CIS 580: Machine Perception, Spring 2020
Homework 1 due Jan 29, 2020 at 11:59pm

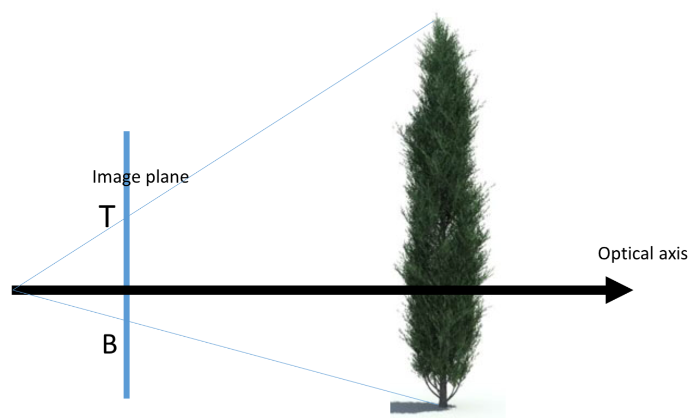
Instructions

- This is an individual homework.
- You must submit your solutions on Gradescope, the entry code is MB8ZJP. We recommend that you use LaTeX, but we will accept scanned solutions as well. Please box your answers if you submit scanned versions.
- Start early! If you get stuck, please post your questions on Piazza or come to office hours!

Homework

1. A world point with camera coordinates $(300, 600, 1200)$ is perspectively projected into an image at coordinates $(485, 490)$. Given that the image center is at $(360, 240)$ and the aspect ratio (ratio between width and height) of the pixels is 1, what is the focal length f of the camera?

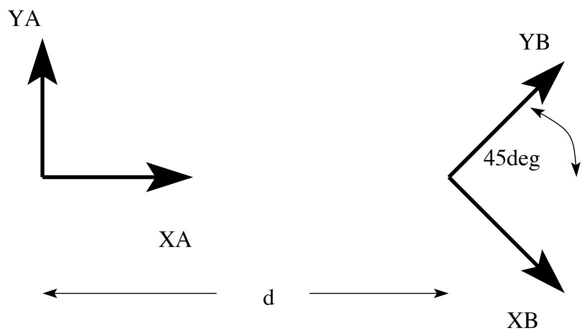
2. Assume that you see the bottom and the top of a vertical tree in front of you. The image plane is vertical as well and you see the bottom and the top of the tree at calibrated ($K = I$) coordinates $B = (0, y_1)$ and $T = (0, y_2)$, respectively.



Without knowing the pole's height can you tell whether the tree will hit the camera if it falls? Prove your answer.

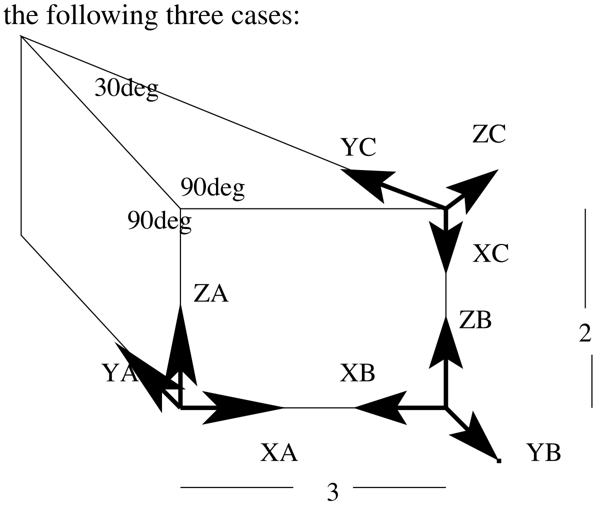
3. Determine the transformation T if

$$\begin{pmatrix} X_a \\ Y_a \\ 1 \end{pmatrix} = T \begin{pmatrix} X_b \\ Y_b \\ 1 \end{pmatrix}.$$



Note: $\cos(\pi/4), \sin(\pi/4)$ can appear in the solution. Do not replace them with numerical values.

4. Determine A, B, C in the following three cases:



You can solve the problem with the rotation column interpretation method or with concatenation of rotations.

$$\begin{pmatrix} X_a \\ Y_a \\ Z_a \\ 1 \end{pmatrix} = A \begin{pmatrix} X_b \\ Y_b \\ Z_b \\ 1 \end{pmatrix}, \qquad \begin{pmatrix} X_c \\ Y_c \\ Z_c \\ 1 \end{pmatrix} = B \begin{pmatrix} X_a \\ Y_a \\ Z_a \\ 1 \end{pmatrix}, \qquad \begin{pmatrix} X_c \\ Y_c \\ Z_c \\ 1 \end{pmatrix} = C \begin{pmatrix} X_b \\ Y_b \\ Z_b \\ 1 \end{pmatrix}.$$

5. Determine the transformation T if

$$\begin{pmatrix} X_c \\ Y_c \\ Z_c \\ 1 \end{pmatrix} = T \begin{pmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{pmatrix}$$

Describe the transformation from camera to world coordinates in the following picture.