Nptel Online Certification Course
Indian Institute of Technology Kharagpur
Computer Vision
Assignment - Week 3

Number of questions: 10 **Total marks: 10x2=20**

QUESTION 1: **Type: MCQ**

Given a projection matrix $P = \begin{bmatrix} 1 & 0 & 1 & 10 \\ 2 & 1 & 2 & 3 \\ 1 & 0 & -1 & 1 \end{bmatrix}$, compute the vanishing point of a line in image coordinates with direction ratio $10 : 8 : 6$.

a) $(2.25, 7.5)$

b) $(2, 5)$

c) $(4, 10)$

d) $(1.33, 3.33)$

Correct Answer: c
Detailed Solution: Vanishing point of the line with direction ratio $a : b : c = P(a, b, c, 0)^T$.

QUESTION 2: **Type: MCQ**

Consider a projection matrix $P = \begin{bmatrix} 1 & 0 & 1 & 10 \\ 2 & 1 & 2 & 3 \\ 1 & 0 & -1 & 1 \end{bmatrix}$, find the camera center in homogeneous coordinates.

a) $(-0.5, 0, -0.5, 1)$

b) $(-0.5, 0, 0.5, 1)$

c) $(0.5, 0, -0.5, 1)$

d) $(-5.5, 17, 4.5, 1)$

Correct Answer: d
Detailed Solution: Considering the left 3x3 sub matrix of P as M and last column of P as p_4, camera center is given by $C = (-M^{-1}p_4, 1)$

QUESTION 3: **Type: MCQ**

If the principal point (p_x, p_y), focal length (f), orientation (R) and the camera centre (C) of a pin hole camera with respect to canonical coordinate convention, are given by $(2, 3)$, 0.5, $\begin{bmatrix} 0.36 & 0.48 & -0.8 \\ -0.8 & 0.6 & 0 \\ 0.48 & 0.64 & 0.6 \end{bmatrix}$ and $(1, 2, 1)$, respectively, compute the 3x4 projection matrix P.

a) $\begin{bmatrix} 3.14 & 1.52 & 9.8 & 4.98 \\ 1.04 & 2.22 & 1.8 & 7.28 \\ 5.48 & 6.64 & 7.6 & 2.36 \end{bmatrix}$

b) $\begin{bmatrix} 1 & 1.2 & 0.8 & 4.98 \\ 1.0 & 2.22 & 8.8 & 7.28 \\ 0.8 & 0.64 & 0.6 & 2.36 \end{bmatrix}$

c) $\begin{bmatrix} 1.14 & 1.52 & 0.8 & 4.98 \\ 1.04 & 2.22 & 1.8 & 7.28 \\ 0.48 & 0.64 & 0.6 & 2.36 \end{bmatrix}$

d) $\begin{bmatrix} 5.14 & 7.52 & 2.8 & 7.98 \\ 1.04 & 2.22 & 1.8 & 1.28 \\ 0.48 & 0.64 & 0.6 & 5.36 \end{bmatrix}$

Correct Answer: c

Detailed Solution: Projection matrix $P = KR[I| - C]$ where calibration matrix for a pin hole camera with principal point (p_x, p_y) is $K = \begin{bmatrix} f & 0 & p_x \\ 0 & f & p_y \\ 0 & 0 & 1 \end{bmatrix}$

QUESTION 4: **Type: MCQ**

Find out the direction of principal axis of the camera with projection matrix $P =$

$$\begin{bmatrix} 51 & 6 & -18 & 10 \\ -23 & 5 & 9 & 0 \\ 1 & 0 & 0 & 1 \end{bmatrix}$$

a) $(1, 0, 0)$

b) $(51, -23, 1)$

c) $(-2, 0, 1)$

d) $(10, 0, 1)$

Correct Answer: a

Detailed Solution: The direction of principal axis is given by m^3 (first three values of third row)

QUESTION 5: **Type: MCQ**

Find out the direction of principal axis of the camera with projection matrix $P =$

$$\begin{bmatrix} 51 & 6 & -18 & 10 \\ -23 & 5 & 9 & 0 \\ 1 & 0 & 0 & 1 \end{bmatrix}$$

a) $(1, 0, 0)$

b) $(51, -23, 1)$

c) $(-2, 0, 1)$

d) $(10, 0, 1)$

Correct Answer: b

Detailed Solution: Principal point of the camera is given by Mm^3, where M is the left hand 3x3 matrix and m^{3T} is the third row of M.

