Nptel Online Certification Course
Indian Institute of Technology Kharagpur
Computer Vision
Assignment - Week 5

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

QUESTION 1: **Type: MCQ**

Consider a plane induced homography $H = \begin{bmatrix} 4 & 3 & 1 \\ 4 & 5 & 6 \\ 2 & 8 & 2 \end{bmatrix}$ of a stereo imaging set up. Epipole $e'(5, 3)$ in right image plane and a point $x(4, 8)$ in left image plane are given. Compute the epipolar line (l') on which the corresponding point of x will lie in right image plane.

a) $(160, -329, 187)$

b) $(-4, 9, 30)$

c) $(1, -1, 1)$

d) None of the above

Correct Answer: a
Detailed Solution: Epipolar line $l' = e' \times Hx$.

QUESTION 2: **Type: MCQ**

Consider a camera with calibration matrix $K = \begin{bmatrix} 6 & 8 & 4 \\ 4 & 6 & 5 \\ 1 & 1 & 1 \end{bmatrix}$ forms an image I of a world scene.

The camera is rotated about its center by $R = \begin{bmatrix} 0.36 & -0.48 & 0.8 \\ 0.8 & 0.6 & 0 \\ -0.48 & 0.64 & 0.6 \end{bmatrix}$ and forms another image I' of the same world scene. Compute the homography between I and I'.

a) $\begin{bmatrix} -0.54 & -0.53 & 12.05 \\ -0.61 & 1.13 & 2.98 \\ -0.22 & 0.26 & 0.97 \end{bmatrix}$

b) $\begin{bmatrix} -21.32 & -11.68 & 141.28 \\ -8.04 & -2.96 & 49.16 \\ -3.96 & -2.04 & 25.84 \end{bmatrix}$

c) $\begin{bmatrix} 4 & 3 & -19 \\ 1.3 & 2.5 & -9.1 \\ 1.02 & 0.9 & -4.94 \end{bmatrix}$

d) None of the above

Correct Answer: a
Detailed Solution: Homography between two images are given by KRK^{-1}

QUESTION 3: **Type: MCQ**

Compute the essential matrix E, provided calibration matrices of two cameras in stereo set up as K (left camera) $= \begin{bmatrix} 4 & 1 & 2 \\ 2 & 3 & 3 \\ 1 & 1 & 1 \end{bmatrix}$ and K' (right camera) $= \begin{bmatrix} 5 & 1 & 2 \\ 2 & 2 & 3 \\ 1 & 4 & 1 \end{bmatrix}$ along with fundamental matrix $F = \begin{bmatrix} 4 & 2 & 3 \\ 1 & 1 & 1 \\ 4 & 2 & 3 \end{bmatrix}$.

a) $\begin{bmatrix} 152 & 88 & 114 \\ 129 & 75 & 97 \\ 90 & 54 & 69 \end{bmatrix}$

b) $\begin{bmatrix} 54 & 62 & 46 \\ 117 & 131 & 97 \\ 81 & 93 & 69 \end{bmatrix}$

c) $\begin{bmatrix} 4 & 2 & 6 \\ 17 & 31 & 97 \\ 1 & 93 & 69 \end{bmatrix}$

d) None of the above

Correct Answer: a

Detailed Solution: Essential matrix $E = K'^{T} F K$.

QUESTION 4: **Type: MCQ**

Given two projection matrices $P = \begin{bmatrix} 4 & 2 & 1 & 3 \\ 2 & 1 & 2 & 8 \\ 8 & 9 & 0 & 4 \end{bmatrix}$, $P' = \begin{bmatrix} 4 & 1 & 6 & 5 \\ 3 & 5 & 5 & 7 \\ 2 & 6 & 9 & 2 \end{bmatrix}$, and a set of corresponding points on both cameras are $((2, 3), (3, 1))$. Compute the line perpendicular to both the directions formed by those points with their respective camera centers C and C'.

a) $(0.41, 0.65, -0.03)$

b) $(-3, -1, 0)$

c) $(-3, -1, -2)$

d) $(-3.39, -1.17, -2.47)$

Correct Answer: a)
Detailed Solution:
Direction along the point $(2, 3)$ is $D_1 = M^{-1}(2, 3, 1)$ and the direction along the point $(3, 1)$ $D_2 = M'^{-1}(3, 1, 1)$. Line perpendicular to both the directions is given by their cross product.

QUESTION 5: **Type: MCQ**

Assume that a stereo imaging setup has two image planes, left and right. Epipoles on left and right image planes are given as e and e', respectively.

Which of the following could be a possible right null vector of given fundamental matrix $F = \begin{bmatrix} 2 & -1 & 3 \\ 1 & 1 & 0 \\ 1 & 1 & 0 \end{bmatrix}$

a) $(2, 2, 14)$

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

c) $(1, -1, -1)$

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

Correct Answer: c

Detailed Solution: Check for $Fe = 0$, where e is the left epipole or right null vector of F.

