Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
MARCH 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. Compute the point of intersection of the following pair of lines in 2D projective space:
L1: x-y =4, L2: y = 1
L1: x = 5, L2: x = 2
Using the results obtained above, discuss the benefits of homogenous representation.

1B. 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.

1C. In a KLT tracker, given two local patches between two consecutive frames, describe the procedure to compute the affine transformation between these two patches

(4+3+3)

2A. Given an 8-bit grayscale image shown in **Figure 2A**. A uniform averaging filter with a kernel size of 3x3 is applied to this image. Calculate the output image

2B. Describe the time of flight range sensors. Discuss two limitations of triangulation-based range sensors.

2C. Define Quaternions. Describe how Quaternions can be used to compute the rigid transformation for registering range images.

(4+3+3)

3A. The two images shown in **Figure 3A** are to be stitched to create an image mosaic.
  i. Suggest an algorithm (in detail) to create the image mosaic
  ii. Discuss the limitation(s) of the above-mentioned approach.

3B. One frame from a video captured by a dashboard camera (installed in a car) of a busy street is shown in **Figure 3B**. The objective is to design a robust tracking algorithm to track the motion of ALL the vehicles (Car/Bus/Truck, etc) visible in the scene.
  i. Discuss the challenges associated in designing the tracking algorithm,
  ii. Suggest an algorithm (in details) to track all the persons present in the scene,
  iii. Describe the limitations of the tracking algorithm presented in B).

Assume that vehicle license plate information is not available due to privacy concerns.

(5+5)

4A. Two cameras with fixed parameters (Internal and External) are setup to capture the same scene from two viewpoint (stereopsis) of an aquarium. The objective is to compute the disparity map for this pair of images. **Figure 4A** shows the left image. Assume baseline = 10 cm.

i. Suggest an algorithm (in detail) to compute the disparity map for the two pair of images.

ii. Describe the limitations of the method described above.

4B. **Figure 4B** shows the aerial view of MIT canteen acquired by an unmanned aerial vehicle (UAV).

i. Identify the scene reconstruction (metric/affine/projective) required to identify if the ventilation shafts (white/blue colored pipes on bottom right corner of the image) is situated on the ground or the building roof. Justify your answer.

ii. Suggest an algorithm (in details) to perform the appropriate scene reconstruction for the task mentioned in a). Assume that there are more than one UAV available capturing the same scene, and the camera parameters (internal and external) of the UAV are unknown.

(5+5)

5A. For a 3D scene point X, assume that the corresponding image points (x, x') are known. Derive the relationship ($x^{\prime T} F x = 0$) between the image points x, x' and F using canonical cameras. Explain the bundle adjustment method for recovering the projective structure of the scene for uncalibrated perspective camera.

5B. Show the algebraic derivation of fundamental matrix.

5C. Given two uncalibrated cameras, describe the method to compute a metric reconstruction of the scene from projective reconstruction using ground control points.

(4+3+3)

