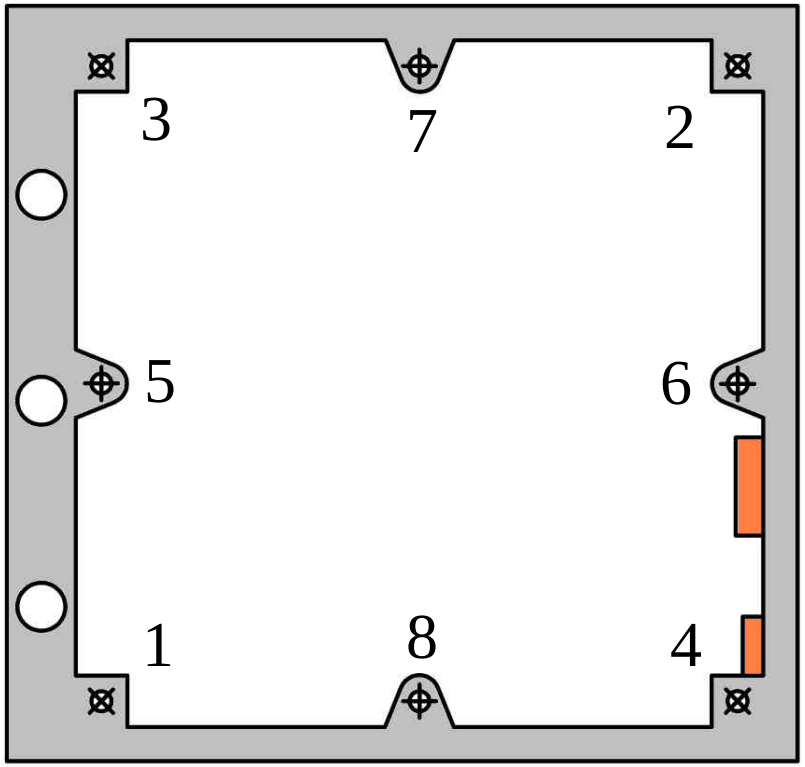
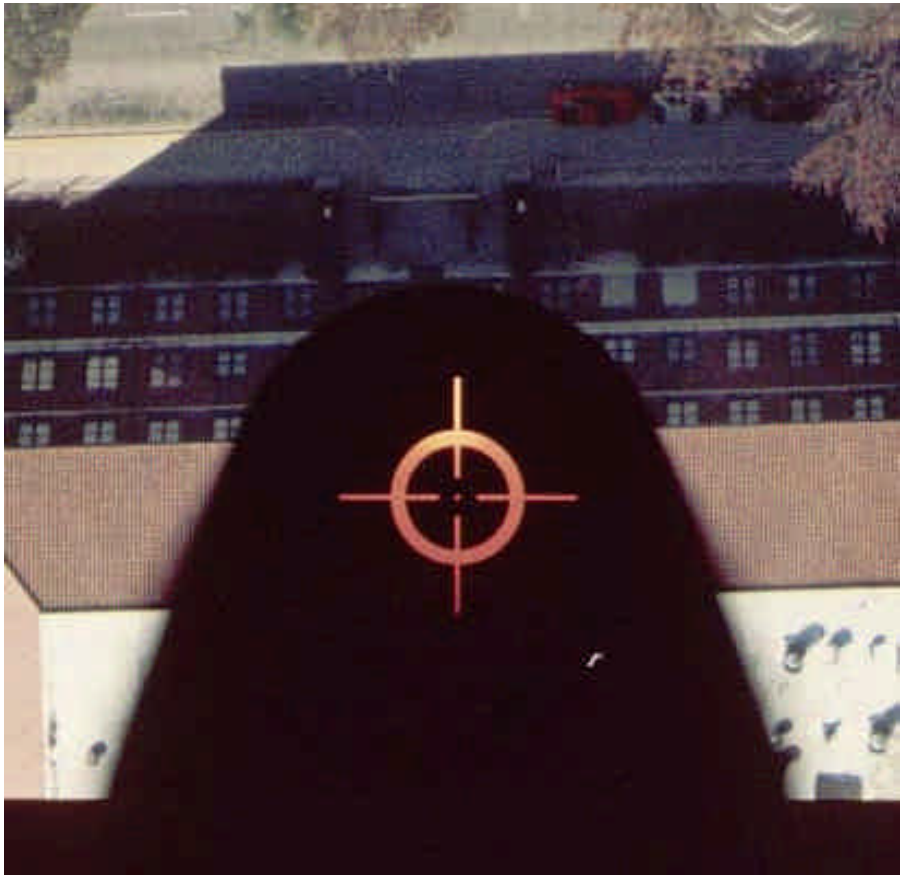
Fiducial Measurement

