



**SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(AUTONOMOUS)**

QUESTION BANK

Year / Semester: III B.Tech VI Semester

Regulation: R23

Subject and Code: 23ECE365B Digital Image Processing

COURSE EDUCATIONAL OBJECTIVES:

1. To learn the fundamentals of Image Processing with different Transforms.
2. To understand functions of Intensity Transformations and working fundamentals of Spatial Filters
3. To implement various models of Restoring and Reconstruction of Images from filtering projections.
4. To study the concepts of image compression using different coding & Wavelets and Multiresolution Processes.
5. To design image processing systems using Segmentation techniques for Morphological & Color Images.

UNIT I - INTRODUCTION

(9)

Introduction: Introduction to Image Processing, Fundamental steps in digital image processing, components of an image processing system, image sensing and acquisition, image sampling and quantization, some basic relationship between pixels, an introduction to the mathematical tools used in digital image processing.

Image Transforms: Need for image transforms, DFT of one variable, Walsh Transform. Hadamard transform, Haar Transform, Slant transform, Discrete Cosine transform, KL Transform, Comparison of different image transforms.

UNIT II - INTENSITY TRANSFORMATIONS AND FILTERING

(9)

Intensity Transformations and Spatial Filtering: Background, Some basic intensity transformation functions, histogram processing, fundamentals of spatial filtering, smoothing spatial filters, sharpening spatial filters, Combining spatial enhancement methods

Filtering in the Frequency Domain: Preliminary concepts, The Basics of filtering in the frequency domain, image smoothing using frequency domain filters, Image Sharpening using frequency domain filters, Selective filtering.

UNIT III - IMAGE RESTORATION AND RECONSTRUCTION

(9)

Image Restoration and Reconstruction: A model of the image degradation / Restoration process, Noise models, restoration in the presence of noise only-Spatial Filtering, Periodic Noise Reduction by frequency domain filtering, Linear, Position –Invariant Degradations, Estimating the degradation function, Inverse filtering, Minimum mean square error (Wiener) filtering, constrained least squares filtering, geometric mean filter, image reconstruction from projections.

UNIT IV - IMAGE COMPRESSION AND MULTIREOLUTION PROCESSING

(9)

Image compression: Fundamentals, Basic compression methods: Huffman coding, Arithmetic coding, LZW coding, Run-Length coding, Symbol-Based coding, Bit-Plane coding, Block Transform coding, Predictive coding Wavelets and Multiresolution Processing: Image pyramids, subband coding, Multiresolution expansions, wavelet transforms in one dimensions & two dimensions.

UNIT V – SEGMENTATION AND MORPHOLOGY

(9)

Image segmentation: Fundamentals, point, line, edge detection, thresholding, region –based segmentation. Morphological Image Processing: Preliminaries, Erosion and dilation, opening and closing, basic morphological algorithms for boundary extraction, thinning, gray-scale morphology, Segmentation using morphological watersheds.

Total Hours:45



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COURSE OUTCOMES:

On successful completion of the course, students will be able to		Pos
CO1	Learn the fundamentals of Image Processing with different Transforms.	PO1, PO2
CO2	Understand the functions of Intensity Transformations and working fundamentals of Spatial Filters	PO1, PO2, PO3
CO3	Implement various models of Restoring and Reconstruction of Images from filtering projections.	PO1, PO2
CO4	Grasp the concepts of image compression using different coding & Wavelets and Multiresolution Processes.	PO1, PO2, PO3
CO5	Design the image processing systems using Segmentation techniques for Morphological	PO1, PO2

TEXT BOOKS:

1. R.C. Gonzalez and R.E. Woods, Digital Image Processing, 3rd edition, Prentice Hall, 2008.
2. Jayaraman, S. Esakkirajan, and T. Veerakumar, Digital Image Processing, Tata McGraw-Hill Education, 2011.

REFERENCE BOOKS:

1. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall of India, 2002.
2. B. Chanda, D. Dutta Majumder, Digital Image Processing and Analysis, PHI, 2009.

