ECE 5273
Homework 2

Spring 2010 Dr. Havlicek

Consider a scene consisting of a black cube against a white background. Specified in units of meters, the corners of the bottom face of the cube have world coordinates (X, Y, Z) given by

$$\begin{aligned} P_1 &= (0.00, 0.00, 0.00), \\ P_2 &= (0.00, 0.00, 0.05), \\ P_3 &= (0.05, 0.00, 0.05), \\ P_4 &= (0.05, 0.00, 0.00). \end{aligned}$$

Another corner of the cube is located at $P_5 = (0.00, 0.05, 0.00)$. Two rotations are then applied to the cube while keeping the point P_1 fixed at $(0.00, 0.00, 0.00)$ as follows:

1. Keeping the bottom face of the cube in the X-Z plane, the cube is rotated clockwise by $30°$ so that edge $\overline{P_1P_2}$ makes an angle of $30°$ with the positive Z-axis.
2. Keeping edge $\overline{P_1P_5}$ in the Y-Z plane, the cube is rotated counterclockwise by $20°$ with respect to the Y-axis so that edge $\overline{P_1P_5}$ makes an angle of $-20°$ with the positive Y-axis.

The cube is then translated so that corner P_1 is located at world coordinates $P_1' = (0.00, 0.00, 1.00)$. An ideal pinhole camera with focal length $f = 50$ mm is used to image the cube at its new position.

a) Find the world coordinates of the eight corners of the cube P_1' - P_8' after the two rotations and the translation have been applied.

b) Find image coordinates of the projections p_1' - p_8' of the eight corners of the cube on the camera focal plane.

c) Carefully sketch the image that is obtained on the camera focal plane.

NOTE: the pinhole camera coordinate system specified in the notes is a **LEFT-HANDED** coordinate system. For this assignment, you can't just copy formulas for the rotation matrices out of your physics book – those are for a **right-handed** coordinate system. For this assignment, you must explicitly consider the left-handed coordinate system and modify the rotation matrices appropriately.

DUE: 2/3/2010