CE 503 Fall 06 Homework 1, assigned Aug 28, Due Sep 6

- Find the camera calibration report in the notes page of class website (may 2005 photography description)
- Measure 2 of the corner fiducial marks on photo 5-13 as (line,sample) – careful, photoshop returns coordinates as x,y
- Find the needed imagery (5-13.tif for scale, 6-10.tif for relief displacement) at either \\geomatics.ecn.purdue.edu\data, in folder \share\bethel\purdue_3 or by anonymous ftp to ftp.ecn.purdue.edu , Go to folder “bethel”. Note each file is approx 250 MB.
- Using measurements and calibrated coordinates for 2 of the fiducial marks, determine the pixel size in micrometers (hint it is usually an integer)
- Using that information open photo 5-13 and find the high school athletic field with 5-yard stripes. (see units discussion later) Determine the approximate photo scale from the ratio of image distance and object distance. Express as unitless ratio. Use the scale value to determine GSD, ground sample distance, from pixel dimension.
- Using that scale value, and focal length from calibration report, determine the approximate flying height above the terrain (in meters).
- Now measure 3 fiducial marks on photo 6-10 as (line,sample)

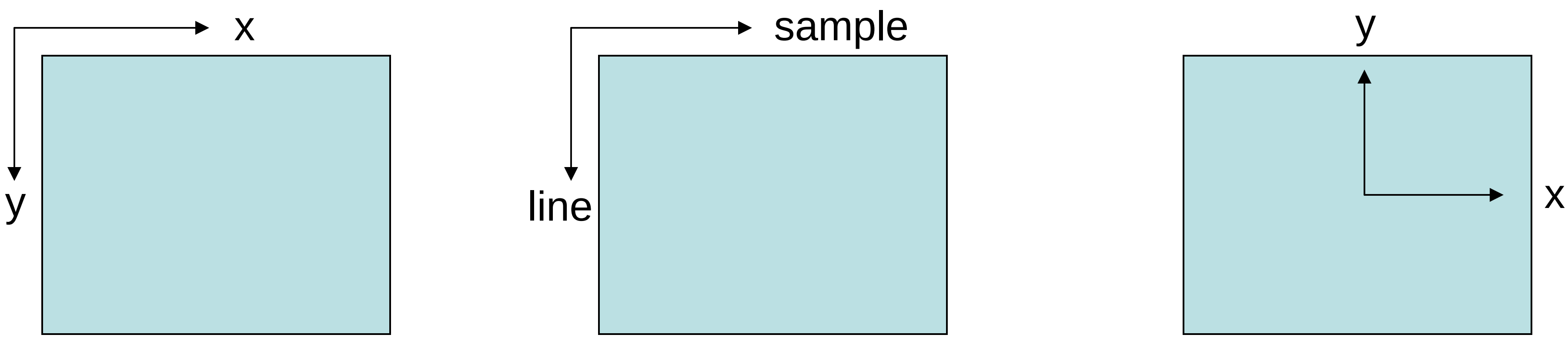
- Use six equations to solve for six unknown affine transformation parameters, as shown below

- Invert the transformation to permit easy conversion of (line, sample) to image coordinate (x,y).

- For each of the vertical features listed, measure and transform coordinates of (1) base of feature, and (2) top of feature. Features: Chem Engr Bldg (SW corner), Chem Bldg (NW corner), Clock Tower (base of roof), Engr. Mall fountain structure, Beering (LAEB, NE corner), Math-Science Bldg (NW corner), Apt. (NE corner).

- Use these with implicit (0,0) at principal point/nadir to obtain “r” and “dr” for the relief displacement formula

- Determine height of each of the features.



Photoshop pixel

Pixel coordinates

Image coordinates
(ref. to calibr. Report)

Image Coordinate Systems

$$l = a_0 + a_1 x + a_2 y$$

$$s = b_0 + b_1 x + b_2 y$$

$$\begin{bmatrix} l \\ s \end{bmatrix} = \begin{bmatrix} a_1 & a_2 \\ b_1 & b_2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} a_0 \\ b_0 \end{bmatrix}$$

