Steps in Georeferencing using Ground Control Points
With emphasis on using Washington and Lee Geology Dept. Instruments and Software

The basic principle of georeferencing is to collect UTM or lon-lat points using a differential gps or have surveyed them in with a combination of benchmarks, known points and Total Station or other method of surveying. These are called Ground Control Points and are used to relate an internal model, image or survey to the real world. Here we are going to emphasize the surveying using the Total Station, and then incorporating into a photogrammetry model, but you can adapt the work flow for other instruments.

Surveying of Ground Control Points

1. Determine where in general you want points to be, ideally 6 or more points, evenly spaced. Use your base map generated from photogrammetry or other methods to make this determination. Make a sketch in your notebook of this whole network.

2. Choose a base station, where you can see clearly all other points, and which is comfortable and free from obstructions for the operator. This will be the location where all of the other measurements are taken (local 0).

3. Choose your first point to define a line between your base station and this point and put a stake in the ground. The bearing of this line is your local or pseudo north. So zero the Total Station to this bearing.

4. Measure the GPS location of the first point using the Trimble. Make sure you are using the correct coordinate system and datum. This is often your greatest uncertainty, so in an ideal world you let these data be collected for 15-30 min or more to improve the precision.

5. Set up the Total Station using the directions provided, being particularly careful to level it properly. Measure the height of your ocular from the ground and using a plumb bob make sure that it sits directly vertically over your stake.

6. Set up the reflecting mirror at the end point of the survey line, and make sure that the mirror height is the same as you used for your Total Station.

7. With the Total Station, measure the inclination, bearing, range, horizontal distance and vertical distance to each control point, record these, and put a stake in the ground for each point.

8. Double check your measurements. Keep the Total Station fixed and reoccupy the reflecting mirror at each control point. If they differ more than a few mm in range, or arc seconds in bearing then measure a third time.

9. Put the Trimble at the location of the base station and collect for 15-30 min if possible.

10. Note a separate way to collect ground control points is to use the differential gps (Trimble) for all the points. The big draw back with this approach is that you ideally want the Trimble to sit a point for 15-30 min to use as a ground control point (vs. a point along a traverse which doesn't need nearly the time). So if you are doing this you will likely only occupy each point for 1-2 min. Using the Trimble for collecting ground control points is generally not as precise as a true Total Station survey but is far easier. You should learn to do both, and we will do both in this class in order to see differences/uncertainties.

Processing

1. Connect the Trimble to the computer and run the Pathfinder software to process the GPS points to make the differential correction.

2. Export the points from Pathfinder as a ShapeFile, and import the relevant points into Excel.

3. Load all your GPS points and measured bearings, ranges, vertical and horizontal distances into a spreadsheet.

4. Construct a scheme for reducing the data. Your objective is to ultimately have all of your points for all of your survey stations in UTM coordinates, at the elevation of the ground. First draw a sketch of the geometry of a vertical sense and then derive the trig relationships necessary to reduce the data.

5. Next put these calculations in Excel and reduce your data. This should be a table as a series of columns of values with measured data on the left, and the calculated data on the right. Think this through before you start making calculations.

6. Export your data as a tab-delimited text file, and import these into PhotoScan. Note you will first want to set up a PhotoScan project with the correct coordinate system and datum, and to have built a photogrammetric model (explained separately). You need to have made Markers in PhotoScan with the exact same name as your surveyed ground control points. You identify these Markers in your model by locating what you know are the real-world features (whatever you used for indicating these, usually a small disk, symbol or sheet).

7. Import the text file by clicking the Reference Pane (lower left) and then choosing the first icon on the upper left (Import). This is the place you associate the real world locations you have calculated with the Markers in the model you have determined to georefence the model.