Nptel Online Certification Course
Indian Institute of Technology Kharagpur
Computer Vision
Assignment - Week 2

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

QUESTION 1: **Type: MCQ**

Compute the point of intersection of the lines $2x + 1 = 0$ and $x + 3y + 1 = 0$.

a) $(-1/6, 1/6)$

b) $(-2/3, 1)$

c) $(-1/2, -1/6)$

d) $(-2/3, -1)$

Correct Answer: c)
Detailed Solution:
Point of intersection is given by
$$\begin{bmatrix} 2 \\ 0 \\ 1 \end{bmatrix} \times \begin{bmatrix} 1 \\ 3 \\ 1 \end{bmatrix}.$$

FOR QUESTIONS 2 AND 3:

Given a homography $H = \begin{bmatrix} 1 & 1 & -2 \\ 2 & 0 & 1 \\ 0 & 2 & -1 \end{bmatrix}$. Based on the given data solve the following questions 2 and 3:

QUESTION 2: **Type: Comprehensive**

Find the transformation of the point $(-1, 7)$.

a) $(1, -4, -10)$

b) $(4, -1, 13)$

c) $(4, 1, -10)$

d) $(2, -1, 13)$

Correct Answer: b)

Detailed Solution:

Transformation of a point x is given by $x' = Hx$.

QUESTION 3: **Type: Comprehensive**

Find the transformation of the line passing through the points $p1 = (2, 0)$ and $p2 = (1, -3)$.

a) $4x - 0.5y - 2.5 = 0$

b) $4x - y + 2.5 = 0$

c) $0.5x - y + 2.5 = 0$

d) $4x + 0.5y - 2.5 = 0$

Correct Answer: a)
Detailed Solution:
Line passing through the points is given by $l = p1 \times p2$.
Transformation of the line l is given by $l' = H^{-T} l$.

QUESTION 4: **Type: MSQ**

Given the circle of radius 5 with centre at $(-3, 2)$ in R^2 and homography $H = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix}$.

Which of the following represents the circle by a conic C?

a) $C = \begin{bmatrix} 1 & 0 & -3 \\ 0 & 1 & -2 \\ -3 & -2 & -12 \end{bmatrix}$

b) $C = \begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & -2 \\ 3 & -2 & -12 \end{bmatrix}$

c) $C = \begin{bmatrix} -1 & 0 & -3 \\ 0 & 1 & -2 \\ 3 & -2 & -12 \end{bmatrix}$

d) $C = \begin{bmatrix} 1 & 0 & 3 \\ 0 & -1 & -2 \\ -3 & -2 & -12 \end{bmatrix}$

Correct Answer: b)

Detailed Solution:

Equation of a circle is given by $ax^2 + bxy + cy^2 + dx + ey + f = 0$. From this equation conic C is given by $C = \begin{bmatrix} a & \frac{b}{2} & \frac{d}{2} \\ \frac{b}{2} & c & \frac{e}{2} \\ \frac{d}{2} & \frac{e}{2} & f \end{bmatrix}$.

QUESTION 5: **Type: MCQ**

Given a homography $H = \begin{bmatrix} 1 & 1 & -2 \\ 2 & 0 & 1 \\ 0 & 2 & -1 \end{bmatrix}$. Find the vanishing line.

a) $(1, 1, 0)$

b) $(-0.5, 0.25, 0.25)$.

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

d) $(0, 0, 1)$.

Correct Answer: b)
Detailed Solution:

The vanishing line is given by $\begin{bmatrix} 1 & 1 & -2 \\ 2 & 0 & 1 \\ 0 & 2 & -1 \end{bmatrix}^{-T} \times \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$.

