HOMEWORK ASSIGNMENT #1

DUE: September 19, 2011
CSCI 574: Computer Vision, Prof. Nevatia
Fall Semester, 2011

1. Do Problem 2.13 from the FP book.
2. In images acquired from a digital camera, it is common to place the origin of the image at the top left corner, the u-axis to be along the top row (pointing to the right) and the v-axis to be pointing downwards at an acute angle of 85 degrees to the u-axis. Assume that the focal length is 25 millimeters and that there is no additional scaling along the u and v axes. For these conditions, derive the intrinsic matrix, *K*, which helps map a point, P, specified in the camera coordinate frame to the image coordinates $(u, v, 1)^T$. Choose a convenient alignment of the axes of the camera coordinate frame. Consider the units in which P and the image point are specified.
3. Consider that a line is specified by two points A and B such that $A = [1,1,1]^T$ and $B = [2,2,2]^T$.
   a) Compute the Plücker coordinates of the line joining A and B (follow the equations given in Exercise 2.15 of the FP book).
   b) Show that the points A and B do satisfy the equation of 2.15, part (e).
   c) Consider the image of this 3-D line on the normalized image plane. First construct the corresponding projection matrix M, then compute the image according to equation (2.23). Show that this answer is consistent with the one obtained by projecting the two points A and B and computing the line by joining these two image points.

4. Consider a camera looking at a scene consisting of a plane (which we can call the *ground plane*) and some objects on this plane. Let the x-axis of the camera be horizontal (parallel to a ground plane) and the camera pointing "downwards" (tilting) at an angle of 45 degrees.
   a) Consider vertical lines (e.g. poles on the ground); their images should all converge to a common vanishing point. Derive the position of this vanishing point in the normalized image coordinates.
   b) All parallel lines in the ground plane will vanish on points on the *horizon* line. Derive the equation of the horizon line (again, in normalized image coordinates).

You are encouraged to use projective equations for lines to help simplify these derivations.