REFERENCE WEBSITE:

1. <https://nptel.ac.in/courses/117105079>

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-
CO	3	2	2	-	-	-	-	-	-	-	-	-



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Max Marks: 10

S.No.	CO	Questions	BT
Unit I: (INTRODUCTION & IMAGE TRANSFORMS)			
1	1	Explain the fundamental steps in digital image processing with a neat block diagram. Discuss the purpose of each stage.	L2
2	1	Describe the components of a digital image processing system and explain the role of each component in practical applications.	L2
3	1	Explain the process of Image Sensing and Acquisition using a single sensor, sensor strips, and sensor arrays.	L2
4	1	Discuss Image Sampling and Quantization. Explain how these processes affect the digital representation of an image	L2
5	1	a) Explain the basic relationships between pixels: Adjacency, Connectivity. b) Elaborate the fundamental mathematical tools used in digital image processing, including i) Array Vs Matrix ii) Linear Vs Non-linear iii) Arithmetic operation	L2 L2
6	1	Derive and explain the Walsh transform. Discuss its basis functions for $N=4$.	L2
7	1	a) Describe the Hadamard Transform and explain how the Hadamard matrix is generated using the Kronecker product. b) Explain the need for image transforms. Compare spatial domain and transform domain processing.	L2 L2
8	1	Explain the Haar Transform and its unique properties compared to other transforms.	L2
9	1	Discuss the Slant Transform and derive its basis function for $N=4$.	L2



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10	1	Define the Discrete Cosine Transform (DCT) and explain why it is widely used in image compression.	L2
11	1	An image of size 512×512 is quantized using 8 bits per pixel. 1. Calculate the total storage required. 2. If quantization is reduced to 6 bits per pixel, compute the percentage reduction in storage. 3. Discuss the expected visual impact.	L2
S.No.	CO	Questions	BT
Unit II: (INTENSITY TRANSFORMATIONS AND FILTERING)			
1	2	Explain basic intensity transformation functions: image negative, log transformation, power-law transformation. Discuss their applications.	L2
2	2	Explain smoothing spatial filters: mean filter, median filter. Compare their noise removal characteristics.	L2
3	2	Explain Smoothing Spatial Filters: Linear (Mean) and Order-Statistic (Median, Max, Min) filters. (L2)	L2
4	2	a) What is Histogram? Explain the histogram equalization? b) Given the 3 bit 5x5 image A. Perform histogram equalization and find the resulting image. $A = \begin{bmatrix} 1 & 2 & 0 & 5 & 7 \\ 11 & 11 & 15 & 7 & 1 \\ 1 & 12 & 14 & 6 & 5 \\ 12 & 15 & 15 & 15 & 6 \\ 9 & 2 & 3 & 5 & 1 \end{bmatrix}$	L2 L3
5	2	Discuss unsharp masking and high-boost filtering. Derive the corresponding expressions.	L2
6	2	Explain the fundamentals of filtering in the frequency domain. Derive the convolution theorem.	L2
7	2	Explain ideal, Butterworth, and Gaussian low-pass filters in frequency domain. Compare their characteristics.	L2



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8	2	a) Discuss the image smoothing and sharpening filter with its model in the spatial domain. b) Compare Spatial and frequency domain image processing.	L2 L2
9	2	Given image: $\begin{bmatrix} 10 & 20 & 30 \\ 40 & 50 & 60 \\ 70 & 80 & 90 \end{bmatrix}$ Apply 3×3 averaging filter and median filter. Compute filtered value at center pixel.	L2
10	2	Given a degraded image spectrum $F(u,v)$ and ideal LPF cutoff $D_0=20$: i) Write ideal LPF transfer function. ii) Explain effect of increasing D_0 .	L2
S.No.	CO	Questions	BT
Unit III: (IMAGE RESTORATION AND RECONSTRUCTION)			
1	3	Explain the image degradation and restoration model with a neat diagram.	L2
2	3	Discuss different noise models: Gaussian, Salt-and-Pepper, Rayleigh, Erlang and Uniform noise. Compare their characteristics.	L2
3	3	Explain restoration in the presence of noise only using spatial filtering techniques.	L2
4	3	Explain how the periodic noise is reduced in frequency domain filtering.	L3
5	3	Derive the Wiener filtering formula. Discuss the assumptions involved.	L2
6	3	Explain Restoration using Spatial Mean Filters: Arithmetic, Geometric, and Harmonic.	L3