$$\mathbf{l} = \mathbf{A}\mathbf{x} + \mathbf{t}$$

$$\mathbf{x} = \mathbf{A}^{-1}(\mathbf{l} - \mathbf{t})$$

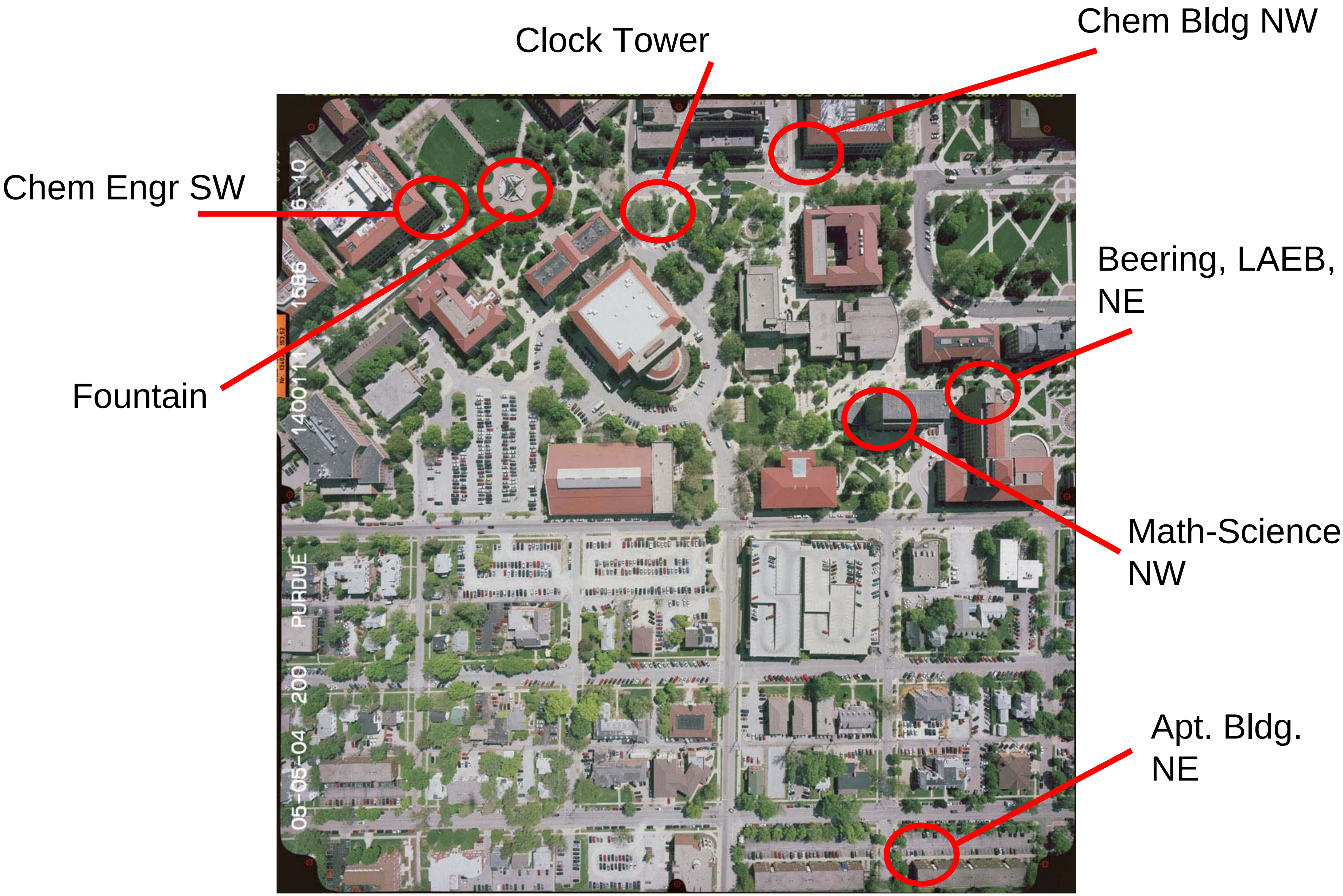
$$\begin{bmatrix} l_1 \\ s_1 \\ l_2 \\ s_2 \\ l_3 \\ s_3 \end{bmatrix} = \begin{bmatrix} 1 & x_1 & y_1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & x_1 & y_1 \\ 1 & x_2 & y_2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & x_2 & y_2 \\ 1 & x_3 & y_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & x_3 & y_3 \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ b_0 \\ b_1 \\ b_2 \end{bmatrix}$$