FOR QUESTIONS 6 AND 7:

Given a homography $H_1 = \begin{bmatrix} 1 & 1 & -2 \\ 2 & 0 & 1 \\ 0 & 2 & -1 \end{bmatrix}$. Based on the given data solve the following questions 6 and 7:

QUESTION 6: **Type: Comprehensive**

Compute the transformation of dual conic C_∞^* $(I.J^T + J.I^T)$ under H_1.

a) $\begin{bmatrix} 2 & 2 & 2 \\ 2 & 4 & 0 \\ 2 & 0 & 4 \end{bmatrix}$.

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

c) $\begin{bmatrix} 1 & 1 & 2 \\ 0 & 2 & 0 \\ 1 & 0 & 2 \end{bmatrix}$.

d) $\begin{bmatrix} 2 & 2 & 4 \\ 2 & 4 & 0 \\ 2 & 0 & 2 \end{bmatrix}$.

Correct Answer: a)

Detailed Solution:

Dual Conic transformed under H_1 can be written as $H_1 C_\infty^* H_1^T$, where $C_\infty^* = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$.

QUESTION 7: **Type: Comprehensive**

A point $p(1, 2, 1)$ in plane P_1 is transformed using H_1 to get a point in plane P_2. The transformed point in P_2 is subjected to another transformation using H_2 matrix to get a point in plane P_3. Given $H_2 = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 1 \end{bmatrix}$. Find the transformed point in plane P_3.

a) $(-1, 5, -9)$

b) $(-1, 9, -5)$.

c) $(1, 9, 5)$.

d) $(1, -5, 9)$.

Correct Answer: c)
Detailed Solution:
A cascade of transformation can be replaced by a single transformation using $H = H_1 H_2$.
Thus, transformed point $x' = Hx$.

QUESTION 8: **Type: Numeric**

Given two lines $l(2, 1, 3)$ and $m(1, 0, -2)$ meet at a point p. Find the Euclidean angle between these two lines. Answer should be in nearest degrees. Discard the decimal values.

Correct Answer: 27

Detailed Solution:

The Euclidean angle is given by $cos\theta = \frac{l^T C^*_\infty m}{\sqrt{(l^T C^*_\infty l)(m^T C^*_\infty m)}}$, where $C^*_\infty = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$.

QUESTION 9: **Type: MSQ**

Recollect Direct Linear Transform (DLT) algorithm for non-homogeneous equation $Ah = 0$. The matrix A is formed from the following equations relating a point X_i and its transformed point $X_i^{'}$ in 2D projective spaces.

$$\begin{bmatrix} 0^T & -w_i' X_i^T & y_i' X_i^T \\ w_i' X_i^T & 0^T & -x_i' X_i^T \\ -y_i' X_i^T & x_i' X_i^T & 0^T \end{bmatrix} \begin{pmatrix} h^1 \\ h^2 \\ h^3 \end{pmatrix} = 0$$

where $X_i' = (x_i', y_i', w_i')^T$ and $X_i = (x_i, y_i, w_i)^T$, $i = 1, 2, \cdots n$. Choose the correct options.

a) Dimension of A= $2n \times 9$
   Dimension of h: 9×1
   Rank: 9

b) Dimension of A= $2n \times 8$
   Dimension of h: 8×1
   Rank: 8

c) If the origin of the plane lies on the vanishing line, no solution exists.

d) If the origin of the plane lies on the vanishing line, unique solution exists.

Correct Answer: b), c)

Detailed Solution: We can solve for H by setting $h_{33} = 1$ as no solution can be obtained with $h_{33} = 0$ (no multiplication scale exists, It happens if the origin of the plane lies on the vanishing line.). Therefore, we will use first two rows of the matrix A and re-frame the problem as minimization problem.

QUESTION 10: **Type:MSQ**

Which of the following statements are true?

a) The cosine angle between two lines are preserved under homography.

b) The circular points are fixed points under homography.

c) Colinearity is preserved under homography.

d) Affine group have 5 degree of freedom.

Correct Answer: a), c)

Detailed Solution:

Affine group have 6 degree of freedom. The circular points are fixed points under homography H if and only if H is a similarity .
