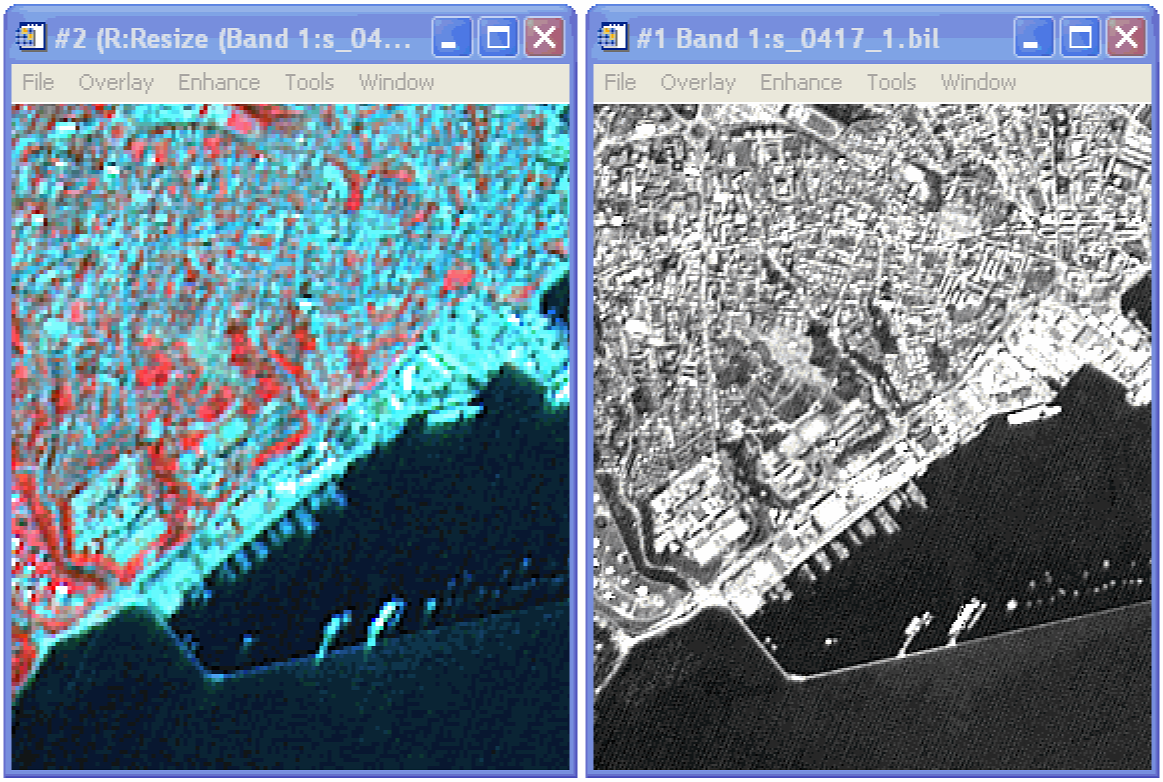
4. In the **xfac** and **yfac** fields, enter **1.999**. You must use a value of 1.999 rather than 2.0 to add an extra pixel to the x and y dimensions, so the images will exactly match. This difference is insignificant for the purposes of this exercise.

5. In the Enter Output Filename field, enter `resize_spotxs` and click **OK**.

6. In the Available Bands List, click **Display #1** and select **New Display**.

7. Display the resized image as an RGB composite in Display #2.

8. From a Display group menu bar, select **Tools → Link → Link Displays** to link the resized SPOT-XS image (Display #2) with the SPOT panchromatic image (Display #1). Click in an Image window to use the dynamic overlay to compare the two images.



The above comparison shows the SPOT-XS data (20 m spatial resolution, left) and the SPOT panchromatic data (10 m spatial resolution, right).

Fuse the SPOT Panchromatic Image

1. From the ENVI main menu bar, select **Transform** → **Image Sharpening** → **HSV**. A Select Input RGB dialog appears.
2. Select **Display #2** (which contains the resized SPOT-XS image) and click **OK**. A High Resolution Input File dialog appears.
3. Select **Band 1** under `s_0417_1.bil` and click **OK**. An HSV Sharpening Parameters dialog appears.
4. In the **Enter Output Filename** field, enter `brest_fused.img` and click **OK**.

Display and Compare Results

1. In the Available Bands List, click **Display #2** and select **New Display**.
2. Load the fused image (`brest_fused.img`) as an RGB composite into Display #3.
3. From a Display group menu bar, select **Tools** → **Link** → **Link Displays**. A Link Displays dialog appears. Click **OK** to link the fused image to the two original SPOT images.
4. When you are finished comparing the images, exit ENVI.