Department of ECE

Details of Lesson Plan

S.No.	Particulars	Details
1.	Course Name	Digital Image Processing
2.	Course Code	ECE-801B
3.	Academic Year	2023-2024
4.	Semester	8th
5.	Number of Lesson plans	35
6.	Faculty Assigned	Dr. Suhaib Ahmed Batt

Faculty Signature

Lesson Plan No. 1	Course Name: Digital Image Processing Topic: Steps and Components of Digital Image Processing	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of digital image and its processing. b. illustrate different steps of digital image processing. c. understand different components required for processing a digital image d. appreciate advantages of using digital image processing
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions. Have you ever wondered how your smartphone camera enhances photos automatically?" "What steps are being followed to enhance photos - Introduce the concept of digital image and digital image processing. - Advantages of digital image processing 2. **Development** (30 minutes) a. Steps of digital image processing (to be illustrated with the help of diagrams) - Image acquisition - Image enhancement - Image restoration - Morphological processing - Segmentation - Representation and description - Object recognition - Image compression - Knowledge base b. Components of digital image processing - Image sensors - Specialized image processing hardware - Image processing software - Computer - Image displays - Mass storage - Network and cloud communication

	3. Exercise (5 minutes) – Give different use-cases for understanding applications of digital image processing. - Healthcare - Industry Automation - Surveillance
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://www.javatpoint.com/dip-image-transformations - https://www.tutorialspoint.com/dip/types_of_images.htm - https://www.javatpoint.com/applications-of-digital-image-processing 3. Homework - Read image of different formats in MATLAB Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 2	Course Name: Digital Image Processing Topic: Elements of Visual Perception	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. articulate the structure of human eye. b. have an understanding of some important functions and limitations of human vision. c. illustrate concepts of brightness adaptation and discrimination d. understand image formation process in human eye
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions. Have you ever wondered how human visual system work? How images are formed and perceived by humans? - Introduce human visual perception system 2. **Development** (30 minutes) a. Structure of the human eye (to be illustrated with the help of diagrams) - Cornea - Sclera - Choroid - Ciliary body - Iris - Lens - Retina - Cones and rods - Fovea b. Image formation in the eye - Explanation of how a camera captures an image - How lens, retina and ciliary body capture image - Example to calculate height of object captured in the retina c. Brightness adaptation and discrimination - Describe brightness adaptation - Perceived intensity - Describe brightness discrimination 3. Exercise (5 minutes) – Give different illustrations for understanding brightness adaptation and discrimination

	- Mach band effect - Simultaneous contrast - Optical illusions
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://www.geeksforgeeks.org/elements-of-visual-perception/ 3. Homework - Explore more examples of how different images are perceived and interpreted by huma eye. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 3	Course Name: Digital Image Processing Topic: Image Sensing and Acquisition	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. articulate the image formation model. b. have an understanding of how images are represented in 2-D. c. illustrate concepts of image acquisition and sensing using different types of sensor configurations.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Two-dimensional representation of signals - Maximum combinations of an n-bit digital signal 2. **Development** (30 minutes) a. Image formation model - Illumination component - Reflection component - Image model as a function of illumination and reflection - Number of intensity levels calculation for n-bit image - Range of intensity levels - Representation of an image as a M×N array b. Image sensing and acquisition (to be illustrated with the help of diagrams) - Using single sensing element - Using sensor strips Linear Circular - Using sensor arrays 3. Exercise (5 minutes) – Give different illustrations for identification of sensor used in applications such as - High precision scanning - Printer - Airborne survey - CT scan
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://buzztech.in/image-acquisition-in-digital-image-processing/

	3. Homework - Prepare a table clearly depicting application wise usage of different image sensing and acquisition methods. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 4	Course Name: Digital Image Processing Topic: Image Sampling and Quantization	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of sampling and quantization. b. understand how sampling and quantization levels affect the digital image created. c. illustrate concepts of spatial resolution and intensity level resolution.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is sampling? What is quantization? - Explain their importance in converting continuous images into digital form for processing and storage. 2. **Development** (30 minutes) a. Image sampling - Discuss the concept of sampling a continuous signal. - Nyquist theorem and its significance in image sampling. - Role of the sampling rate in determining the quality and fidelity of the sampled image. b. Image quantization - Discuss quantization process of assigning discrete values to the sampled image points. - Impact of quantization levels on image quality and file size. - Uniform and non-uniform quantization. c. Sampling and quantization in practice - Examples of how sampling and quantization are applied in digital imaging devices such as digital cameras and scanners. - Trade-offs involved in choosing appropriate sampling rates and quantization levels based on application requirements. 3. Exercise (5 minutes) – Give a numerical to quantize an analog signal into a 3-bit digital signal containing 8 discrete levels.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.

