Homework 4. 2D Polynomial Models

CE603 Spring 2006, Assigned Friday, 24 Feb, Due Monday, 6 March

To gain some insight into the merits and deficiencies of various image/ground transformation models let's look at the common but often abused practice of 2D polynomial modeling. (Note: the ground to image transformation is really a 3D to 2D projection and any model which ignores the third coordinate will eventually fail, sometimes spectacularly).

Use the control points that you inventoried in homework 2, estimate by least squares the parameters, residuals, and summary statistics for the listed 3 models. For ground coordinates, convert to (x,y) UTM zone 16, meters, with local origin at point A4. (last step keeps magnitudes manageable), for image coordinates, use your measured values in the form (line,sample) = (row,column) to keep everything right handed. For each model report the parameter values, the residuals, and summary statistics (RMSV-line, RMSV-sample, MAXV-line, MAXV-sample).

Lastly, do the same three model estimations, but use a "LOO" leave-one-out approach where you make the estimation with n-1 points and compute the "residual" only for the left out point. Then tabulate the summary statistics only for the left out points.

Models:

Four Parameter (first order conformal):

$$l = a_0 + a_1 x + a_2 y$$
$$s = b_0 - a_2 x + a_1 y$$

Six Parameter (first order):

$$l = a_0 + a_1 x + a_2 y$$
$$s = b_0 + b_1 x + b_2 y$$

Twelve Parameter (second order):

$$l = a_0 + a_1 x + a_2 y + a_3 x^2 + a_4 y^2 + a_5 xy$$
$$s = b_0 + b_1 x + b_2 y + b_3 x^2 + b_4 y^2 + b_5 xy$$

Study questions: how would you decide which model to use? Is there a scientific reason? Notice that higher order models give a "better fit", so do you just increase the order until the fit is "good". Should it be conformal or not? How are these decisions related to the number of control points or equivalently to the redundancy? To what extent are you confounding (i.e. mixing or confusing) terrain/relief effects with sensor, scanning, or

view effects? Where are approximate methods appropriate? Google vs. Engineering mapping and geopositioning? Where does GIS fit in this picture?