**EECS C106B / 206B Robotic Manipulation and Interaction** **Spring 2022**

# Discussion 7 : Two-View Geometry

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## 7.1 Question 1: Fundamental Matrix

Let:

$$F = \begin{bmatrix} f_1 & f_4 & f_7 \\ f_2 & f_5 & f_8 \\ f_3 & f_6 & f_9 \end{bmatrix}$$

and let $\mathbf{f} = [f_1, ..., f_9]$. Show that the epipolar constraint can be represented as the following inner product:

$$a(x_i, x_i')\mathbf{f} = 0$$

where $a(x_i, x_i')$ is a row vector that depends only on the coordinates of the point $x_i$ and $x_i'$

Note: $x_i' F x_i = 0$

## 7.2 Question 2: Fundamental Matrix Details

Answer the following questions, providing an adequate justification.

1. How many degrees of freedom does the fundamental matrix F have?
2. How many independent equations do we need to estimate f? Why?
3. Explain how the system of equations can be written in matrix form as Af = 0. What are the dimensions of A? Write explicitly A.
4. How would you estimate f via constrained least squares?

## 7.3 Question 3: One more Time - Fundamental Matrix

Recall that the fundamental matrix can be written as $F = \hat{e}'K'RK^{-1}$. Show that $e' \times x' = Fx$.

## 7.4 Question 4: Homographies

Let $p$ correspond to a point on one image and let $p$ correspond to the same point in the scene, but projected onto another image. Write a general equation for how a homography matrix $H$ maps points from one image to another. How would $H$ be restricted if it must describe an affine transformation?

## 7.5 Question 5: Homographies

How many points do you need to calculate a homography and why?