	2. Suggested Reading - https://sisu.ut.ee/imageprocessing/book/2 3. Homework - Prepare a comparative analysis of over sampling and under sampling on a reconstructed analog signal. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 5	Course Name: Digital Image Processing Topic: RGB and HSI Color Models	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of colors and their fundamentals. b. have an understanding of how different color models work. c. illustrate concepts of conversion of RGB and HIS color models.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is color spectrum? What is electromagnetic spectrum? What is the wavelength range of visible light 2. **Development** (30 minutes) a. Color Fundamentals - Radiance, luminance, brightness, hue and saturation - Mixtures of light (additive primaries) Primary colors of light Secondary colors of light - Mixtures of pigment (subtractive primitives) Primary colors of pigment Secondary colors of pigment - Chromaticity, trichromatic coefficients, CIE Chromaticity diagram - Color models as mathematical representations of colors and its types - Importance of color models in digital image processing b. RGB color model - Cartesian coordinate system for representation or R, G and B components - Discuss the concept of additive color mixing in the RGB model. - Explain how colors are represented using numerical values ranging from 0 to 255 for each primary color of 8-bit. c. HIS color model - Introduce the HSI (Hue, Saturation, Intensity) color model as an alternative to RGB - Hexagonal shape representation for calculation of H, S and I components of any color

	- Advantages of the HSI model for color manipulation and image processing tasks. d. Color model conversion - Process of converting RGB values to HSI and vice versa - Mathematical formulas for conversion of RGB values to HIS and vice versa 3. Exercise (5 minutes) – Give a numerical to convert RGB image into HSI image.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://www.allaboutcircuits.com/technical-articles/understanding-color-models-used-in-digital-image-processing/ 3. Homework - Write a MATLAB program to perform color model conversions Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 6	Course Name: Digital Image Processing Topic: Two-dimensional mathematical preliminaries	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of linear transformations and their significance in image processing b. understand and apply matrix and vector operations in the context of digital images c. illustrate concepts of basic mathematical operations relevant to image manipulation
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is scaling? How is rotation of signals performed? 2. **Development** (30 minutes) a. Matrices and Vectors - Define matrices and vectors - Explain the representation of digital images as matrices - Discuss vector operations and their applications in image processing b. Matrix Operations - Matrix addition and subtraction - Matrix multiplication and its significance in image transformations - Identity matrix and inverse matrix c. Linear Transformations - Define linear transformations and their properties - Discuss common transformations in image processing: translation, rotation, scaling, and shearing - Demonstrate how transformations are applied using matrices d. Color model conversion - Process of converting RGB values to HSI and vice versa - Mathematical formulas for conversion of RGB values to HIS and vice versa 3. Exercise (5 minutes) – Give numerical on Matrix operations.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://www.geeksforgeeks.org/digital-image-processing-basics/ 3. Homework - Write a MATLAB program to perform matrix multiplication, addition and scaling. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 7	Course Name: Digital Image Processing Topic: 2D transforms, DFT, DCT	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. articulate the concepts of 2D transforms in image processing b. understand the Discrete Fourier Transform (DFT) and Discrete Cosine Transform (DCT) its applications c. illustrate the application of DFT and DCT to digital images and interpret the results.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is Fourier Transform? How is Fourier Transform applied on digital signals? 2. **Development** (30 minutes) a. 2D Transforms Overview - Introduce the concept of 2D transforms - Discuss their importance in image processing for tasks like filtering, compression, and feature extraction b. Discrete Fourier Transform (DFT) - Explain the mathematical basis of the DFT - Describe how DFT is used to transform an image from the spatial domain to the frequency domain - Discuss the significance of frequency components and how they relate to image features - Demonstrate the application of DFT c. Discrete Cosine Transform (DCT) - Explain the mathematical basis of the DCT - Discuss the role of DCT in image compression, particularly in JPEG compression - Describe how DCT focuses on energy compaction and redundancy reduction - Demonstrate the application of DCT 3. Exercise (5 minutes) – Give numerical on 2D DCT.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these.

