EECS 442 Computer Vision, Fall 2016 Homework 1

Due on Thursday, September 22, 2016 at 11:55pm.
Please submit your assignment on Canvas. Format PDF.
Put your name on the top of the first page or it will not be graded!

Problem 1

(a) Derive the combined rotation and translation needed to transform world coordinate W into camera coordinate C as illustrated in figure 1. Notice that C_z and C_x belong to the plane defined by W_z and W_x.

(b) Consider a square in the world coordinate system defined by the points a,b,c,d. Assume such a square has unit area. Show that the same square in the camera reference system has still unit area.

(c) Are parallel lines in the world reference system still parallel in the camera reference system? Justify your answer.

(d) Does the vector defined by a and b have the same orientation in both reference system? Justify your answer.

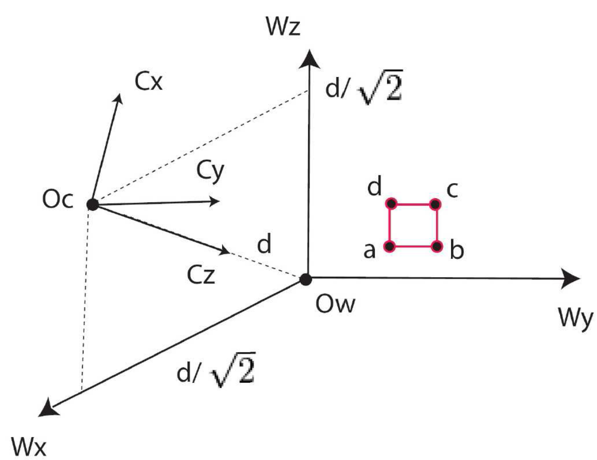

Figure 1

Problem 2

Consider a perspective projection where a point

$$P = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

is projected onto an image plane Π' represented by $k = f'$ as shown in figure 2. The first, second and third coordinate axes are denoted by **i**,**j**, and **k**, respectively. Consider the projection of an infinitely long line

$$Q = \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix} + t \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$$

in the world coordinate system where $-\infty \leq t \leq -1$. Calculate its two endpoints.

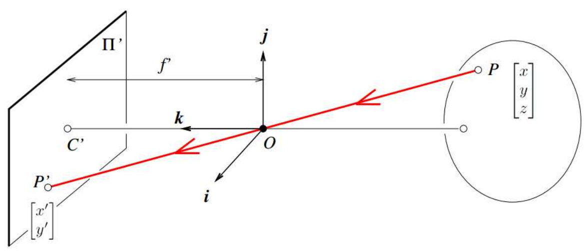

Figure 2

Problem 3

Two points $\mathbf{x_1} = (1, 3)^\top$, $\mathbf{x_2} = (3, 1)^\top$ in $\mathbb{R}^2$ are transformed to $\mathbf{x_1'}$, $\mathbf{x_2'}$ by a planar projective transformation H

$$H = \begin{bmatrix} 1.520 & -1.902 & 1.000 \\ 3.300 & 23.490 & 3.000 \\ 1.000 & 3.000 & 1.000 \end{bmatrix}$$

(a) Find the line $\mathbf{l}$ that passes through $\mathbf{x_1}$ and $\mathbf{x_2}$.

(b) Find the line $\mathbf{l'}$ that passes through $\mathbf{x_1'}$ and $\mathbf{x_2'}$. You can use MATLAB to help with your computation.

(c) Derive an analytical expression that relates $\mathbf{l}$ with $\mathbf{l'}$ through H.