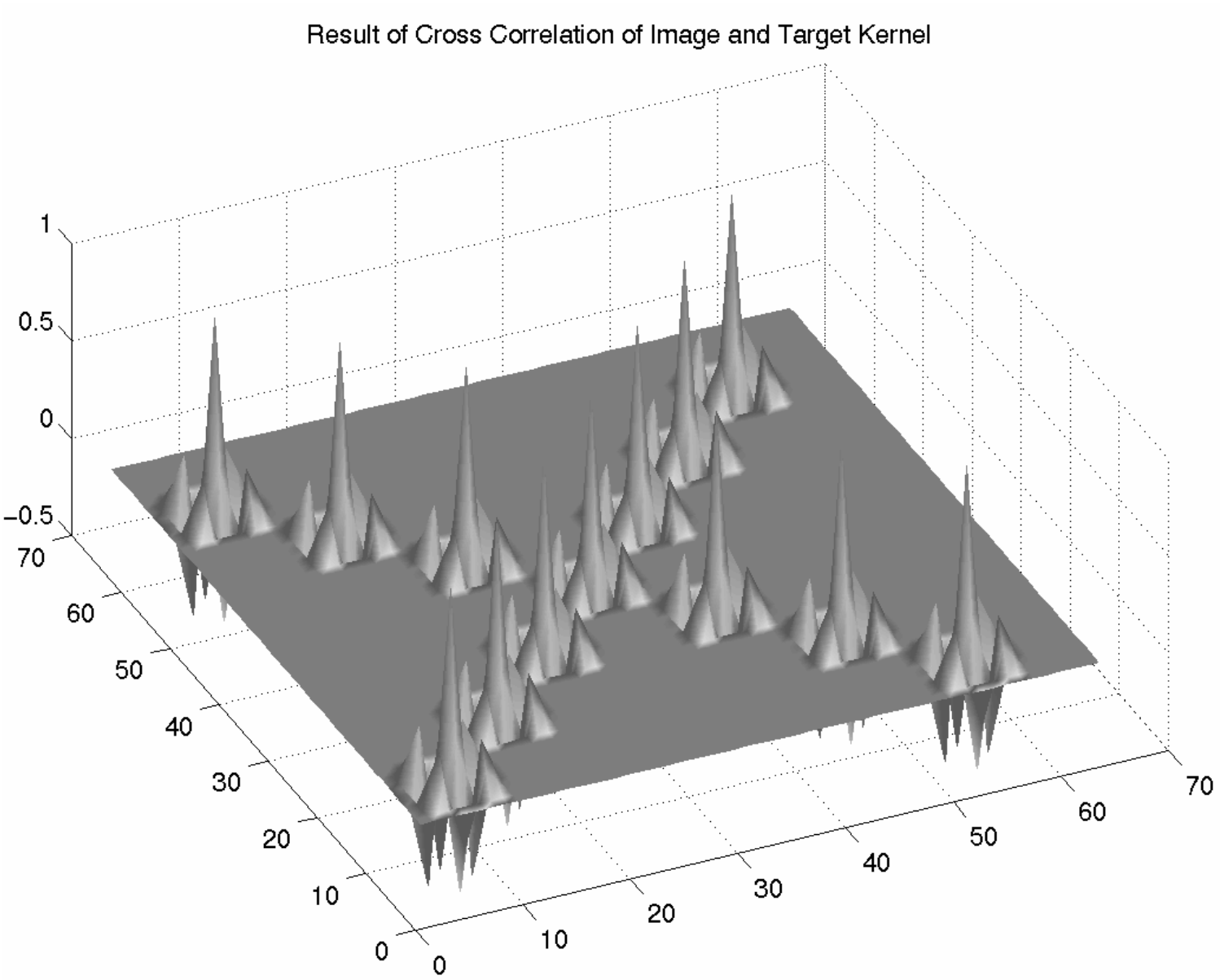


Get the correct correspondence between what you measure and its coordinates

Well defined camera fiducial marks suggest that matching/automation could be used to locate