	2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://uweb.engr.arizona.edu/~dial/ece533/notes9.pdf 3. Homework - Write a MATLAB program to perform 2D DFT and DCT on any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 8	Course Name: Digital Image Processing Topic: Gray level transformations	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. articulate the concepts of gray level transformations and their significance in image processing b. identify and apply different types of gray level transformations c. Utilize gray level transformations to enhance images for specific applications
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is image enhancement? How can we improve quality of images? 2. **Development** (30 minutes) a. Linear Transformations - Explain linear transformations, including contrast stretching and negative transformations. - Demonstrate how linear transformations can enhance image contrast. b. Logarithmic and Exponential Transformations - Describe logarithmic and exponential transformations and their effects on image brightness and contrast. - Show examples of applying these transformations to images. c. Power-Law (Gamma) Transformations - Explain power-law transformations and the concept of gamma correction. - Discuss applications in image enhancement and correction. 3. Exercise (5 minutes) – Give numerical on different transformation techniques.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://www.tutorialspoint.com/dip/gray_level_transformations.htm 3. Homework - Write a MATLAB program to perform various transformation techniques on images

	Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 9	Course Name: Digital Image Processing Topic: Histogram Processing	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. articulate the concept of histograms and their role in image processing b. analyse and interpret histograms for different types of images c. apply histogram equalization to enhance image contrast d. perform histogram specification (matching) to modify image histograms
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is a histogram, and how is it used in data analysis? Can anyone think of a real-world application where analysing image brightness levels would be important? 2. **Development** (30 minutes) a. Understanding Histograms - Define histograms - Explain their representation of pixel intensity distribution in an image. - Discuss the role of histograms in analysing image contrast and brightness. b. Histogram Equalization - Explain the concept of histogram equalization and its goal of enhancing image contrast. - Discuss the process of redistributing pixel intensity values to achieve a uniform histogram. - Show examples of images before and after histogram equalization to highlight contrast improvement. c. Histogram Specification - Define histogram specification and its purpose in transforming one image's histogram to match another. - Discuss applications in image enhancement and matching images from different sources. 3. Exercise (5 minutes) – Give numerical on Histogram equalization.

Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://www.geeksforgeeks.org/histogram-equalization-in-digital-image-processing/ 3. Homework - Write a MATLAB program to perform Histogram Equalization and Matching Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 10	Course Name: Digital Image Processing Topic: Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. articulate the concepts of spatial filtering in digital image processing b. explain the differences between smoothing and sharpening filters c. illustrate the application of smoothing and sharpening filters to highlight edges, reduce noise and enhance images
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions How do digital cameras handle noise and image details? What techniques do you think are used to make images clearer and more detailed? 2. **Development** (30 minutes) a. Introduction to Spatial Filtering - Define spatial filtering and explain its role in digital image processing. - Discuss the importance of spatial filtering for noise reduction and feature enhancement. - Introduce the concept of a convolution operation as the basis for spatial filtering. b. Smoothing Spatial Filters - Explain the purpose of smoothing filters for noise reduction and blurring. - Describe different types of smoothing filters, such as averaging and Gaussian filters. - Demonstrate the application of smoothing filters. - Discuss the impact of smoothing on image quality, including the trade-off between noise reduction and loss of detail. c. Sharpening Spatial Filters - Explain the purpose of sharpening filters to enhance image details and edges. - Describe different types of sharpening filters, such as Laplacian and unsharp masking. - Demonstrate the application of sharpening filters.

