

Georeferencing an Image

Aerial image is a very informative representation of Earth's surface. However, it is not a map. While looking at such a photograph, we may not know what part of the world is shown on it and what are the names for different plants, streets, towns, or lakes found on that image? Using GIS to overlay image with other available data layers is the first step in using aerial images.

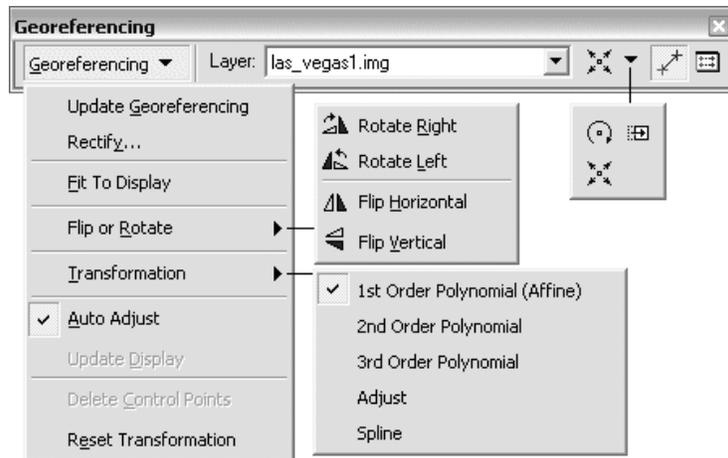
Explorer's Guide

Before You Start

In small groups, take a large (~ 3x3 ft) piece of material, newspaper, or wrinkled paper and place it on the floor. Using a washable marker, place one or more dots to show both on the material and the floor. Remove the material and try to place it back at the same spot. How many dots did you need to fix the position of material with respect to the floor? What rules did you use to select locations of these dots?

Learning by Doing

1. Use GoogleEarth software to georeference Capitol.jpg image obtained from <http://dnr.ne.gov> website. Use the following steps to complete the task:
 - a) Navigate to Nebraska Capitol Building.
 - b) Click the *Add Image Overlay* button 
 - c) The Add Image Overlay dialog box will appear along with green marks on the screen that can be used to move and stretch the image.
 - d) Give your image overlay a name (State Capitol) and click the *Browse* button. Navigate to the image file that your instructor gives you (Capitol.jpg).
 - e) Once you load the image, drag the green markers around the image manually till the image is georeferenced (placed on the top of corresponding Google Earth image). The best way to do this is to zoom into each corner or road intersections and manually drag the green markers till they overlap the corresponding location on Google Earth.
 - f) Leave the default values for View, Altitude, and Refresh tab. The refresh tab allows you to automatically set the image overlay up to refresh to the latest view of the image. This is used when the image that you're placing updates frequently, but in our case the image is static so we don't have a need to refresh our image. The refresh functionality is useful when dealing with data such as weather radar images that are continuously updating. The altitude tab can be used to display the image a set distance above the ground for situations where you want the image to "hover" above the terrain. Again, in this case we do not need our image to hover, but it can be useful in some instances. Finally, the View tab can be used to set the current camera properties for the 3D viewer.
 - g) Check to see if the imported image is correctly georeferenced. Use the *Transparency slider* to make sure the new image conforms to the underlying imagery
2. Complete the same task using ArcGIS software. Following are the primary steps:
 - a) Start ArcGIS. Using  ., add Lincoln_corrected.jpg which is already georeferenced.
 - b) The same way, add the new (non-referenced) image layer (Capitol.jpg)
 - c) To display the Georeferencing toolbar go to menu View > Toolbars > Georeferencing