QUESTION 6: **Type: MCQ**

Consider a stereo imaging set up with two cameras $P = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}$ (left camera) and $P' = \begin{bmatrix} 2 & 2 & 1 & 1 \\ 1 & 2 & 3 & 3 \\ 1 & 2 & 2 & 1 \end{bmatrix}$ (right camera), compute the fundamental matrix F.

a) $\begin{bmatrix} 8 & 5.35 & 2.37 \\ 2 & 2 & 4 \\ 34 & 1 & 1.1 \end{bmatrix}$

b) $\begin{bmatrix} 2 & 4 & 3 \\ 1 & 0 & -1 \\ -5 & -4 & 0 \end{bmatrix}$

c) $\begin{bmatrix} 1.7 & 1.1 & 2 \\ 2.2 & 2 & 3 \\ 9 & 4 & 1 \end{bmatrix}$

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

Correct Answer: d

Detailed Solution: Fundamental matrix $F = [m]_X M$, where m is the last column of P' and M is the left 3x3 matrix of P'.

QUESTION 7: **Type: MSQ**

Consider the following matrix F and the camera matrices P and P' (for left and right cameras). Which of the following statement (s) are true.

$$F = \begin{bmatrix} 10 & 2 & 0 \\ 8 & -7 & 2 \\ -4 & -3 & -12 \end{bmatrix} \qquad P = \begin{bmatrix} 7 & 4 & -6 & 3 \\ 8 & -1 & 2 & -5 \\ 9 & -10 & 4 & 1 \end{bmatrix} \qquad P' = \begin{bmatrix} 6 & 4 & -6 & 10 \\ 8 & -5 & 2 & -7 \\ 9 & -10 & 6 & 2 \end{bmatrix}$$

a) P and P' are compatible to F as a fundamental matrix.

b) P and P' are not compatible to F as a fundamental matrix.

c) Given the fundamental matrix F, P and P' are the only pair of camera matrices.

d) P and P' provide a unique fundamental matrix given one of its non-zero element fixed to the value 1.

Correct Answer: b,d)
Detailed Solution: $P'^T F P$ is not a skew symmetric matrix. Thus it is not compatible.

QUESTION 8: **Type: MCQ**

Compute a homography induced by plane at infinity H_∞ for camera matrices $P = \begin{bmatrix} 4 & 2 & 4 & 3 \\ 1 & 5 & 4 & 4 \\ 8 & 2 & 0 & 1 \end{bmatrix}$ and $P' = \begin{bmatrix} 2 & 4 & 5 & 1 \\ 3 & 1 & 7 & 3 \\ 2 & 3 & 4 & 2 \end{bmatrix}$.

a) $H_\infty = \begin{bmatrix} 0.65 & 0.6 & -0.15 \\ 2.15 & -0.4 & -0.65 \\ 0.6 & 0.4 & -0.1 \end{bmatrix}$

b) $H_\infty = \begin{bmatrix} 66 & 66 & 0 \\ 60 & 36 & -0.27 \\ 65 & 2 & -0.62 \end{bmatrix}$

c) $H_\infty = \begin{bmatrix} 6.6 & 1 & 0 \\ 0 & 1 & -0.27 \\ 6 & 2 & -0.62 \end{bmatrix}$

d) All of the above

Correct Answer: a)

Detailed Solution:

$H_\infty = M' M^{-1}$, where M' and M are left 3×3 matrices of P' and P, respectively.

QUESTION 9: **Type: MCQ**

$P' = [[e']_X F + e'v^T|\lambda e']$, where e' is the right null vector of F given as $(-1, 0, 1)$, λ is a non zero scalar and v is a 3D vector.

Given a fundamental matrix $F = \begin{bmatrix} -2 & 2 & 2 \\ -7 & -2 & -2 \\ -2 & 2 & 2 \end{bmatrix}$, compute the canonical camera matrices P and P' corresponding to F. Consider a 3-vector v as $(1, 1, 1)$.

a) $P = [I|0]$ and $P' = \begin{bmatrix} 8 & 2 & 1 & -\lambda \\ -4 & 4 & 0 & 0 \\ 7 & 2 & 0 & \lambda \end{bmatrix}$, where λ is a non zero scalar

b) $P = [I|0]$ and $P' = \begin{bmatrix} 7 & 2 & 2 & -\lambda \\ -4 & 4 & 4 & 0 \\ 7 & 2 & 2 & \lambda \end{bmatrix}$, where λ is a non zero scalar

c) $P = [I|0]$ and $P' = \begin{bmatrix} 4 & 5 & 1 & -\lambda \\ -14 & 24 & 34 & 0 \\ 17 & 12 & 12 & \lambda \end{bmatrix}$, where λ is a non zero scalar

d) None of the above

Correct Answer: a)

Detailed Solution:

The general formula for a pair of canonical camera matrices corresponding to F is given by $P = [I|0]$ and $P' = [[e']_X F + e'v^T|\lambda e']$, where e' is the right null vector of F and λ is a non zero scalar.

QUESTION 10: **Type: True or False**

Harris measure is invariant to 2D rotation

a) True

b) False

Correct Answer: True
Detailed Solution: Harris measure is invariant to 2D rotation

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