QUESTION 6: **Type: MCQ**

Conside a camera centric world coordinate system with the image plane parallel to principal plane and its x and y coordinate axes are parallel to those of world coordinate system respectively. If the principal point is located at $(7, 9)$ in the coordinate system of the image plane, what would be the image coordinates of the world point $(10, 7, 5)$, using a pin hole camera with focal length $f = 0.5$?

a) $(4.3, 4.4)$

b) $(8, 9.7)$

c) $(2.4, 9.6)$

d) $(4.1, 9.7)$

Correct Answer: b

Detailed Solution: If the origin of image plane is not at the principal point, then the mapping from world coordinates (X, Y, Z) to image coordinates (x, y) with principal point at (p_x, p_y) is given by $((fX/Z) + p_x, (fY/Z) + p_y)$

QUESTION 7: **Type: MCQ**

Consider that the camera projection matrix $P = \begin{bmatrix} 28 & 5 & 4 & 0 \\ 1 & 81 & 9 & 0 \\ 2 & 1 & 10 & 0 \end{bmatrix}$, two image points $x_1 = (-3, 12)$, $x_2 = (5, -7)$ and the camera center O. Find the unit normal to plane Ox_1x_2.

a) $(-0.70, 0.70, 0.16)$

b) $(-0.07, 0.95, 0.32)$

c) $(-0.53, 0.8, -0.28)$

d) $(-0.26, 0.93, 0.26)$

Correct Answer: c
Detailed Solution: Normal to the plane Ox_1x_2 is given as $P^T(x_1 \times x_2)$. Unit vector is obtained by dividing the vector with its magnitude.

QUESTION 8: **Type: MCQ**

Consider a projection matrix $P = \begin{bmatrix} 8 & 51 & 4 & 0 \\ 7 & 8 & 19 & 0 \\ 10 & -5 & 8 & 1 \end{bmatrix}$, compute the camera center C in world coordinates

a) $(-0.122, 0.016, 0.038)$

b) $(-0.280, 0.0946, -1.0624)$

c) $(-0.0280, 0.0946, -0.0624)$

d) $(-1.020, 0.0946, -1.0624)$

Correct Answer: a
Detailed Solution: Camera center in homogeneous coordinates is given by $(-M^{-1}p_4)$, where M is left 3×3 matrix of P and p_4 is the last column of M.

QUESTION 9: **Type: MCQ**

A projective camera $P = \begin{bmatrix} 8 & 51 & 4 & 0 \\ 1 & -8 & 9 & 0 \\ 2 & 1 & 11 & 0 \end{bmatrix}$ images a 3D line L as $l = (17, 2, 23)$. Compute the plane formed by projected line l and camera center.

a) $(16, 24, 25, 0)$

b) $(8, 12, 12.5, 0)$

c) $(6, 4, 5, 0)$

d) $(184, 874, 339, 0)$

Correct Answer: d
Detailed Solution: Plane formed by the camera center C and l is given as $P^T l$.

QUESTION 10: **Type:MCQ**

Conside a camera centric world coordinate system with the image plane parallel to principal plane and its x and y coordinate axes are parallel to those of world coordinate system respectively. If the principal point is located at $(3, 5)$ in the coordinate system of the image plane, what would be the projection matrix of a pin hole camera with focal length $f = 2$?

a) $\begin{bmatrix} 2 & 0 & 3 & 2 \\ 0 & 2 & 5 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$

b) $\begin{bmatrix} 2 & 0 & 3 & 0 \\ 0 & 2 & 5 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$

c) $\begin{bmatrix} 2 & 0 & 3 & 0 \\ 0 & 2 & 5 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$

d) $\begin{bmatrix} 3 & 0 & 2 & 0 \\ 0 & 5 & 2 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$

Correct Answer: b

Detailed Solution: For a pin hole camera with focal length f and offset p_x and p_y, projection matrix is given by $\begin{bmatrix} f & 0 & p_x & 0 \\ 0 & f & p_y & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$
