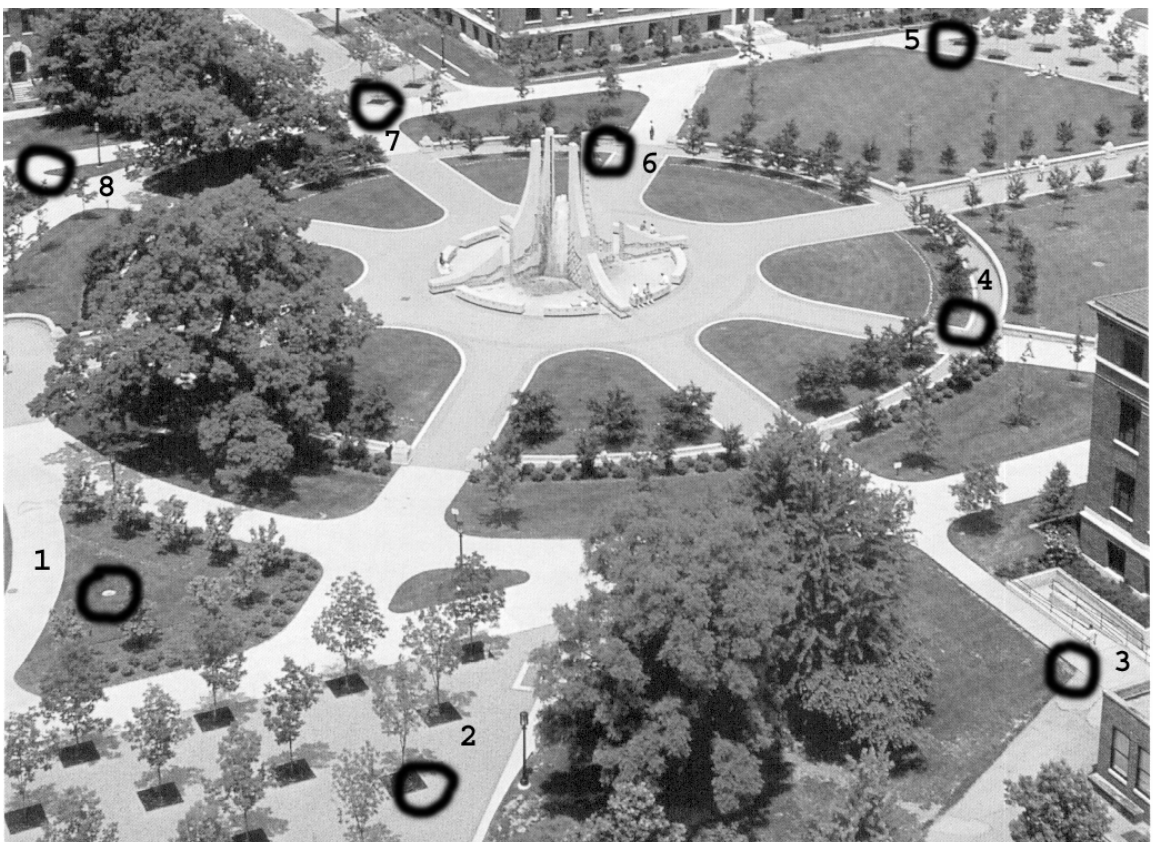
CE 503
Homework #1 8-Parameter Transformation
Assigned 28-August-02, due one week.

The 8-parameter transformation is used to relate corresponding points in two planes that are related by perspective projection (i.e. a film plane and an object plane). We will assume that the area around the engineering mall is a plane. Download the annotated image file shown below, and measure the image points in a program like *Adobe Photoshop.* Make sure the measuring units are set to "pixels". To avoid ambiguity call the image coordinates (row,column) or (r,c) rather than photoshop's (y,x). For each point you can form 2 matrix equations in 8 unknowns. Thus with 8 points you should have 16 equations. Solve that overdetermined system and submit your results with (a) the parameter values, and (b) the image point residuals.



Control Points (units meters)			
ID	X	Y	Z
1	14374.19	75071.87	189.5
2	14397.55	75057.60	189.5
3	14427.64	75075.23	189.5
4	14419.03	75121.11	189.5
5	14412.81	75198.59	189.5
6	14384.74	75156.97	189.5
7	14358.01	75164.70	189.5
8	14336.41	75138.63	189.5

See equation for one point below. Use MATLAB and build a 16x8 coefficient matrix, **A**, and a 16x1 vector **b**. Then solve for the unknowns by **x = inv(A^{T}A)*A^{T}b**, etc. Suggestion: type your commands into a *.m file, then if you later want to rerun, you do not have to type everything again. We are using a linear approximation to the true nonlinear 8-parameter model. Obtain the residual by **b – A*x** , where **x** is the solution vector that you solved for. This is the first step to performing a simple rectification. Notice that we assume all points are in the object plane so the **z** coordinate is not used. The transformation is not valid for any points displaced from that object plane. (notes: (1) for image points 5 & 7, use the dark corner nearest Hovde Hall – the one with columns. (2) to avoid numerical problems, subtract from each r, the mean of all the r's, likewise the c's, the x's, and the y's)

$$r = \frac{a_0 + a_1 x + a_2 y}{1 + c_1 x + c_2 y}$$

$$c = \frac{b_0 + b_1 x + b_2 y}{1 + c_1 x + c_2 y}$$

$$r + r c_1 x + r c_2 y = a_0 + a_1 x + a_2 y$$

$$c + c c_1 x + c c_2 y = b_0 + b_1 x + b_2 y$$

$$r = a_0 + a_1 x + a_2 y - r c_1 x - r c_2 y$$

$$c = b_0 + b_1 x + b_2 y - c c_1 x - c c_2 y$$

$$\begin{bmatrix} r \\ c \end{bmatrix} = \begin{bmatrix} 1 & x & y & 0 & 0 & 0 & -rx & -ry \\ 0 & 0 & 0 & 1 & x & y & -cx & -cy \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ b_0 \\ b_1 \\ b_2 \\ c_1 \\ c_2 \end{bmatrix}$$