EECS C106B - Robotic Manipulation and Interaction **(Week 12)**

Discussion #11

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Problem 1 - Camera Intrinsics

The camera intrinsic parameter matrix K can be represented

$$\begin{bmatrix} fs_x & s_\theta & o_x \\ 0 & fs_y & o_y \\ 0 & 0 & 1 \end{bmatrix} \tag{0.1}$$

What do each of these terms represent?

Problem 2 - Homography Matrix Transform

When the image features lie in a plane in the real world, the two-image correspondence problem is called planar homography. The real world coordinates of a point X are X_1 in the frame of camera 1, and X_2 in the frame of camera 2. We assume that X lies on a plane with normal vector N (defined with respect to camera 1). We know that the transform between the cameras is of the form $X_2 = RX_1 + T$, an affine transformation, but by assuming that X lies on the plane we can represent this transformation with a *homography matrix* H where

$$X_2 = HX_1 \tag{0.2}$$

where $H = R + \frac{1}{d}TN^T$, where d is the shortest distance between the plane and camera 1 ($d = N^T X_1$).

1. If we switch the roles of the first and second cameras, we should still be able to define a homography matrix $\tilde{H}$ such that $X_1 = \tilde{H}X_2$. Assume that $d_1 = 1$, so $H = R + TN^T$. Show that the new homography matrix $\tilde{H}$ is defined

$$\tilde{H} = \left(R^T + \frac{-R^T T}{1 + N^T R^T T} N^T R^T \right) \tag{0.3}$$

2. What is the relationship between H and $\tilde{H}$?