- d) Activate the given referenced image Lincoln_corrected.jpg and zoom in to the capitol area.
- e) In the Georeferencing toolbar, click the Layer dropdown arrow and click the image layer you want to georeference (Capitol.jpg).
- f) Click Georeferencing > Fit To Display. This will display the same area in both images. Use the Shift, Rotate, Scale tools to move the image dataset as needed. This is similar to what you've done using GoogleEarth.
- g) Now click Control Points tool  to add control points. This is done by adding links between georeferenced and non-referenced images. Click the mouse pointer on a specific location (e.g., road intersection, building corners, etc.) in Capitol.jpg data layer and then click on the same location in Lincoln_corrected.jpg data layer. Repeat the process several times. Control points should be spread around in an image. This is very similar to Before You Start activity.
- h) Observe if both images are overlaid correctly. Go to menu View > Toolbars > Effects to get the Effects toolbar to adjust the transparency of both the images.
- i) For every set of control points you create, an entry is created in a table that records the original coordinates, the control point coordinates, and the residual error. Access this table by clicking the *View Link Table* icon  from the Georeferencing toolbar. Entries in this table can be deleted one at a time (highlight the entry in the table and click the delete icon) thus making corrections easy.
- j) Add enough links for the transformation order. You need a minimum of three links for a first-order transformation, six links for a second order, and 10 links for a third order. The higher order of transformation, the more adjustment to the new image is made.
- k) Click View Link Table to evaluate the transformation. You can examine the residual error for each link and the RMS error. If you're satisfied with the registration, you can stop entering links.
- l) Click Georeferencing > Update Georeferencing to save the transformation information with the image dataset. This creates a new file with the same name as the image dataset, but with an .aux file extension. It also creates what we call a world file containing information about geographic location of the image. Click Georeference > Rectify to use the rectified image for later use.

How Does It Work

Georeferencing means converting map coordinates from digitizer units (inches) to a real world coordinate system. Raster data is commonly obtained by scanning maps or collecting aerial photographs and satellite images. These raster datasets should be aligned or georeferenced to

a map coordinate system to use it in conjunction with other spatial data. Georeferencing raster data allows it to be viewed, queried, and analyzed with other geographic data layers.

A simple way to georeference an image is to place it on the top of any georeferenced data and manually transform the image to achieve the best visual fit. The more advanced process involves identifying a series of ground control points (known x,y coordinates) that link locations on the raster dataset with locations in the spatially referenced data (previously loaded to the same project). Control points shall represent locations that can be accurately identified on the new image and any georeferenced data layer. There are many different types of features that can be used as identifiable locations, such as: road or stream intersections, the mouth of a stream, the corner of an established field, street corners etc.

The control points are used to build a polynomial transformation that will convert the raster dataset from its existing location to the spatially correct location. The connection between one control point on the raster dataset (from point) and the corresponding control point on the aligned target data (to point) is a link. Spreading out the links over the entire image to be georeferenced rather than concentrating them in one area is a good habit. Typically, having at least one link near each corner of the raster dataset and a few throughout the interior produces the best results. At least a minimum of three control points should be used.

A more advanced process of image georeferencing can be done using information about actual location and orientation of the camera when taking photos and knowing terrain of the area photographed. Such corrected images are called orthophotos, and the process is referred to as orthorectification.

Additional Challenge

Use the concept of image georeferencing to write your name or create “alien circles” on the top of any georeferenced data. Just scan your hand drawn image or create an electronic image using drawing software and georeference it to any dataset you select.

Vocabulary

Georeferencing is the process of assigning proper geographic coordinates to an image (or another raster dataset) with respect to already georeferenced data layers

World file is a special file that contains information about geographic coordinates for a given image.

Orthorectification is the process of correcting a photograph for the rotations around the X, Y, and Z axis of the camera, and the removing the effects of relief displacement.

Orthophoto is photograph that has undergone the orthorectification process.

Interesting to Know

There are several websites that contain high-resolution orthophotos for every part of Nebraska with free access to the public.

*Viacheslav Adamchuk and Shana Thomas
Phone: 402-472-8431
E-mail: vadamchuk2@unl.edu
Last updated: May 12, 2008*