	- Discuss the effects of sharpening on image quality and the importance of avoiding over-sharpening. 3. Exercise (5 minutes) – Give numerical on smoothing and sharpening filtering.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://www.geeksforgeeks.org/spatial-filtering-and-its-types/ 3. Homework - Write a MATLAB program to perform various sharpening and smoothing filtering in spatial domain on noisy images. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 12	Course Name: Digital Image Processing Topic: Smoothing and Sharpening frequency domain filters	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept of frequency domain filtering in image processing. b. differentiate between spatial and frequency domain filtering techniques. c. apply smoothing filters (low-pass) and sharpening filters (high-pass) in the frequency domain. d. analyze the effects of these filters on image quality.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is the difference between spatial domain and frequency domain in image processing? Why might we need to process an image in the frequency domain instead of the spatial domain? Can you think of real-world applications where noise reduction (smoothing) or detail enhancement (sharpening) is essential? 2. **Development** (30 minutes) a. Concept of Frequency Domain Filtering: - Brief overview of the Fourier Transform: converting images from the spatial domain to the frequency domain. - Low-frequency components: smooth areas in the image. - High-frequency components: edges and noise. b. Smoothing Filters in the Frequency Domain *Low-Pass Filtering:* - Purpose: Reduce noise by attenuating high-frequency components while preserving low frequencies. - Examples of filters: Ideal Low-Pass Filter (ILPF): Hard cutoff frequency. Gaussian Low-Pass Filter (GLPF): Smooth frequency attenuation. Butterworth Low-Pass Filter (BLPF): Controlled attenuation with order dependency. c. Sharpening Filters in the Frequency Domain *High-Pass Filtering:* - Purpose: Enhance details by attenuating low-frequency components while preserving high frequencies.

	- Examples of filters: Ideal High-Pass Filter (IHPF): Sharp cutoff frequency. Gaussian High-Pass Filter (GHPF): Smooth frequency preservation. Butterworth High-Pass Filter (BHPF): Adjustable sharpness. 3. Exercise (5 minutes) – Numerical on low-pass and high-pass filters in the frequency domain.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.pace.edu.in/img/course/Module_3-img.pdf 3. Homework - Write a MATLAB program to perform filtering on any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 13	Course Name: Digital Image Processing Topic: Ideal, Butterworth and Gaussian filters	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the characteristics of ideal, butterworth, and gaussian filters. b. explain the differences between smoothing (low-pass) and sharpening (high-pass) filters in the frequency domain. c. analyze the mathematical foundations and performance of these filters. d. apply these filters to images and interpret their effects.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions Why are frequency domain filters preferred for certain image processing tasks? Can you describe the characteristics of an ideal filter in terms of sharp transitions? How do you think smoother transitions (like Gaussian) might affect image processing results? 2. **Development** (30 minutes) a. Concept of Frequency Domain Filtering - Brief review of Fourier Transform: conversion of images to frequency components. - Low-frequency components represent smooth regions. - High-frequency components represent edges and noise. b. Ideal Low-Pass and High-Pass Filters - Definition: Filters with sharp transitions at the cutoff frequency. - Mathematical Representation - Applications: Simple filtering tasks; not suitable for smooth transitions. - Limitations: Ringing artifacts due to sharp transitions. c. Butterworth Low-Pass and High-Pass Filters - Definition: Filters with gradual transitions determined by order. - Mathematical Representation - Advantages: Smoother transitions reduce artifacts. - Parameters: Cutoff frequency and filter order.

	d. Gaussian Low-Pass and High-Pass Filters - Definition: Filters with the smoothest transition due to exponential behavior. - Mathematical Representation: - Applications: Preferred for noise reduction and minimal distortion. - Advantages: No ringing artifacts, best suited for continuous-tone images. 3. Exercise (5 minutes) – Provide an example image and ask students to apply all three types of filters for both smoothing and sharpening
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.pace.edu.in/img/course/Module_3-img.pdf 3. Homework - Write a MATLAB program to show how Ideal, Butterworth and Gaussian filters affect an image. - Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 14	Course Name: Digital Image Processing Topic: Homomorphic filtering	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept of homomorphic filtering and its role in enhancing images. b. explain the importance of separating illumination and reflectance components of an image. c. analyze and design homomorphic filtering techniques for image enhancement. d. apply homomorphic filtering for practical applications.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is the effect of uneven illumination on images? Why might it be important to separate illumination and reflectance in an image? Can you think of situations where improving image contrast and details is essential? 2. **Development** (30 minutes) a. Purpose: - Homomorphic filtering enhances images by addressing issues of uneven illumination while highlighting details. - Separates two components of an image: Illumination: Represents overall brightness, often non-uniform. Reflectance: Represents details and textures. b. Key Idea: - Uneven lighting is considered a low-frequency component. - Image details (like edges and textures) are high-frequency components. - Homomorphic filtering reduces the effect of uneven lighting and enhances details. c. Steps in Homomorphic Filtering - Convert to Frequency Domain: o Use frequency domain techniques to analyze the image. o Identify and separate the low-frequency (illumination) and high-frequency (details) components. - Filter Application:

	○ Apply a high-pass filter in the frequency domain to reduce the dominance of low-frequency components (illumination) while amplifying high-frequency components (reflectance). - Back to Spatial Domain: ○ Convert the processed image back to the spatial domain for visualization. - Adjustment: ○ Enhance the final image to ensure a balance between brightness and contrast. d. Applications of Homomorphic Filtering - Enhance medical images (e.g., X-rays, MRI scans). - Improve images with uneven lighting in photography or document imaging. - Contrast enhancement for better feature visibility. e. Advantages: - Improves image quality by balancing illumination and reflectance. - Enhances visibility of details in low-contrast areas. f. Limitations: - May amplify noise in the image. - Results depend on the choice of filter parameters. 3. Exercise (5 minutes) – Give numerical on performing homomorphic filtering on an image.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://matematicas.uam.es/~fernando.chamizo/dark/d_homom.html 3. Homework - Write a MATLAB program to perform homomorphic filtering on any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 15	Course Name: Digital Image Processing Topic: Color image enhancement	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the need for enhancing color images in various applications. b. explain techniques for improving the quality of color images. c. apply color image enhancement methods. d. analyze the impact of enhancement techniques on image quality.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions Why do you think enhancing color images might be more complex than grayscale images? Can you list some applications where enhancing color images is crucial (e.g., photography, remote sensing)? What are the challenges of enhancing images captured in poor lighting conditions? 2. **Development** (30 minutes) a. Importance of Color Image Enhancement - Explain the purpose of enhancing color images: • Improving visual appearance. • Highlighting features for better interpretation. • Adapting images for specific applications (e.g., medical imaging, object detection). - Discuss the challenges of working with color images compared to grayscale images: • Presence of multiple color channels (e.g., RGB). • Balancing brightness, contrast, and color fidelity. b. Techniques for Color Image Enhancement - Histogram Equalization: • Enhance contrast by redistributing pixel intensity values across each color channel. • Discuss the challenges of applying histogram equalization to individual channels and its impact on color balance. - Contrast Stretching: • Improve contrast by stretching the range of intensity values for each color channel.

	• Show how contrast stretching is simpler than histogram equalization but effective in certain scenarios. - Color Balance and White Balancing: • Adjust colors to ensure accurate reproduction of real-world colors. • Explain the concept of white balancing to correct color temperature in images. - Saturation and Intensity Adjustments: • Discuss enhancing saturation to make colors more vivid. • Adjust intensity to improve brightness without overexposing the image. - Advanced Techniques: • Adaptive Histogram Equalization (AHE): Apply local contrast enhancement to color images for better results. • Edge-Preserving Filters: Enhance details without affecting the overall smoothness of the image. 3. Exercise (5 minutes) – Give numerical on histogram equalization.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.thaiscience.info/journals/Article/ECTI/10985463.pdf 3. Homework - Write a MATLAB program to enhance the image using two techniques (e.g., histogram equalization and color balance) Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	2. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 16	Course Name: Digital Image Processing Topic: Image Restoration, degradation model, Properties	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept of image restoration and its applications. b. explain the image degradation model and its components. c. analyze properties of degradation and restoration processes. d. apply basic restoration techniques to recover degraded images.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What are some common causes of image degradation (e.g., motion blur, noise)? Why is it important to restore degraded images in applications like medical imaging or surveillance? Can you think of the difference between enhancement and restoration in image processing? 2. **Development** (30 minutes) a. Definition - Image restoration is the process of recovering an original image that has been degraded by various factors. - Unlike enhancement, restoration focuses on reconstructing the original image based on a model of degradation. b. Applications - Medical imaging (e.g., improving clarity of X-rays or MRIs). - Satellite imaging (e.g., removing atmospheric distortions). - Forensics and surveillance (e.g., improving blurred or noisy images). c. Image Degradation Model Components - Original Image: The image before degradation. - Degradation Function: Represents imperfections like motion blur or defocus. - Noise: Random distortions, such as Gaussian noise or salt-and-pepper noise. - Resulting Degraded Image: The combination of degradation and noise observed as the final output.