(l,s): line, sample image pixel measurements

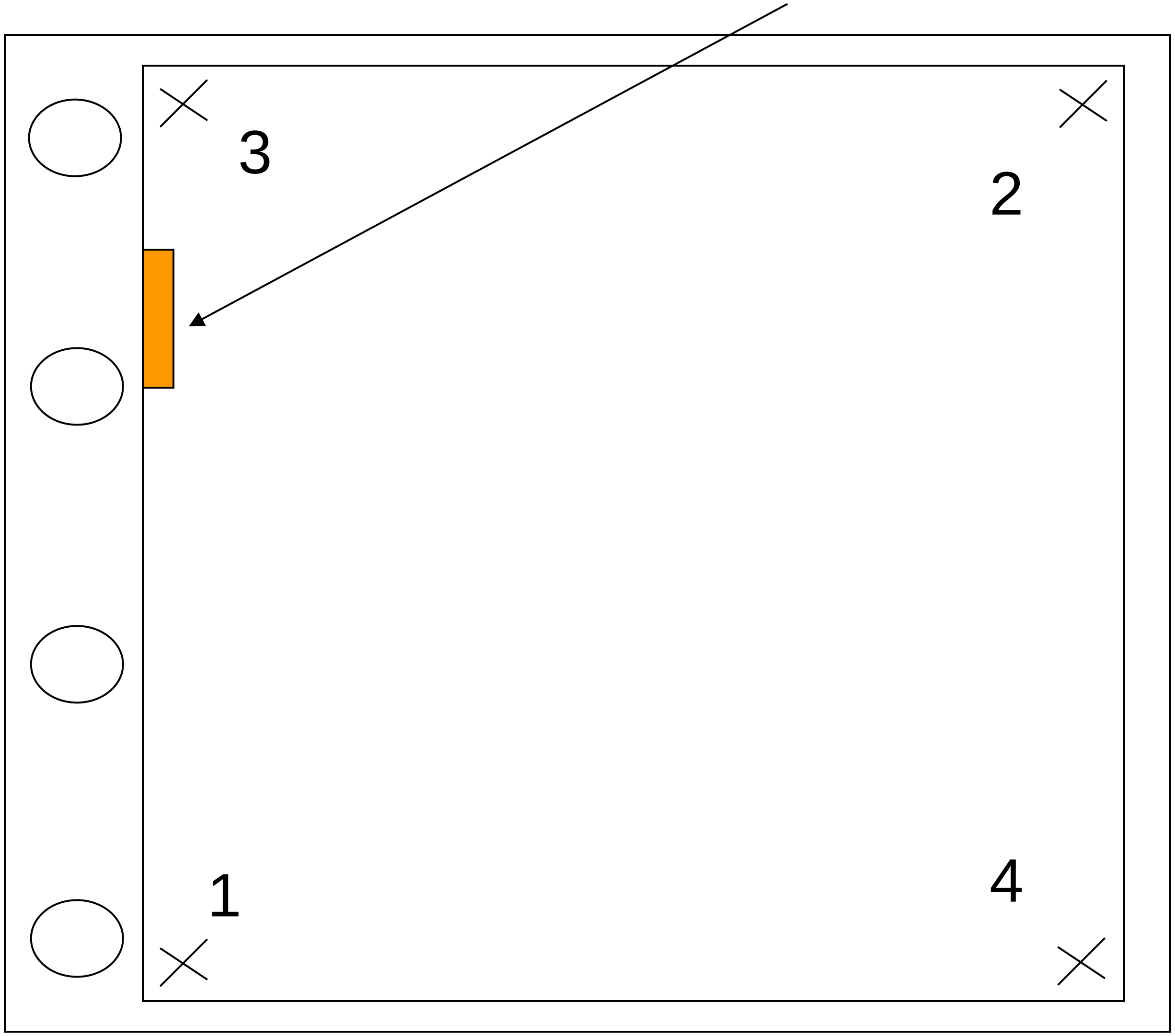
(x,y) coordinate referenced to the calibrated fiducial system

$$\mathbf{L} = \mathbf{B}\mathbf{X}$$

$$\mathbf{X} = \mathbf{B}^{-1}\mathbf{L}$$


Clock Tower
Chem Bldg NW
Chem Engr SW
Beering, LAEB, NE
Fountain
Math-Science NW
Apt. Bldg. NE
PURDUE

If data strip not visible, you may be able to use other visible features to orient the photograph to the camera



Note on Units

When dealing with US units (feet, inches, yards) there are two versions which are ALMOST the same but not quite:

- **U.S. Survey Foot:** The exact conversion is 39.37 inches per meter. It is equivalent to 0.30480060960…meters per foot. This is used for most surveying/geodetic/gis applications.

- **International Foot:** the exact conversion is 0.3048 meters per foot, or 2.54 centimeters per inch. This is used for laboratory scale science and engineering measurements.

(In both: 1 foot = 12 inches, 1 yard = 3 feet.)

The two systems differ by about 2 parts per million so the difference is not significant over short distances, the instances where you see significant differences are coordinates covering large zones, or continuous stationing along roads or alignments.

Advice: Insist that people define carefully their units and coordinate systems, and wherever possible use metric units.