Ref. No. : Ex/MECE 521/2024

M.TECH. INTELLIGENT AUTOMATION AND ROBOTICS FIRST YEAR FIRST SEMESTER – 2024

DIGITAL IMAGE AND SPEECH PROCESSING

Answer any 5 questions.

Time: 3 Hours **Full Marks: 100**

1. a) What is clustering?
   b) What is image segmentation?
   c) How clustering of data points can be applied to an image for its segmentation into n-disjoint components?
   d) State the pre-requisite conditions of fuzzy c-means clustering.
   e) Derive the expressions for cluster centre updates and membership updates in FCM clustering. Also state the FCM algorithm.
   f) How FCM clustering is applied to mouth region in face image? What features do you consider to segment the image into mouth and non-mouth region? [2+2+2+4+8+2]

2. a) What do you mean by 'edge' on an image? Draw a face image and mark possible edges?
   b) How first spatial derivatives are used to construct edge-mask? Explain.
   c) What is Laplacian filter? What are its benefits over edge-computing using first spatial derivatives? [4+6+10]

3. Write notes on the following topics with applications:
   a) Object contour detection
   b) Camera modeling [10+10]

4. a) Define 2-dimensional Fourier transform for application in spatial domain.
   b) What do you understand by u, the frequency along x-axis, and v, the frequency along y-axis in the Fourier transform F (u,v) applied on an image f (x, y) for $1 \leq x \leq M$ and $1 \leq y \leq N$? Given F (10, 30) = 40. What does it mean?
   c) How will you filter an image with $u \leq 10$ and $v \leq 20$? Write down the algorithm. What is the type of this filter and why?
   d) Write down the transfer function of one 2-dimensional Low Pass Image filter. Explain how it acts as an LPF. [2+4+6+8]

[Turn over

5. a) What is a Median filter? Explain why it falls under the order statistics filter category.
   b) When do we prefer a median filter over a mean filter?
   c) What is the difference between max filter and min filter?
   d) State the steps of Adaptive Median filter and explain how it works to remove noise.

[6+4+4+6]

6. a) Show that the Fourier transform of an imaginary function, f(x,y) is conjugate anti-symmetric.
   b) Explain the autocorrelation function of Fourier Transform.
   c) Prove that both the 1-D continuous and discrete Fourier transforms are linear operations.
   d) Write an expression for a 2-D continuous convolution.

[5+6+5+4]

7. a) An image is blurred by using a 3×3 averaging mask and then its histogram is obtained. Explain how the histogram will be different for the original image and the blurred image?
   b) Why does a 3×3 Laplacian mask with -8 at its centre produce sharper results than with -4 at its centre?
   c) In a given application, an averaging mask is applied to input images to reduce noise, and then a Laplacian mask is applied to enhance small details. Explain what would happen if the two operations are reversed.

[6+6+8]

8. a) State the difference between global and local thresholding.
   b) Restate the basic global thresholding algorithm so that it uses the histogram of an image instead of the image itself.
   c) Describe Otsu's method.
   d) How does thresholding help in object detection?

[4+6+5+5]