SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

RAMAPURAM

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

ANSWER KEY SUBMISSION

Date of Exam & Session	**06/10/23**	**Category of Exam**	**CLA2**
Course Name	**COMPUTER VISION**	**Course Code**	**21CSE390T**
Name of the Faculty submitting	**R. RAJESH KANNA**	**Date of submission of Answer Key**	**09/10/23**
Department to which the Faculty belongs to	**CSE**	**Total Marks**	**50**

PART A (10 X 1= 10)
ANSWER ALL THE QUESTIONS

Q.No.	MCQ Questions	Marks	CO	BL	PI
1	**A global descriptor describes________________** a)**a complete object or point cloud** b) region c)pixel d)patch	1	2	1	1.6.1
2	**In Histogram-based segmentation, we measure the** a) **Color or intensity of objects** b) Region of objects c) Gradient d) Pixel	1	2	2	1.6.1
3	**Regions of the image must be** a)Joint b)**Disjoint** c)Connected d)Overlapped	1	2	1	1.6.1
4	**Suppose we are using a Hough transform to do line fitting, but we notice that our system is detecting two lines where there is actually one in some example image. Which of the following most likely to alleviate this problem?** a) **Increase the size of the bins in the Hough transform**. b) Decrease the size of the bins in the Hough transform. c) Sharpen the image.	1	2	2	1.6.1

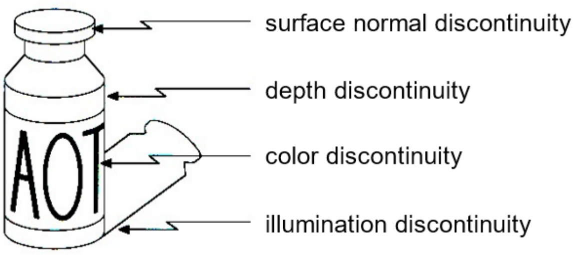
	d) Make the image larger				
5	**What is the process of breaking an image into groups?** a) Edge detection b) Smoothing c) **Segmentation** d)Edge Linking	1	2	1	1.6.1
6	**In scissors which shortest path algorithm is used** a) Floyd algorithm b) Depth first algorithm **c) Dijkstra's algorithm** d) Wharshell Algorithm	1	3	1	1.6.1
7	**Mean-shift and mode finding techniques are** **a) k-means and mixtures of Gaussians technique** b) Laplacian technique c) Line detection d) Edge detection	1	3	1	1.6.1
8	**Active contour algorithm is used for** a)Edge detection b)Clustering c)**Image Segmentation** d)Image Filtering	1	3	1	1.6.1
9	**Snakes are -----------------------** a)Joint Photographic Experts Group b)Radio Waves c)**Two-dimensional generalization of the 1D energy-minimizing splines** d)High pass filter	1	3	1	1.6.1
10	**Watershed segmentation is a** **a) Region-Based Technique That Utilizes Image Morphology** b) Compression technique c) Stitching Technique d) Snakes	1	3	1	1.6.1

PART B (4 X 4 = 16)
ANSWER ANY 4 QUESTIONS

Q. No.	Questions	Marks	CO	BL	PI
11	Explain Briefly about Feature Tracking Feature Tracking: The u and v components of the shift are obtained based on the shift which results in the minimum SSD. The feature tracker is also able to detect lost points or points which could not be tracked. 2D Feature Tracking: Eight tracking windows are initialized on the nose, the mouth tips and the eyes automatically as shown. These windowed correlation trackers acquire templates from	4	2	2	2.5.2

<table>
<tr><td></td><td>the image and minimize the SSD of the underlying image patch from one frame to the next.

The image patches first undergo contrast and brightness compensation.

Registration of the image patch from one frame to the next is accomplished by minimizing the normalized correlation over translation, scaling and rotation parameters.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>12</td><td>Discuss about Edge detection.
Edges are significant local changes of intensity in an image
• Geometric events surface orientation (boundary) discontinuities depth discontinuities
• color and texture discontinuities
• Non-geometric events
• illumination changes
• specularities
• shadows
• inter-reflections

</td><td>4</td><td>2</td><td>1</td><td>2.5.1</td></tr>
<tr><td>13</td><td>How we can quantify the performance of a matching algorithm?
The first is to select a matching strategy, which determines which correspondences are passed on to the next stage for further processing.

