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# MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

*(A constituent unit of MAHE, Manipal)*

**SEVENTH SEMESTER B.TECH. (E & C) DEGREE END SEMESTER EXAMINATION**
**DECEMBER 2018/ JANUARY 2019**
**SUBJECT: MOTION AND GEOMETRY BASED METHODS IN COMPUTER VISION**
**(ECE - 4039)**

**TIME: 3 HOURS** **MAX. MARKS: 50**

**Instructions to candidates**

- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. Given the following sets of lines, compute the point of intersection for each pair of lines using homogeneous representation:

a) $x = 1$, and $y+x=0$, b) $x+5y=0$ and $4x+5y = 0$, c) $2x+3y=2$ and $x-y=4$.

Given three planes in the 3D space represented as $\pi_i, i = 1, 2, 3$. Describe a procedure to calculate the point of intersection of these planes using homogenous vector representation.

1B Given a rigid object, where the target set ($T = \{y_j\}$, j=1,..,N) is rotated, translated and scaled version of the source set ($S = \{x_i\}$, i=1,..M) and there might be some noise. Describe a least square based procedure for estimating the rotation, translation and scale parameter. Also, describe iterated closest point algorithm for registering a rigid object.

(5+5)

2A In a KLT tracker, given two local patches between two consecutive frames, describe the procedure to compute the affine transformation between these two patches.

2B Define the Gaussian kernel. Assume that the Gaussian smoothing is utilized to reduce the noise in a grayscale image. Discuss the effect of varying the standard deviation of the Gaussian kernel in Gaussian smoothing.

2C Assume we wish to register a rigid object by searching the space of correspondence. But there might be multiple correspondences between source and the target. Describe a RANSAC-based approach to estimate the transformation parameters in this scenario.

(4+3+3)

3A Differentiate between stratified approach and direct approach for upgrading a projective reconstruction to metric reconstruction. For a 3D scene point $X$, assume that the corresponding image points ($x$,$x'$) are known. Derive the relationship ($x'^{T}Fx = 0$) between the image points $x$, $x'$ and F (fundamental matrix) using canonical perspective cameras.

3B Compare the two simple strategies for tracking an object: Tracking by detection and tracking by matching. State one limitation of optical flow-based trackers and one limitation of tracking by detection.

(6+4)

4A Define image rectification. Explain its utility in scene reconstruction. State ordering and smoothness constraint which are incorporated in global approaches for establishing pixel-wise image correspondence.

4B Show mathematically that the solution (*P, P', X*) determined for the internally calibrated perspective camera is up to a Euclidean transformation.

4C Describe an approach for upgrading a projective reconstruction to affine reconstruction.

(4+3+3)

5A For an internally calibrated perspective camera, discuss the usefulness of data normalization proposed by Hartley in estimating the fundamental matrix. State the minimum number of scene points needed to recover the Euclidean and Affine reconstruction. Justify your answer

5B Describe the time of flight range sensors. Discuss two limitations of triangulation-based range sensors

5C Define step and roof edges in range images. Explain why the methods used to calculate edges in grayscale images cannot be used in case of range images.

(4+3+3)