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

SIXTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
MAY/JUNE 2023
SUBJECT: Computer Vision (ECE 4051), SET-1

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

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

Q. No.	Questions	M*	C*	A*	B*
1A.	For the 3x3 image I(x,y) given below, compute the 3x3 output images of the Gaussian kernel G(x,y) and the Laplacian kernel L(x,y). Use zero padding. Compare the output images of both the kernels and give applications where these kernels can be used. $I(x,y) = \begin{bmatrix} 160 & 160 & 0 \\ 160 & 160 & 0 \\ 160 & 160 & 0 \end{bmatrix}$ $G(x,y) = \frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$ $L(x,y) = \begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	4	1	1	3
1B.	Compute the quantization of the given 8-bit input image into a 4-bit digital output image. Draw the histogram of the output and comment on the contrast of the output image. Justify your reasoning. $Img = \begin{bmatrix} 96 & 112 & 112 & 112 & 112 \\ 128 & 144 & 128 & 144 & 128 \\ 144 & 128 & 144 & 128 & 112 \\ 128 & 112 & 128 & 144 & 112 \\ 112 & 96 & 112 & 128 & 96 \end{bmatrix}$	3	1	1	3
1C.	Explain how the Histogram of Gradients (HoG) algorithm extract local features of an image. Analyze its advantages and disadvantages over other feature extraction techniques, in terms of its ability to capture object shapes and orientations?	3	2	2	4
2A.	With the help of a suitable example, compare the non-maximum suppression algorithm and hysteresis thresholding for thinning of edges in an image.	4	2	2	4
2B.	Analyze the strengths and limitations of Harris corner detector in detecting corners in an image. Discuss the impact of different parameters on the performance of the Harris corner detector algorithm, and explain how	3	2	2	4

<table>
<tr><td></td><td>adjusting these parameters can affect the accuracy and speed of corner detection.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2C.</td><td>Construct GLCM $C_1(0,1)$ and $C_1(1,1)$ for the given image. Discuss what information is obtained from these two matrices?
$$Img = \begin{bmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \\ 2 & 1 & 2 & 1 \\ 1 & 1 & 2 & 2 \end{bmatrix}$$</td><td>3</td><td>2</td><td>1</td><td>3</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3A.</td><td>Discuss the step-by-step procedure of how Active Shape Model can be used for segmentation of a given object. List some pointers for annotation of useful landmark points on the object for modeling.</td><td>4</td><td>4</td><td>1</td><td>2</td></tr>
<tr><td>3B.</td><td>Describe Least Square minimization for line fitting using suitable equations. Discuss the major advantage of Total Least Square minimization over Least Square, with the help of an example.</td><td>3</td><td>4</td><td>2</td><td>4</td></tr>
<tr><td>3C.</td><td>Explain M-estimator used to reduce the influence of outliers. Compare how M-estimators handle outliers as compared to RANSAC.</td><td>3</td><td>4</td><td>2</td><td>4</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4A.</td><td>Apply K-means clustering to group the data point distribution, shown in Table 1 below, into 2 clusters. Assume the initial centroids of the two clusters to be C1=(3,2) and C2=(6,3).
Table 1. Data point distribution
<table>
<tr><td>Points</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td>Coordinates</td><td>(2,3)</td><td>(6,3)</td><td>(3,1)</td><td>(7,3)</td><td>(3,2)</td><td>(1,1)</td><td>(5,2)</td><td>(6,1)</td></tr>
</table></td><td>4</td><td>4</td><td>3</td><td>3</td></tr>
<tr><td>4B.</td><td>Given a dataset of 10 samples with 1 feature in Table 2 below. Draw the decision tree and calculate the Total Gini impurity.
Table 2. Data samples with input feature and output class
<table>
<tr><th>Data sample</th><th>Feature attribute</th><th>Target class</th></tr>
<tr><td>1</td><td>Yes</td><td>1</td></tr>
<tr><td>2</td><td>Yes</td><td>0</td></tr>
<tr><td>3</td><td>No</td><td>1</td></tr>
<tr><td>4</td><td>No</td><td>0</td></tr>
<tr><td>5</td><td>Yes</td><td>1</td></tr>
<tr><td>6</td><td>Yes</td><td>0</td></tr>
<tr><td>7</td><td>Yes</td><td>1</td></tr>
<tr><td>8</td><td>No</td><td>0</td></tr>
<tr><td>9</td><td>No</td><td>1</td></tr>
<tr><td>10</td><td>No</td><td>0</td></tr>
</table></td><td>3</td><td>5</td><td>3</td><td>3</td></tr>
<tr><td>4C.</td><td>How does the perceptron learning algorithm adjust its weights to optimize the classification performance of a neural network? Discuss the limitations of perceptron in handling non-linearly separable data sets and how can these limitations be overcome?</td><td>3</td><td>5</td><td>2</td><td>4</td></tr>
</table>

5A.	With the help of suitable diagrams, compare rigid, affine and projective reconstructions in images, in terms of the degrees of freedom of the transformations and the properties preserved. Which reconstruction is preferred when the size of objects has to be determined? Justify your answer.	4	3	2	4
5B.	Compute the Local Binary Pattern (LBP) Map of the given 3x3 image, *Img*, using LBP with radius = 1 and neighbours = 8. Assume zero padding. $$Img = \begin{bmatrix} 50 & 100 & 75 \\ 25 & 40 & 100 \\ 100 & 75 & 50 \end{bmatrix}$$	3	2	1	3
5C.	A classifier was trained for quality check on an image dataset containing defective items (Class 1) and non-defective items (Class 0). While testing on a test set containing 250 images of defective items and 250 images of non-defective items, the classifier correctly classified 230 images of defective items and 190 images of non-defective items. Write the confusion matrix of the test results. Calculate the sensitivity, specificity and accuracy of the classifier.	3	5	3	3

M*--Marks, C*--CLO, A*--AHEP LO, B* Blooms Taxonomy Level