Computer Vision - ELL793

Prof. Brejesh Lall

First Mid Term (Minor 1), Date: 6th Feb, 2023

Time: 1 hrs. | 2022-23 II Semester | Max. mark: 20

Read the following instructions carefully:

- All questions are necessary.
- The exam is divided into Long answer type questions and Multiple Choice Questions (MCQs). There are 3 long answer type questions with 8 MCQs with the distribution of points given at the start of the question. **MCQ sheet will be collected from you in 15 minutes from the start of the exam**. Divide your time accordingly.
- There is a negative marking for MCQs ONLY. Not attempting an MCQ will yield no points in that MCQ. Some MCQs can have multiple correct options. For MCQs with multiple correct options, points will only be awarded if **all correct choices** are selected. Otherwise, it is treated wrong and will incur negative $\frac{1}{2}$ points. Incorrect and/or partial selection of correct options will yield negative $\frac{1}{2}$ of the points in that MCQ. Please draw a circle around the option(s) to indicate your answer. No points will be awarded for unclear/ambiguous answers. Write your entry number and your name on the MCQ sheet clearly.

---

1. **(4 points)** Explain pinhole camera model. Show the mapping of a point P in the 3D world reference frame to a point P' in the 2D image plane. Derive the camera matrix in the process and explain the intrinsic and extrinsic parameters as well.

2. (a) **(2 points)** Given a triangle with the coordinates of its vertices as $A(0, 2)$, $B(-4, 4)$ and $C(-4, 0)$. Rotate this triangle 90 degree counterclockwise (along $z-$axis) about another point $P(1, 2)$ in the plane and give the corresponding output coordinates obtained after such an operation. *Assume $z-$ axis to be perpendicular to the writing sheet.*

   (b) **(2 points)** Given a triangle with the coordinates of its vertices as $A(1, 1)$, $B(4, 2)$, and $C(2, 3)$. Determine the coordinates as a reflection on X-axis. Then, translate it $+3$ units on $Y-$axis and $+2$ units on $X-$ *axis*. Give the corresponding output coordinates. *Assume $x-$ axis to be horizontal to the writing sheet, and $y-$ axis to be vertical to the writing sheet.*

3. Figure *1* shows a scene point $\mathbf{X}$ imaged at points $\mathbf{x}$ and $\mathbf{x}'$ in cameras $\mathbf{C}$ and $\mathbf{C}'$.

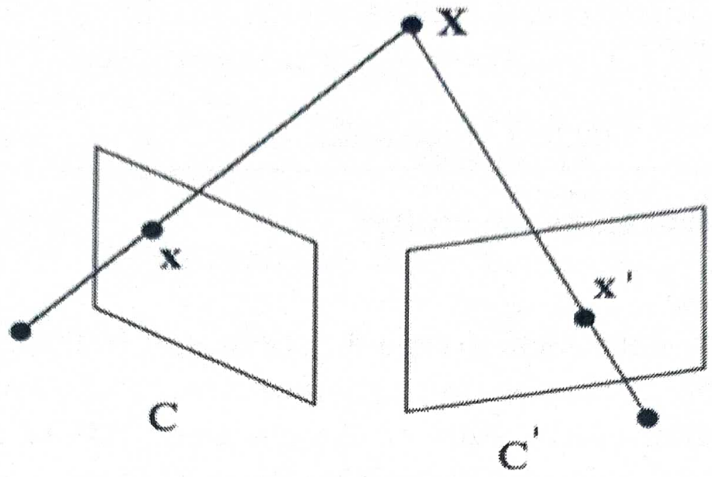

Figure 1:

(a) **(2 points)** Define epipolar constraint. Show that the epipolar constraint can be written as the following inner product: $\mathbf{a}(\mathbf{x_i}, \mathbf{x_i'})\mathbf{f} = \mathbf{0}$ where, $\mathbf{a}(\mathbf{x_i}, \mathbf{x_i'})$ is a row vector that depends only on the coordinates of the points $\mathbf{x_i}$ and $\mathbf{x_i'}$.

(b) **(2 points)** Given a Fundamental Matrix $\mathbf{F} = \begin{bmatrix} -0.003 & -0.028 & 13.19 \\ 0.003 & 0.008 & 29.2 \\ 2.97 & 56.38 & -9999 \end{bmatrix}$, and given a point in the left Image $\mathbf{x} = \begin{bmatrix} 343 \\ 221 \\ 1 \end{bmatrix}$, find the equation for epipolar line in the right Image.