The second is to devise efficient data structures and algorithms to perform this matching

FEATURE MATCHING: SSD
– Simple approach is SSD(f_1, f_2
– sum of square differences between entries of the two descriptors
– Doesn’t provide a way to discard ambiguous (bad) matches</td><td>4</td><td>2</td><td>2</td><td>2.7.1</td></tr>
</table>

	– FEATURE DISTANCE: RATIO OF SSDS • Better approach: ratio distance = $SSD(f_1, f_2) / SSD(f_1, f_2')$ – f_2 is best SSD match to f_1 in I_2 – f_2' is 2^{nd} best SSD match to f_1 in I_2 – An ambiguous/bad match will have ratio close to 1 – Look for unique matches which have low ratio • true positive rate (TPR), $\mathrm{TPR} = \frac{\mathrm{TP}}{\mathrm{TP+FN}} = \frac{\mathrm{TP}}{\mathrm{P}};$ • false positive rate (FPR), $\mathrm{FPR} = \frac{\mathrm{FP}}{\mathrm{FP+TN}} = \frac{\mathrm{FP}}{\mathrm{N}};$ • positive predictive value (PPV), $\mathrm{PPV} = \frac{\mathrm{TP}}{\mathrm{TP+FP}} = \frac{\mathrm{TP}}{\mathrm{P'}};$ • accuracy (ACC), $\mathrm{ACC} = \frac{\mathrm{TP+TN}}{\mathrm{P+N}}.$				
14	Explain 2D alignment using Least Squares in detail. • 2D alignment using least squares Given a set of matched feature points {(xi, x′i)} and a planar parametric transformation of the form x′ = f (x; p), • How can we produce the best estimate of the motion paramethe Use least squares, i.e., to minimize the sum of squared residuals Many of the motion models , i.e., translation, similarity, and affine, have a *linear* relationship between the amount of motion $\Delta \boldsymbol{x} = \boldsymbol{x}' - \boldsymbol{x}$ and the unknown parameters $\boldsymbol{p}$, $\Delta \boldsymbol{x} = \boldsymbol{x}' - \boldsymbol{x} = \boldsymbol{J}(\boldsymbol{x})\boldsymbol{p}, \quad (6.4)$ where $\boldsymbol{J} = \partial \boldsymbol{f} / \partial \boldsymbol{p}$ is the *Jacobian* of the transformation $\boldsymbol{f}$ with respect to the motion parameters $\boldsymbol{p}$ (see Table 6.1). In this case, a simple *linear* regression (linear least squares problem) can be formulated as $E_{\mathrm{LLS}} = \sum_i \lVert \boldsymbol{J}(\boldsymbol{x}_i)\boldsymbol{p} - \Delta\boldsymbol{x}_i \rVert^2 \quad (6.5)$ $= \boldsymbol{p}^T \left[\sum_i \boldsymbol{J}^T(\boldsymbol{x}_i)\boldsymbol{J}(\boldsymbol{x}_i) \right] \boldsymbol{p} - 2\boldsymbol{p}^T \left[\sum_i \boldsymbol{J}^T(\boldsymbol{x}_i)\Delta\boldsymbol{x}_i \right] + \sum_i \lVert \Delta\boldsymbol{x}_i \rVert^2 \quad (6.6)$ $= \boldsymbol{p}^T \boldsymbol{A} \boldsymbol{p} - 2\boldsymbol{p}^T \boldsymbol{b} + c. \quad (6.7)$	4	3	2	2.6.2

15	Explain in detail about Mean Shift and Mode Finding. • k-means and mixtures of Gaussians • Model the feature vectors associated with each pixel (e.g., color and position) as samples from an unknown probability density function and then try to find clusters (modes) in this distribution. • use a parametric model of the den-sity function • Density is the superposition of a small number of simpler distributions (e.g., Gaussians) whose locations (centers) and shape (covariance) can be estimated • Meanshift is falling under the category of a clustering algorithm in contrast of Unsupervised learning • Assigns the data points to the clusters iteratively by shifting points towards the mode • Mode is the highest density of data points in the region, in the context of the Meanshift • Given a set of data points, the algorithm iteratively assigns each data point towards the closest cluster centroid • Direction to the closest cluster centroid is determined by where most of the points nearby	4	3	1	2.7.1
16	Discuss in detail about Intelligent Scissors. • Intelligent scissors system developed by Mortensen and Barrett • User draws a rough outline (the white curve in the system computes and draws a better curve that clings to high-contrast edges • To compute the optimal curve path (live-wire), the image is first pre-processed to associate low costs with edges (links between neighboring horizontal, vertical, and diagonal, i.e., N8 neighbors) that are likely to be boundary elements. • system uses a combination of zero-crossing, gradient magnitudes, and gradient orientations to compute	4	3	2	2.5.1

<table>
<tr><td></td><td>these cost
• Instead of re-computing an optimal curve at each time instant, a simpler system can be developed by simply “snapping” the current mouse position to the nearest likely boundary point
• Applications of these boundary extraction techniques are image cutting and pasting.</td><td></td><td></td><td></td><td></td></tr>
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PART C (12X 2 = 24)
ANSWER ALL THE QUESTIONS

<table>
<tr><th>Q. No.</th><th>Questions</th><th>Marks</th><th>CO</th><th>BL</th><th>PI</th></tr>
<tr><td>17</td><td>a) Explain about Hough transform technique with algorithm, examples, diagrams, and mention some of the applications of this technique.

