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Paper Code : PEC-AI701B/PECAIDS701B/PECAIML701B Computer Vision

UPID : 007800

Time Allotted : 3 Hours

Full Marks : 70

The Figures in the margin indicate full marks.

Candidate are required to give their answers in their own words as far as practicable

## Group-A (Very Short Answer Type Question)

1. Answer any ten of the following :

[ 1 x 10 = 10 ]

- (I) True or False: Morphological operations, such as erosion and dilation, are primarily used for sharpening image details.
- (II) True or False: The Prewitt operator is used for edge detection but is not sensitive to diagonal edges.
- (III) True or False: K-means can be applied to time series data for pattern recognition.
- (IV) True or False: K-means can be used for both vector quantization and clustering.
- (V) True or False: PCA can be applied to both numerical and categorical data.
- (VI) True or False: Edge detection is an unsupervised learning technique.
- (VII) The Bayes classifier is a discriminative model that directly models the decision boundary between classes.
- (VIII) True or False: ANNs can automatically learn and adapt to extract discriminative features from raw data.
- (IX) True or False: ANNs can only perform pattern recognition tasks when the patterns are predefined and labeled.
- (X) True or False: The first principal component captures the least amount of variance in the data.
- (XI) True or False: The Bayes classifier assumes that features are conditionally independent given the class label.
- (XII) True or False: The LoG operator is computationally faster than other edge detection methods like Canny.

## Group-B (Short Answer Type Question)

Answer any three of the following :

[ 5 x 3 = 15 ]

2. You have a binary image with a resolution of 800 pixels by 600 pixels. In this image, there are 150,000 white pixels (pixel value = 1) and the rest are black pixels (pixel value = 0). Calculate the percentage of white pixels in the image. [5]
3. You have an 8-bit grayscale image, and you want to compute its histogram. The image has the following pixel values: 100, 120, 130, 140, 120, 130, 130, 140, 150, 150, 160. Calculate the histogram for this image, showing the frequency of each pixel value. [5]
4. What are opening and closing operations, and how are they used to process binary images? [5]
5. How does a small "k" value impact KNN predictions compared to a large "k" value? [5]
6. Why are principal components orthogonal to each other in PCA, and what does this property signify? [5]

## Group-C (Long Answer Type Question)

Answer any three of the following :

[ 15 x 3 = 45 ]

7. (a) Suppose you have the following data points in a two-dimensional space: (2, 3), (3, 4), (5, 6), (10, 12), (12, 15). Perform K-means clustering with K=2, starting with the initial cluster centroids at (3, 4) and (10, 12). After one iteration, what are the updated cluster centroids? [5]
- (b) For the same datapoint, perform K-means clustering with K=3, starting with the initial cluster centroids at (2, 3), (5, 6), and (10, 12). After two iterations, what are the updated cluster centroids for each cluster? [8]
- (c) Explain the notion of local optima in K-means clustering. How can you improve the chances of finding the global optimum solution? [2]
8. (a) What is feature analysis in the context of image processing, and why is it important? [3]
- (b) Describe the difference between global and local features in image analysis. Provide examples of each. [3]
- (c) How can the Euler number be used to distinguish between different types of shapes? Provide examples. [3]
- (d) How can a histogram help in image segmentation and object recognition tasks? [3]

- (e) In shape analysis, what are some commonly used shape descriptors, and how do they help in characterizing objects in images? [3]
9. (a) What are some common challenges and considerations when designing neural networks for real-world applications? [6]
- (b) What is the primary purpose of the "backpropagation" algorithm in training neural networks? [4]
- (c) What is the role of activation functions in artificial neural networks, and why are they necessary? [5]
10. (a) Explain the key characteristics that make a point in an image a "corner" according to the Harris corner detection algorithm. [3]
- (b) Describe the steps involved in the Harris corner detection process, including the calculation of the Harris corner response. [4]
- (c) Given a small 3x3 image region with pixel intensity values: [8]
- |     |     |      |
|-----|-----|------|
| 100 | 150 | 100, |
| 150 | 200 | 150, |
| 100 | 150 | 100] |
- Calculate the Harris corner response at the central pixel (200) using the Harris' corner detection formula:
- $$R = \det(M) - k * (\text{trace}(M))^2$$
- $$k = 0.04$$
11. (a) Explain the key steps involved in the Canny edge detection algorithm and their significance. [3]
- (b) What are the main parameters in the Canny edge detection algorithm, such as the high and low thresholds, and how do they affect the detection of edges? [3]
- (c) How does non-maximum suppression contribute to the effectiveness of Canny edge detection, and what does it aim to achieve? [3]
- (d) Describe the role of edge tracking by hysteresis in Canny edge detection. How does it help in distinguishing between strong and weak edges? [6]

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