Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH. (CSE AI&ML)

END SEMESTER EXAMINATION, NOV/DEC 2023

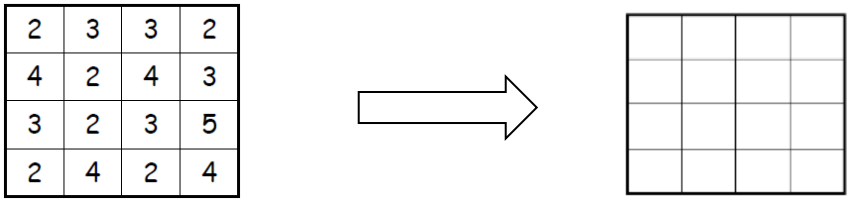
SUBJECT: FOUNDATIONS OF COMPUTER VISION [CSE 3172]

(- / - /2023)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Missing data may be suitably assumed.

Q No.	Questions		CO	AHEP LO	Blooms level
1A.	Briefly explain the following image enhancement methods: (i) Power-law (Gamma) transformation. (ii) Histogram Specification	4M	CO1	1	2
1B.	Consider the following image segment with gray levels in the range [0, 9] as given in Fig 1B. Apply the histogram equalization on this and fill in the equalized gray levels in the space provided.  Fig. 1B	4M	CO1	1	3
1C.	Describe the process of spatial filtering of an image using convolution operation. Identify the filter that can be used to remove salt and pepper noise.	2M	CO1	1	3
2A.	Interpret the significance of Eigen values in an interest point detector. How Harris method can be used to detect interest points?	4M	CO2	3	2
2B.	Explain Histogram of oriented Gradients (HOG) features for detecting humans in images.	3M	CO2	3	2
2C.	Illustrate the RANSAC line fitting algorithm responsible for removing outliers among the matched points. Give an equation to calculate the number of trials required to find right set of	3M	CO2	3	2

	inliers with a probability of 99.9%.				
3A.	Derive the constraint $X_r^T F X_l = 0$, where X_r^T is a point in right image, X_l is a point in left image and F is the fundamental matrix. Draw a neat diagram from the explanation.	**4M**	**CO3**	**2**	**4**
3B.	Suppose you are given a relationship between a point in 3D to the corresponding point in 2D using $C_h = A W_h$, where C_h is a column matrix of 2D point, A is 4×4 camera matrix containing unknown coefficients and W_h is a point in 3D space. (i) Develop a method to determine these 12 unknowns in camera matrix. (ii) Using the camera matrix, determine the camera location and orientation.	**4M**	**CO3**	**2**	**5**
3C	Demonstrate the use of various scales to identify blobs in individual images?	**2M**	**CO2**	**3**	**2**
4A.	To update the change in parameters in KLT tracker, we have the following equation: $\Delta p = H^{-1} \sum_{\mathbf{x}} \left[\nabla I \frac{\partial W}{\partial p}\right]^T [T(x) - I(W(\mathbf{x}, \mathbf{p_0}))]$ Where $H = \sum_{\mathbf{x}} \left[\nabla I \frac{\partial W}{\partial p}\right]^T \left[\nabla I \frac{\partial W}{\partial p}\right]$ Given that the 2D motion we are trying to track is a similarity motion parameterized by $p = \begin{bmatrix} a \\ b1 \\ b2 \end{bmatrix}$ such that x' = ax + b1 and y' = ay + b2, solve the following: i) Derive the Jacobian $\frac{\partial W}{\partial p}$ ii) Derive the H matrix in terms of image derivatives (Ix and Iy) and the pixel locations (x and y).	**4M**	**CO4**	**1,3**	**3**
4B.	What is optical flow? Derive motion vectors U and V using Lucas and Kanade method.	**4M**	**CO4**	**1,3**	**3**
4C.	What is the rank of a fundamental matrix? In the 8-point algorithm, what mathematical technique is used to enforce the estimated fundamental matrix to have the proper rank?	**2M**	**CO3**	**2**	**2**
5A.	With a neat block diagram explain a simple pipeline for object recognition. Name and explain few challenges that are present in	**4M**	**CO5**	**1,3**	**2**

	the existing visual recognition algorithms.				
5B.	You are supposed to implement lane line detection for self-driving cars. Illustrate the use Hough transform approach to achieve this task.	**4M**	**CO2**	**3**	**3**
5C.	After running the Canny edge detector on an image, we notice that long edges are broken into short segments separated by gaps. In addition, some spurious edges appear. For each of the two thresholds (low and high) used in hysteresis thresholding, state how you would adjust the threshold (up or down) to address both problems. Assume that a setting exists for the two thresholds that produces the desired result. Explain your answer very briefly.	**2M**	**CO1**	**1**	**3**

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