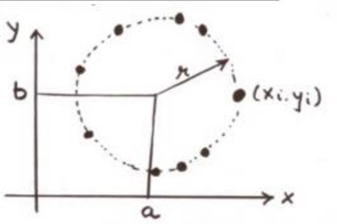
Finding Circles by Hough Transform

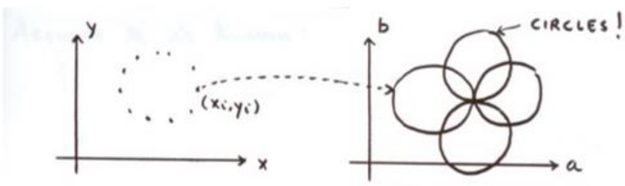
Equation of Circle:

$$(x_i - a)^2 + (y_i - b)^2 = r^2$$

If radius is known: (2D Hough Space)

Accumulator Array $A(a, b)$





Generalized Hough Transform

Find Object Center (x_c, y_c) given edges (x_i, y_i, ϕ_i)

Create Accumulator Array $A(x_c, y_c)$

Initialize: $A(x_c, y_c) = 0 \quad \forall (x_c, y_c)$

For each edge point (x_i, y_i, ϕ_i)

For each entry $\bar{r}_k^i$ in table, compute:

$$x_c = x_i + r_k^i \cos \alpha_k^i$$
$$y_c = y_i + r_k^i \sin \alpha_k^i$$

Increment Accumulator: $A(x_c, y_c) = A(x_c, y_c) + 1$

Find Local Maxima in $A(x_c, y_c)$</td><td>12</td><td>2</td><td>2</td><td>2.5.2</td></tr>
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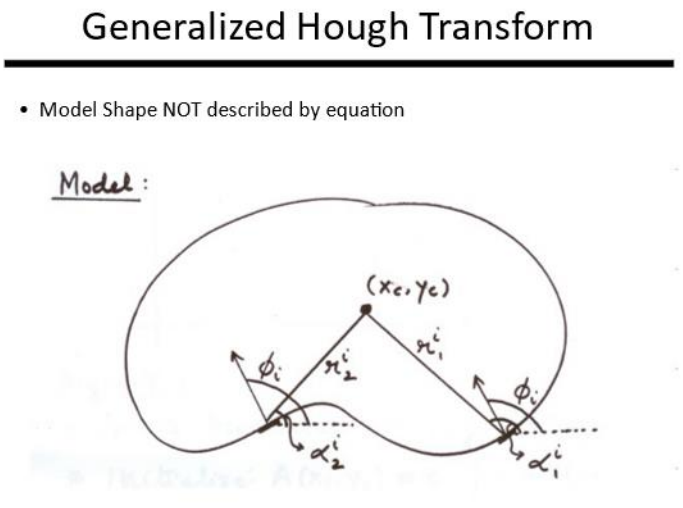

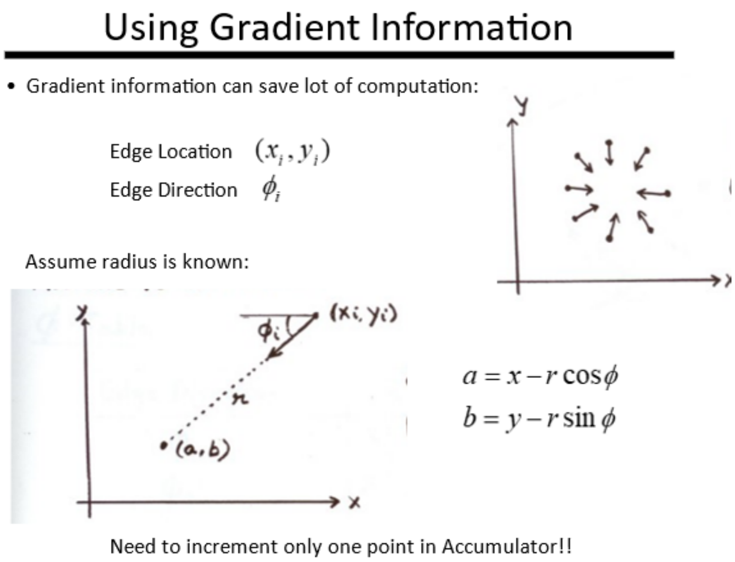

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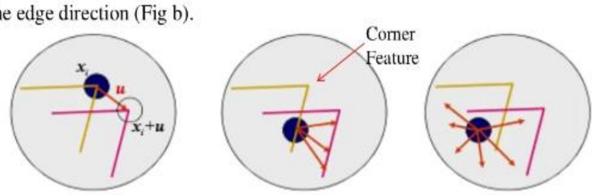
<td>b) What kinds of features need to be detected and then matched in order to establish an alignment or set of correspondences? Compare those features.
Feature Detection:

❖ Machine learning has become an important part of feature detection.