0	0	0	0	0	0
0	0	10	10	0	0
0	0	10	10	0	0
0	0	10	10	0	0
0	0	0	0	0	0
0	0	0	0	0	0

Figure. 2A

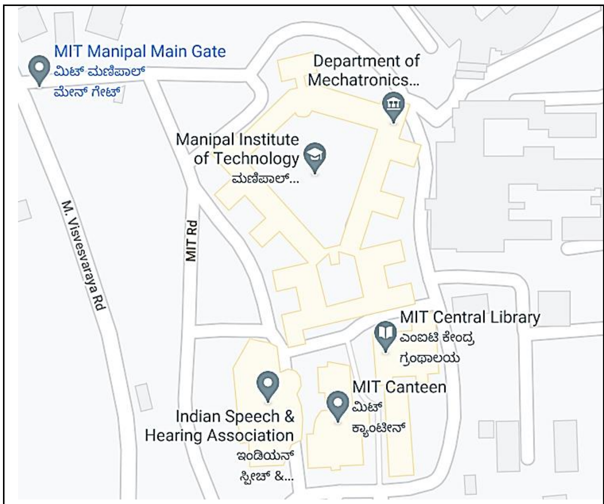
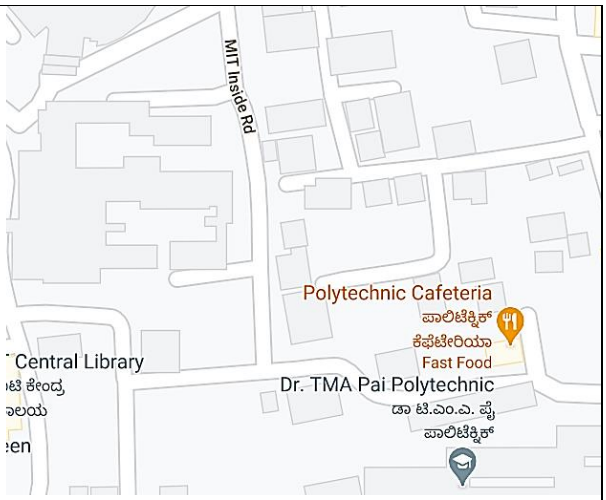
Image 1	Image 2
	

Image 1 | Image 2

Figure. 3A

Figure. 3B

Figure. 4A

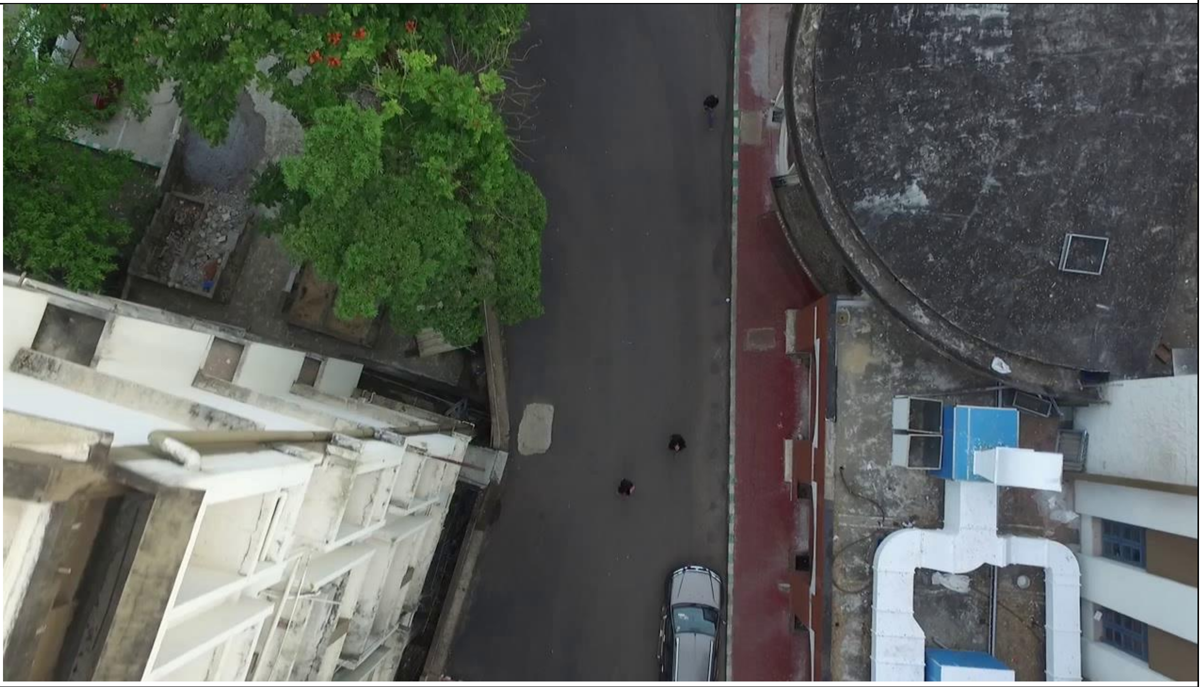


Figure. 4B