Reg. No. : | | | | | | | | | | | | |

**Question Paper Code : 20455**

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2022.

Sixth/Seventh/Eighth Semester

Biomedical Engineering

EC 8093 – DIGITAL IMAGE PROCESSING

(Common to Computer Science and Engineering/
Computer and Communication Engineering/
Electronics and Communication Engineering/
Electronics and Instrumentation Engineering/
Electronics and Telecommunication Engineering/
Instrumentation and Control Engineering/
Mechatronics Engineering/Medical Electronics/Information Technology)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define subjective brightness.

2. Determine the number of bits that are required to store a digital image of dimension 1024 × 1024 with four quantization levels.

3. For the 2 × 2 transform $A$ and image $U$

$$A = \frac{1}{2}\begin{bmatrix}\sqrt{3} & 1\\ -1 & \sqrt{3}\end{bmatrix} \qquad U = \begin{bmatrix}2 & 3\\ 1 & 2\end{bmatrix}$$

Calculate the transformed image V and basis images.

4. Show that subtracting the Laplacian from an image is proportional to unsharp masking.

5. Outline the advantages of Wiener filter over an Inverse filter?

6. Show that the Fourier Transform of the 2D continuous sine function $f(x, y) = A\sin(u_0 x + v_0 y)$ in the pair of conjugate pulses.

7. Define Roof Edges.

8. Obtain the eroded image from the given the input $I = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$ when processed using the structuring element $S = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix}$.

9. What is Inter-Pixel redundancy?

10. Consider an 8-pixel line of intensity data, {108, 139, 135, 244, 172, 173, 56, 99}. If it is uniformly quantized with 4-bit accuracy, compute the RMS error and RMS Signal-to-Noise Ratios for the quantized data.

PART B — (5 × 13 = 65 marks)

11. (a) (i) A CCD camera chip of dimensions 7 × 7 mm, and having 1024 × 1024 elements is focused on a square, flat area, located 0.5 m away. How many line pair per mm will this camera be able to resolve? The camera is equipped with a 35-mm lens. (3)

(ii) The image $f(x, y) = 4\cos 4\pi x \cos 6\pi y$ is sampled with $\Delta x = \Delta y = 0.5$ and $\Delta x = \Delta y = 0.2$. The reconstruction filter is an ideal low-pass filter with bandwidths $\left(\frac{\Delta x}{2}, \frac{\Delta y}{2}\right)$. Determine the reconstructed image. (10)

Or

(b) (i) Obtain the 2D-DCT of the given image strip. (8)

$$x = \begin{bmatrix} -3 & -2 & -1 & 0 \\ -2 & -1 & 0 & 1 \\ -1 & 0 & 1 & 2 \\ 0 & 1 & 2 & 3 \end{bmatrix}$$

(ii) How many minutes would it take to transmit a 1024 × 1024 image with 256 gray levels using a 56 K baud modem? (3)

What would the time be at 750K baud, a representative speed of a phone DSL connection. (2)

12. (a) Perform histogram equalization of the given 8x8 image and attain the transformed image. (13)

$$\begin{bmatrix} 52 & 55 & 61 & 66 & 70 & 61 & 64 & 73 \\ 63 & 59 & 55 & 90 & 109 & 85 & 69 & 72 \\ 62 & 59 & 68 & 113 & 144 & 104 & 66 & 73 \\ 63 & 58 & 71 & 122 & 154 & 106 & 70 & 69 \\ 67 & 61 & 68 & 104 & 126 & 88 & 68 & 70 \\ 79 & 65 & 60 & 70 & 77 & 68 & 58 & 75 \\ 85 & 71 & 64 & 59 & 55 & 61 & 65 & 83 \\ 87 & 79 & 69 & 68 & 65 & 76 & 78 & 94 \end{bmatrix}$$

Or

(b) Decompose the following 4 × 4 image strip

$$A = \begin{bmatrix} 1 & 2 & 2 & 3 \\ 5 & 6 & 4 & 1 \\ 3 & 7 & 6 & 2 \\ 2 & 8 & 1 & 1 \end{bmatrix}$$

into respective areas by considering the fact that the resulting sub-matrices are of dimensions (number of rows/2) × (number of columns/2). (13)

13. (a) Assume that an image is stationary. There is a camera mounted on a vehicle moving with a velocity 'v' along the 'x' direction. Find out the transfer function of the filter used for deconvolution in order to compensate the blurring effect introduced by the relative motion. (13)

Or

(b) Consider a linear, position-invariant image degradation system with impulse response

$$h(x-\alpha, y-\beta) = e^{\left[(x-\alpha)^2+(y-\beta)^2\right]}.$$

Suppose that the input to the system is an image consisting of a line of infinitesimal width located at $x = \alpha$, and modeled by $f(x, y) = \delta(x-\alpha)$ where $\delta$ is the impulse function. Assuming no noise, what is the output image $g(x, y)$? (13)

14. (a) With relevant sketches, explain the process of edge linking using Hough Transform. (13)

Or

(b) Suppose that an image $f(x, y)$ is convolved with a mask of size $n \times n$ (with coefficients $1/n^2$) to produce a smoothed image $\bar{f}(x, y)$. Derive an expression for edge strength of the smoothed image as a function of mask size. Assume for simplicity that $n$ is odd and that edges are obtained using the partial derivatives.

$\partial\bar{f}/\partial x = \bar{f}(x+1, y) - \bar{f}(x, y)$ and $\partial\bar{f}/\partial y = \bar{f}(x, y+1) - \bar{f}(x, y)$. (13)

15. (a) A networking company uses a compression technique to encode the message before transmitting over the network. The message contains the following characters with their frequency :

| Character : | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| Frequency : | 5 | 9 | 12 | 13 | 16 | 45 |

If the compression technique used is Huffman Coding, how many bits will be saved in the message? Obtain its entropy. (13)

Or

(b) Decode the message 0.23355 given the coding model using arithmetic coding : (13)

| Symbol | Probability |
|---|---|
| *a* | 0.2 |
| *e* | 0.3 |
| *i* | 0.1 |
| *o* | 0.2 |
| *u* | 0.1 |
| *i* | 0.1 |

PART C — (1 × 15 = 15 marks)

16. (a) With relevant illustrations, explain in detail how image segmentation is used monitoring tumors in CT scanned images.

Or

(b) Elaborate the process of face detection and the utilization of the same for payroll Processing across industries with relevant diagrams.

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