❖ State-of-the-art for object detection/ recognition based on dense deep network features</td>
<td>12</td>
<td>2</td>
<td>3</td>
<td>2.6.4</td>
</tr>
</table>

	Feature detectors **Figure shows aperture problem for various images.** • The two images I_0 (yellow) and I_1 (red) are overlaid. • The red vector u indicates the displacement between the patch centers • $w(x_i)$ weighting function (patch window) is shown as a dark circle. • Patches with gradients in at least two (significantly) different orientations are the easiest to localize.(Fig a). • Although straight line segments at a single orientation suffer from the aperture problem i.e., it is only possible to align the patches along the direction normal to the edge direction (Fig b).  (a) Patch with stable (point –like) flow (b) Classic aperture problem (barber-pole illusion) (c) Textureless region				

18	a) Illustrate Graph cuts and energy-based methods with neat diagram.
	• **Graph cut** is an efficient **graph**-based **segmentation** technique that has two main parts
	• Data part to measure the image data's conformity inside the **segmentation** areas, which includes the image's features
	• Regularization part to smooth the boundaries of the **segmented** regions (ROI) by keeping the spatial .
	  ◦ Graph
	  ◦ node for each pixel, link between pixels
	  ◦ specify a few pixels as foreground and background
	    ▪ create an infinite cost link from each bg pixel to the “t” node
	    ▪ create an infinite cost link from each fg pixel to the “s” node
	  ◦ compute min cut that separates s from t
	• Energy Function is heuristic for quantization of a combination of Data Features on an N-D Image.
	• Simple Examples: Distance metric – Image is sent as a binary image, graph is represented as points in the plane
		12	3	3	2.7.1

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Energy cost functions

$$E(f) = \sum_{i,j} E_r(i,j) + E_b(i,j), \quad (5.50)$$

where the region term

$$E_r(i,j) = E_S(I(i,j); R(f(i,j))) \quad (5.51)$$

tics of region $R(f(i,j))$ and the boundary term

$$E_b(i,j) = s_x(i,j)\delta(f(i,j) - f(i+1,j)) + s_y(i,j)\delta(f(i,j) - f(i,j+1)) \quad (5.52)$$

measures the inconsistency between $\mathcal{N}_4$ neighbors modulated by local horizontal and vertical smoothness terms $s_x(i,j)$ and $s_y(i,j)$.

Region statistics can be something as simple as the mean gray level or color (Leclerc 1989), in which case

$$E_S(I;\mu_k) = \|I - \mu_k\|^2. \quad (5.53)$$

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b)What is meant by Region Splitting and Region Merging? Explain in detail.

- Recursively splitting the whole image into pieces based on region statistics
- Merging pixels and regions together in a hierarchical fashion.
- It is also possible to combine both splitting and merging by starting with a medium-grain segmentation (in a quadtree representation) and then allowing both merging and splitting operations

Watershed

- Technique related to thresholding, since it operates on a grayscale image, is watershed com-putation
- Segments an image into several catchment basins, which are the regions of an image (interpreted as a height field or landscape) where rain would flow into the same lake

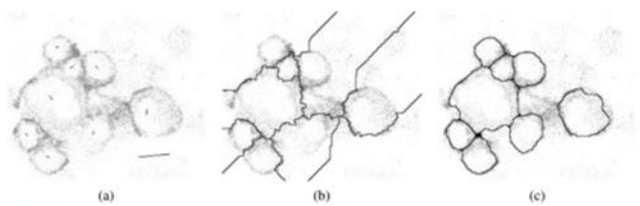

Figure 5.13 Locally constrained watershed segmentation (Beare 2006) © 2006 IEEE: (a) original confocal microscopy image with marked seeds (line segments); (b) standard watershed segmentation; (c) locally constrained watershed segmentation.

</td><td>4</td><td>3</td><td>2</td><td>2.5.2</td></tr>
</table>

	Graph-based segmentation  (a) (b) (c) **Figure 5.14** Graph-based merging segmentation (Felzenszwalb and Huttenlocher 2004b) © 2004 Springer: (a) input grayscale image that is successfully segmented into three regions even though the variation inside the smaller rectangle is larger than the variation across the middle edge; (b) input grayscale image; (c) resulting segmentation using an $\mathcal{N}_8$ pixel neighborhood.				

Course Incharge **Course Coordinator** **HOD/CSE**