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7	3	Explain three different ways of estimating the degradation function from the given degraded image.	L3
8	3	a) Explain Inverse Filtering and discuss why it often fails in the presence of noise. b) Describe the Constrained Least Squares Filtering technique.	L2 L2
9	3	a) Discuss image reconstruction from projections with an example. b) Critically analyze the failure cases of restoration filters in high-noise environments.	L2 L2
10	3	An image is degraded by a Blur function $H(u,v)$ and additive noise. If the signal-to-noise ratio (SNR) is constant $K = 0.01$ and $H(u,v) = 0.5$, calculate the Wiener filter response $W(u,v)$.	L3

S.No.	CO	Questions	BT
Unit IV: (IMAGE COMPRESSION AND MULTIREOLUTION PROCESSING)			
1	4	Explain the fundamentals of image compression. Define redundancy types.	L2
2	4	A source emits four symbols {a,b,c,d} with the probabilities 0.4,0.2,0.1 and 0.3 respectively. Construct arithmetic coding to encode and decode the word "dad".	L3
3	4	a) Explain image compression scheme with neat block diagram and what are the necessity for image compression. b) A block of matrix is given as $f(m,n) = \begin{matrix} 65 & 75 & 80 & 70 \\ 72 & 75 & 82 & 68 \\ 84 & 72 & 62 & 65 \\ 66 & 68 & 72 & 80 \end{matrix}$ Apply BTC coding procedure to this block and obtain the reconstructed value.	L2 L2



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4	4	Symbols and probabilities: A=0.4 B=0.2 C=0.2 D=0.2 1. Construct Huffman tree. 2. Find codewords. 3. Compute average code length.	L3
5	4	Explain how compression is achieved in LZW coding with example.	L2
6	4	a) Given binary sequence: 11111000001111 i) Encode using run-length coding. ii) Calculate compression ratio. b) Compare lossy and lossless compression techniques	L2 L2
7	4	Explain predictive coding and its mathematical formulation.	L2
8	4	Explain image pyramids and multiresolution representation.	L2
9	4	Discuss the concept of Subband Coding and how images are decomposed into LL, LH, HL, and HH bands.	L2
10	4	Explain the Discrete Wavelet Transform (DWT) in one dimension.	L2
11	4	Explain Multiresolution Expansions using Scaling and Wavelet functions. (L2)	L2

S.No.	CO	Questions	BT
Unit V: (SEGMENTATION AND MORPHOLOGY)			



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1	5	Discuss the Detection of Discontinuities: Point, Line, and Edge detection	L2
2	5	Explain edge detection techniques: Sobel, Prewitt, Laplacian, Canny. Compare their performance.	L2
3	5	a) Explain global and local thresholding techniques. b) Derive Otsu's method for optimal threshold selection.	L2 L2
4	5	Explain region-based segmentation methods: region growing and region splitting & merging.	L2
5	5	Define morphological operations: erosion and dilation. Explain with structuring element.	L2
6	5	Explain opening and closing operations. Discuss their applications.	L2
7	5	a) Explain thinning and skeletonization algorithms. b) Describe the Hit-or-Miss Transformation and its importance in shape detection	L2 L2
8	5	Explain watershed segmentation using morphological approach.	L5
9	5	Given 3×3 image patch and Sobel mask: $\begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$ Compute gradient at center pixel.	L4
10	5	Given binary image: $\begin{bmatrix} 0 & 1 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 0 \end{bmatrix}$ Structuring element: $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$	L3



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		<ol style="list-style-type: none">1. Perform erosion.2. Perform dilation.3. Comment on shape change.	
11	5	Find the edge magnitude and direction for the center pixel of the following image using Sobel Operators: $A = \begin{bmatrix} 50 & 50 & 50 \\ 10 & 10 & 10 \\ 0 & 0 & 0 \end{bmatrix}$	L3

Note: L1-Remembering, L2-Understanding, L3-Applying, L4-Analyzing, L5-Evaluating, and L6-Creating