

## CSE252B – Computer Vision II – Assignment #1

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<http://cseweb.ucsd.edu/classes/wi11/cse252b>

Target Due Date: Tue. Jan. 18, 2011.

1. What is the silhouette of a sphere of radius  $r$  with its center at coordinates  $(X_o, 0, Z_o)^\top$  under perspective projection on a planar surface? The perpendicular distance from the pinhole to the image plane is  $f$ .
2. Clicking and drawing points and lines.
  - (a) Write a function for collecting the coordinates of  $n$  hand-clicked points on an image. Include the option to plot and label the points on the image.
  - (b) Write a function that draws a line with homogeneous coordinates  $\ell = (a, b, c)^\top \in \mathbb{R}^3$ .

*Note:* see MaSKS Figure 6.7 for an example using the + pointmarker, integer point labels (using `text.m`), and thin white lines.
3. Consider the square viewed under perspective projection shown in Figure 1.
  - (a) Solve for the vanishing point for each pair of parallel lines.
  - (b) Write down an expression for the line at the horizon.

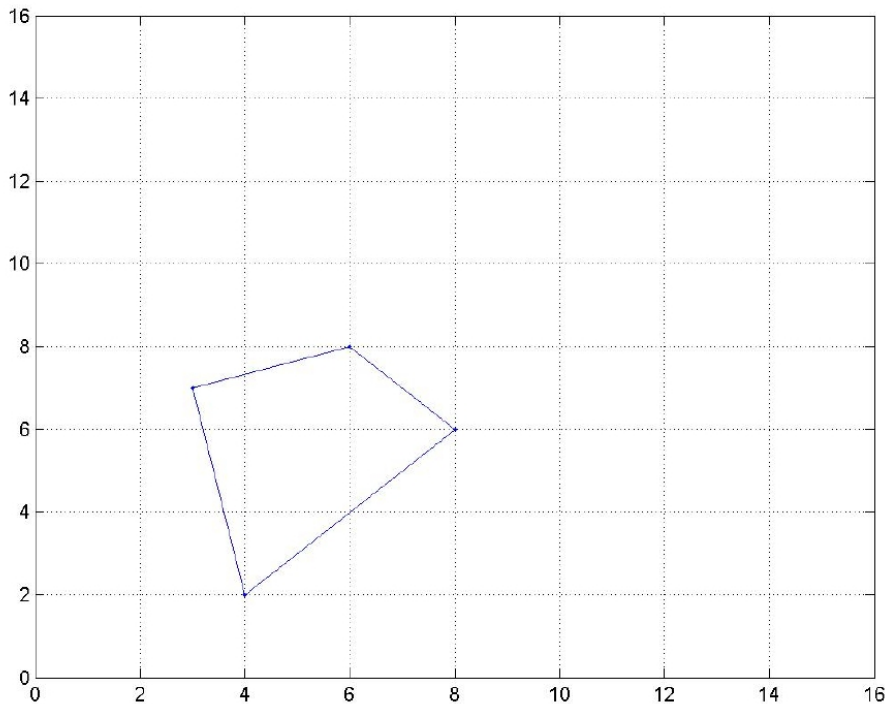


Figure 1: A square viewed under perspective projection.

4. MaSKS Exercise 2.11 (Axis and angle representation), p. 39.
5. MaSKS Exercise 2.12 (Properties of rotation matrices), p. 39.

6. MaSKS Exercise 3.10 (Vanishing points), p. 64.

7. Projection Matrices and Image Formation.

- (a) Write a function to produce a  $3 \times 4$  (general) projection matrix  $\Pi$  as defined in MaSKS on p. 56. The inputs to your function should be the intrinsic calibration parameters (i.e. the entries of the  $K$  matrix) and a rigid body motion  $g = (R, T) \in SE(3)$ .
- (b) Write a function to display a planar grid of points under perspective projection. The inputs to your program should be the size of the grid, its depth (the  $Z$  coordinates of the points), and a projection matrix  $\Pi$ . Demonstrate your program for an  $11 \times 11$  grid of points for three different choices of  $\Pi$ . For example, pretend the grid is painted on the wall and your job is to show what it looks like to several observers of varying heights standing roughly in front of it.
- (c) Extend your function from Problem 7b to include texture mapping (using `griddata.m`) for an arbitrary image. Show the result applied to an image of your choice (e.g. the built-in Matlab image `logo.tif`) from three different interesting viewpoints.

8. Conic Fitting.

- (a) Write a function that fits a conic to a set of points  $\{\mathbf{x}^i\}_{i=1}^n$ ,  $n \geq 5$ , and plots the result.
- (b) Use this function to illustrate fits to three sets of points resulting in one of each of the following types of conic: ellipse, parabola, hyperbola.
- (c) Perform a fit to a circle by specifying three points on the circle and the two circular points  $\mathbf{I} = (1, i, 0)^\top$  and  $\mathbf{J} = (1, -i, 0)^\top$ .