Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
DECEMBER 2020/JANUARY 2021
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. State the representation of line and conics in 2D projective space. Compute the equation of a 2D line (using homogenous representation) passing through the following pair of points in 2D projective space

a) P1: (1,1), and P2: (2,2)

b) P1: (1,2) and P2: (1,4)

The points P1 and P2 are shown in non-homogeneous representation.

1B. Define Quaternions. Describe how Quaternions can be used to compute the rigid transformation for registering range images.

1C. State two applications of range images. Discuss two limitations of triangulation-based range sensors.

(4+3+3)

2A. Compute the output image I_{out} obtained by applying 3 x 3 uniform smoothing operator on the 8-bit grayscale image I_{in} shown in Figure 2A. Using the output image I_{out} as an example, identify which operator (Uniform or Gaussian) is a better approximation of a defocused camera. Justify your answer.

2B. Describe a RANSAC-based approach to estimate the transformation parameters in case of multiple correspondences between the source and the target image. Assume a rigid body image registration.

2C. Suppose we have a television view of a soccer field with players moving around, and each player occupies 10-30 pixels rectangular box. Describe a procedure to track the rectangular box in the video, assuming a pure translation motion model. List one limitation of this approach and suggest a possible approach to overcome this limitation.

(4+3+3)

3A. Describe the bundle adjustment-based method for creating image mosaic from five images (I1, I2, I3, I4, and I5) of a scene. State two limitations of this approach.

3B. Describe the different steps of a simple KLT tracker. In a KLT tracker, given two local patches between two consecutive frames, describe the procedure to compute the affine transformation between these two patches.

(5+5)

4A. Calculate the minimum number of 3D scene points needed to obtain a perspective structure from motion from four cameras. For a 3D scene point X, assume that the corresponding image points (x, x') are known. Derive the relationship $(x'^T F x = 0)$ between the image points x, x' and F using canonical cameras.

4B. Show that the fundamental matrix F can be defined as $F = [e']_\times H_\pi$, where e' is the epipole for the second image and H_π is a 2D homography mapping x to x' via plane π. The notation $[a]_\times$ denotes the skew-symmetric matrix for a vector a.

4C. Given two static cameras observing a scene. Assume the camera parameters (camera projection matrices) and the image points x, x' corresponding to the scene point X are known. Describe in detail three approaches for computing the 3D scene point X from these corresponding image points.

(4+3+3)

5A. Explain affine epipolar geometry and affine epipolar constraint. Assume that the affine fundamental matrix has been computed, describe the procedure to compute the camera matrix from the affine fundamental matrix using the affine epipolar constraint.

5B. Explain the process of upgrading a projective reconstruction to an affine reconstruction with the help of multiple parallel lines present in the scene.

5C. Describe in detail the smoothness constraint-based approach for finding corresponding image points x, x' for a given 3D scene point X.

(4+3+3)

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Figure 2A. The input image I_{in}