

SIMG-782 Introduction to Digital Image Processing
 Homework 2 – Due September 15, 2005

1. Let $\mathbf{u} = [u_1, u_2, 1]^T$ and $\mathbf{v} = [v_1, v_2, 1]^T$ denote the homogeneous coordinates of points in planes P and Q , respectively. Matching point pairs are related by a projection matrix \mathbf{H} as

$$\mathbf{v}_i = \mathbf{H}\mathbf{u}_i, \quad i = 1, 2, \dots, n$$

- (a) A transform from P to Q in the form of a translation by (x_0, x_1) then a rotation by θ then a scaling by (s_0, s_1) is described by the matrix

$$\mathbf{H} = \begin{bmatrix} 0.951623 & 0.443749 & -6.97686 \\ -0.401487 & 0.860992 & -2.29753 \\ 0 & 0 & 1 \end{bmatrix}$$

Determine the values of $(x_0, x_1, s_0, s_1, \theta)$.

- (b) A transform from P to Q in the form of a translation by (x_0, x_1) then a scaling by (s_0, s_1) then a rotation by θ is described by the matrix

$$\mathbf{H} = \begin{bmatrix} 0.951623 & 0.401487 & -6.76555 \\ -0.443749 & 0.860992 & -2.08622 \\ 0 & 0 & 1 \end{bmatrix}$$

Determine the values of $(x_0, x_1, s_0, s_1, \theta)$ for this order transformations.

2. Matching pairs of points from P and Q are given by the columns of the arrays \mathbf{U} and \mathbf{V} below.

$$\mathbf{U} = \begin{bmatrix} 21.630 & 28.280 & 31.870 & 46.150 & 28.230 & 36.530 & 24.540 & 31.940 \\ 59.260 & 62.040 & 65.310 & 36.440 & 50.510 & 60.200 & 37.740 & 57.080 \\ 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 \end{bmatrix}$$

$$\mathbf{V} = \begin{bmatrix} 17.536 & 23.468 & 26.280 & 46.697 & 25.960 & 31.992 & 25.144 & 28.163 \\ 52.587 & 56.753 & 60.691 & 36.368 & 45.732 & 56.870 & 32.699 & 52.848 \\ 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 & 1.000 \end{bmatrix}$$

- (a) Find a matrix \mathbf{H} that maps points from P to Q .
- (b) Assume that the mapping is a translation, a scaling, and a rotation in that order. Find the parameters of the individual transformations.
3. Images LWIR087c.png, MWIR087c.png, SWIR087c.png are provided in the images directory <http://www.cis.rit.edu/class/simg782/images>
- (a) Find a transformation matrix \mathbf{H}_1 that maps the MW image to the LW image.
- (b) Find a transformation \mathbf{H}_2 that maps the SW image to the LW image.
- (c) Construct two greyscale images by mapping the MW and SW images.
- (d) Construct an RGB image by building an array that has the mapped SW, the mapped MW and the original LW as array layers. This is a raw image array that can be displayed with IDL or other tools.