# Indian Institute of Space Science and Technology Trivandrum

I SEMESTER , **2025**
**ExamType: Quiz 1**

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## DEPARTMENT OF AVIONICS
### computer vision/ computer vision and advanced image processing
### (Time allowed: ONE hours)

**NOTE:** Read all questions first. **There are questions worth 30 marks.** If something is missing in a problem description, clearly mention your assumptions with your solution. If required, use sketches to illustrate your findings.

**1.** Perspective projection. Consider a person standing on the road viewing the road at the viewing angle $\alpha$. (4 marks)


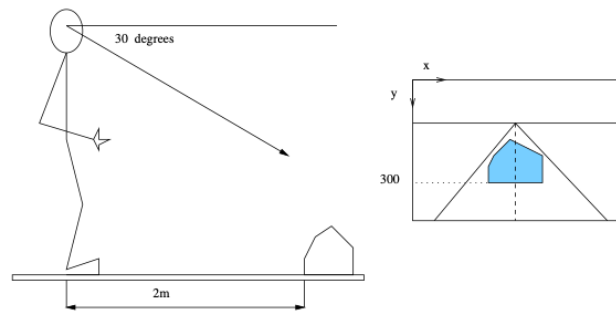
Figure 1: pinhole camera

(a) How would you compute the viewing angle, providing that you can observe the y image coordinate of the horizon1 line?

(b) Suppose that the computed viewing angle is $30^o$ and that there is an obstacle in front the person at the distance of 2 meters from the feet. Consider that the parameters of the imaging system can be well approximated by a pinhole camera where the resulting image is of resolution $400 \times 400$, the focal length is $f = 30$ and the image of the projection center is the center of the image. The y-coordinate of the obstacle in the image is 300 pixels. How tall is the person ?

**2.** Consider four points in the extended Euclidean plane (2D), with homogeneous coordinates given by x1 = (1,2,1), x2 = (2,-1,1), x3 = (-1,5,1), x4 = (1,2,0). (4 marks)

(a) Determine which of these points lies closest to the line with dual homogeneous coordinates l = (12, -5, 26).

(b) Compute the ideal point on the line through x1 and x2.

(c) Suggest a simple test that determines whether three points (in the extended Euclidean plane), given as homogeneous coordinates, lie on the same line or not. Explain why it works, and then use your test on x1 , x2 , and x3

**3.** Consider a 2D space (x,y) whose points are represented using homogeneous coordinates. Give a product of matrices that performs the following. Rotate the scene by theta degrees clockwise around the point (x,y) = (2,3). That is, the given point stays fixed and all other points are moved. (4 marks)

**4.** When performing camera calibration, we set up a system of equations $A||p|| = 0$ in the parameters $p$ that define the camera projection matrix. We then tried to minimize Ap subject to $||p|| = 1$. Here, we constrain $||p|| = 1$ because: (give reasoning too. ) (2 marks)

(a) A camera projection matrix is valid only if its Frobenius norm is 1

(b) The constraint makes the optimization easier to implement.

(c) The correspondences used to form A might be noisy.

(d) The equations $A||p|| = 0$ are not sufficient to produce a unique matrix $P$, and will produce a family of solutions.

**5.** For a particular camera, the intrinsic camera parameters are K = I. Its projection matrix P is one of the following. Which is it? give reasoning too. (2 marks)

(a) $\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

(b) $\begin{bmatrix} 0.8 & 0.6 & 0 \\ -0.6 & 0.8 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix}$

(c) $\begin{bmatrix} 0.8 & 0.6 & 0 & 5 \\ -0.6 & 0.8 & 0 & 7 \\ 0 & 0 & 1 & 1 \end{bmatrix}$

(d) $\begin{bmatrix} 3 & 0 & 0 & 0 \\ 0 & 5 & 0 & 0 \\ 0 & 0 & 7 & 0 \end{bmatrix}$

**6.** Which of the following factor does not affect the intrinsic parameters of a camera model (2 marks)

(a) Focal length

(b) Offset of optical center

(c) Exposure

(d) Image resolution

**7.** Which of the following always hold(s) under affine transformations? (2 marks)

(a) Parallel lines remain parallel

(b) Ratio of lengths of parallel line segments remain the same

    (c) Ratio of areas remain the same

    (d) Perpendicular lines remain perpendicular

    (e) Angles between two line segments remain the same

8. Explain RANSAC algorithm. Show that RANSAC requires a finite numbers of iterations for the convergence. What are the usage of RANSAC in computer vision? (4 marks)

9. explain the differences between CMOS and CCD cameras. (3 marks)

10. Show mathematically that two parallel lines in P2 (homogenous space)space really do intersect at infinity, and their intersection point is part of the $L_\infty$ line. (3 marks)

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