Correlation Matching of Signalized Points



Transform Calibrated XY to row, column

$$r = a_0 + a_1 X + a_2 Y$$

$$c = b_0 + b_1 X + b_2 Y$$

Rearrange with unknown vector

Six Parameter Transformation

$$\begin{bmatrix} r \\ c \end{bmatrix} = \begin{bmatrix} 1 & X & Y & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & X & Y \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ b_0 \\ b_1 \\ b_2 \end{bmatrix}$$

but we must apply in the OTHER direction

so, invert

$$\begin{bmatrix} \mathrm{X} \\ \mathrm{Y} \end{bmatrix} = \begin{bmatrix} a_1 & a_2 \\ b_1 & b_2 \end{bmatrix}^{-1} \left[\begin{pmatrix} r \\ c \end{pmatrix} - \begin{pmatrix} a_0 \\ b_0 \end{pmatrix} \right]$$

Q. Why not write & solve directly in the form we want to use?

for example,

$$X = a_0 + a_1 r + a_2 c$$

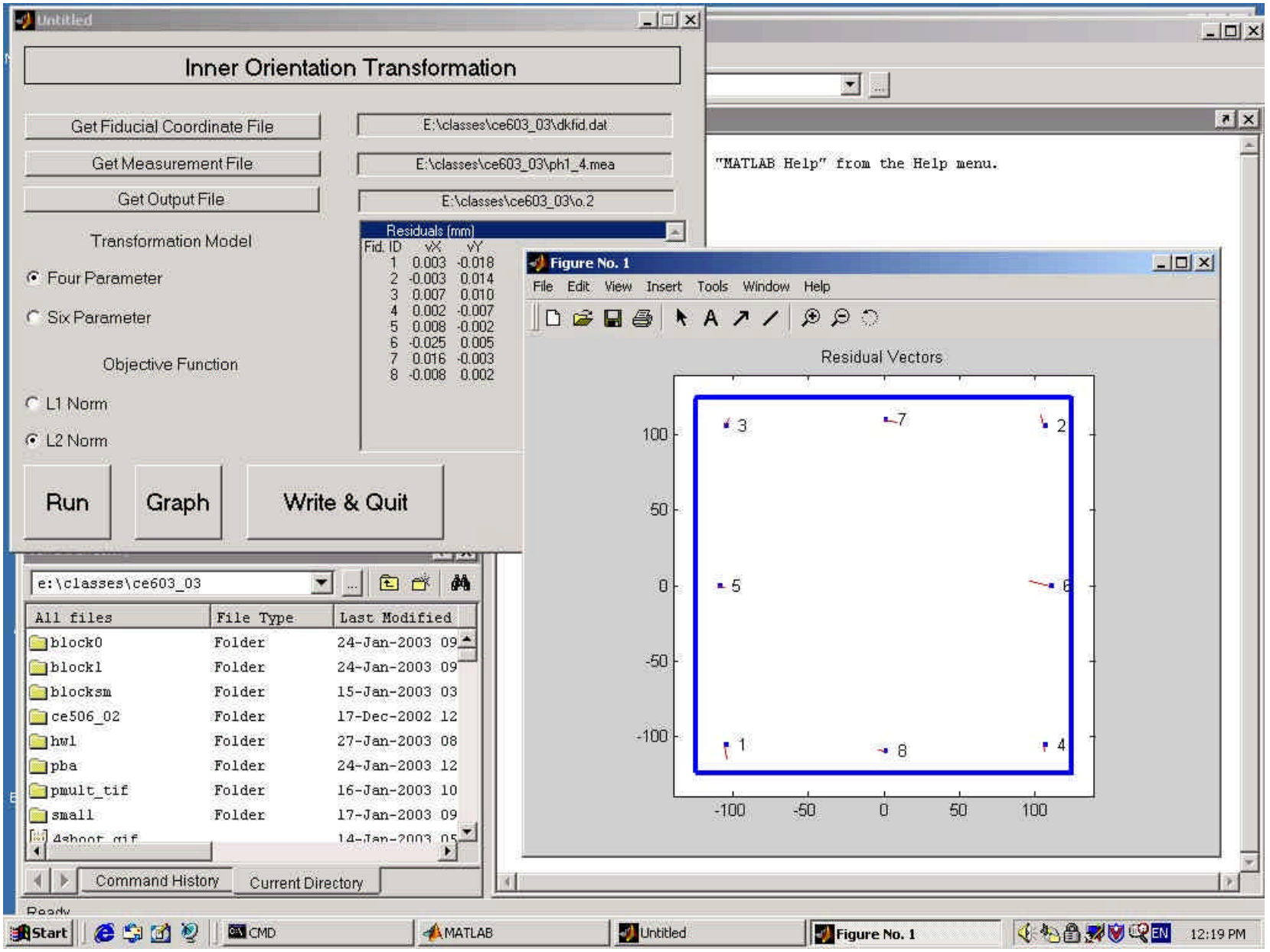
$$Y = b_0 + b_1 r + b_2 c$$

in matrix form,

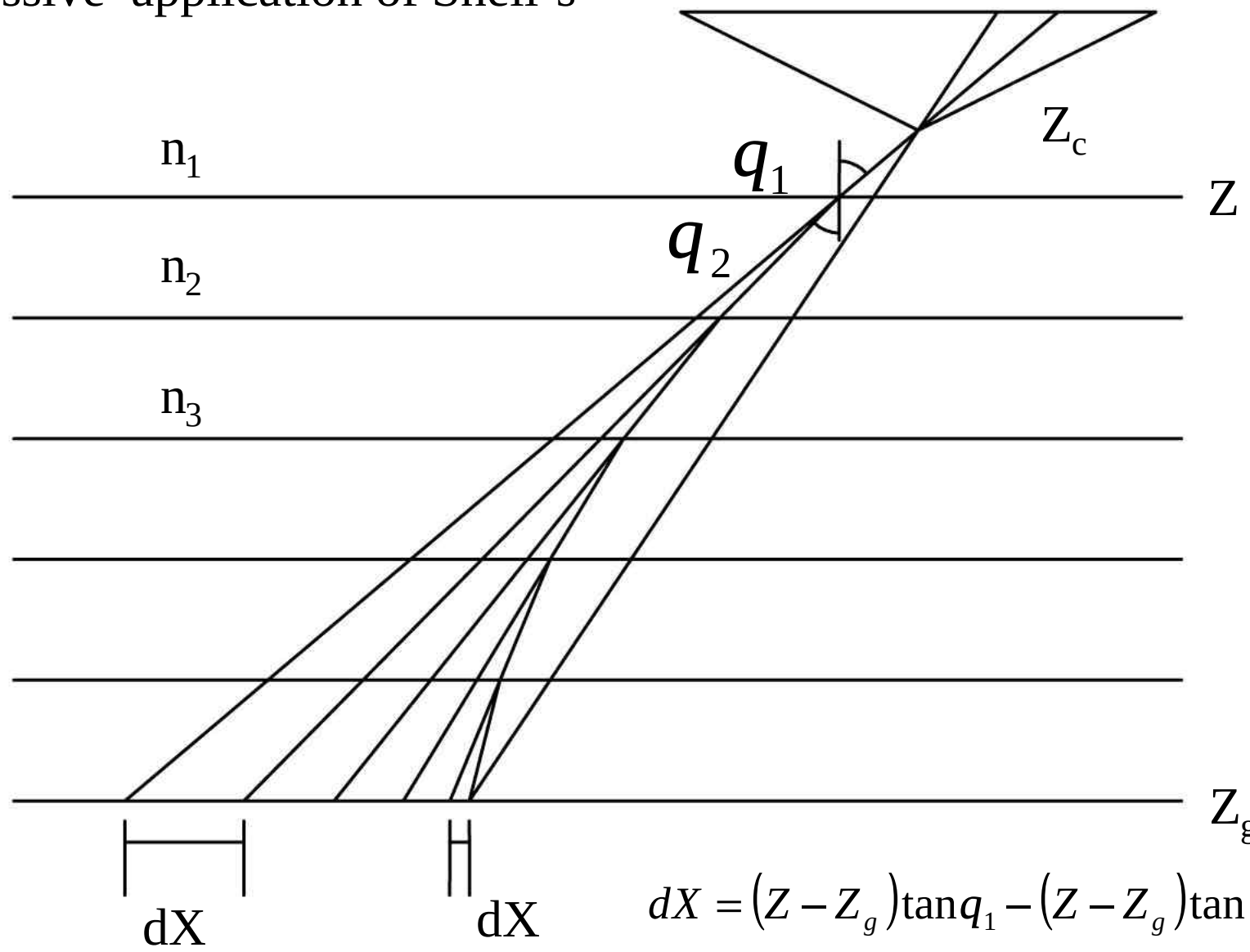
$$\begin{bmatrix} X \\ Y \end{bmatrix} = \begin{bmatrix} 1 & r & c & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & r & c \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ b_0 \\ b_1 \\ b_2 \end{bmatrix}$$

Don't we save the inversion step by this approach?

MATLAB GUI to Compute & Apply 2D Coordinate Transformation



Atmospheric Refraction from the successive application of Snell's Law



$$dX = (Z - Z_g)\tan q_1 - (Z - Z_g)\tan q_2$$

ChemEngr. Roof Points for Terrestrial block