	d. Key Factors - Type of degradation (e.g., motion blur, defocus blur). - Nature of noise (e.g., random, periodic). - Understanding these components is crucial for effective restoration. e. Properties of Degradation and Restoration - Degradation Properties: • Different types of degradation have unique spatial and frequency characteristics. • Understanding the source of degradation helps determine appropriate restoration techniques. - Restoration Properties: • Restoring images requires knowledge of the degradation process (e.g., type and extent of blur). • Trade-offs often occur between restoration accuracy and noise amplification. 3. Exercise (5 minutes) – Differentiate between image restoration and degradation.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.egyankosh.ac.in/bitstream/123456789/88078/1/Unit-9.pdf 3. Homework - Write a MATLAB program to perform image restoration on any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 17	Course Name: Digital Image Processing Topic: Noise Models	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept of noise in digital images and its impact on image quality. b. identify and describe common noise models in digital image processing. c. analyze the characteristics and sources of different types of noise.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What do you think causes noise in digital images (e.g., sensors, transmission errors)? Why is understanding noise important for improving image quality? Can you list some scenarios where noise could significantly affect image processing tasks (e.g., medical imaging, remote sensing)? 2. **Development** (30 minutes) a. 2D Transforms Overview - Introduce the concept of 2D transforms - Discuss their importance in image processing for tasks like filtering, compression, and feature extraction b. Concept of Noise - Definition: • Noise refers to random variations in pixel intensity values that degrade image quality. • It is caused by imperfections in image acquisition or transmission. - Impact: • Reduces image clarity and detail. • Affects the accuracy of image analysis and interpretation. c. Common Noise Models - Gaussian Noise: Characteristics: • Intensity values follow a normal distribution.

	• Commonly occurs due to sensor noise in low-light conditions. Appearance: Smooth variations; uniformly distributed across the image. - Salt-and-Pepper Noise: Characteristics: • Pixels are randomly set to extreme values (0 or 255 in an 8-bit image). • Typically caused by bit errors in transmission. Appearance: Bright and dark spots scattered across the image. - Poisson Noise: Characteristics: • Intensity values follow a Poisson distribution. • Associated with photon counting in low-light or specialized imaging. Appearance: Random noise, intensity dependent. - Speckle Noise: Characteristics: • Multiplicative noise common in coherent imaging systems (e.g., ultrasound, radar). • Related to interference of scattered wave signals. Appearance: Grainy texture, often dependent on pixel intensity. d. Noise Properties - Spatial Distribution: Noise can be uniformly distributed or clustered in certain regions. - Frequency Domain Characteristics: Noise can occupy high, low, or broad frequency ranges depending on its type. - Intensity Dependency: Some noise models (e.g., Poisson, speckle) depend on pixel intensity, while others (e.g., Gaussian) do not. 3. Exercise (5 minutes) – Give numerical on different noise models.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.geeksforgeeks.org/noise-models-in-digital-image-processing/ 3. Homework - Write a MATLAB program to add different types of noise to a clean image and visualize and compare the effects of each noise model.

	Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 18	Course Name: Digital Image Processing Topic: Mean Filters, Order Statistics	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the purpose of spatial domain filtering for noise reduction. b. explain the working of mean filters and order statistics filters. c. analyze the applications of these filters for image smoothing and noise removal.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is the impact of noise on image quality? How can smoothing filters improve noisy images? Can you name situations where reducing noise is crucial (e.g., medical imaging, remote sensing)? 2. **Development** (30 minutes) a. Mean Filters - A spatial filter that smoothens an image by replacing each pixel value with the average of its neighborhood pixels. - Arithmetic Mean Filter: • Simplest form of mean filtering. • Suitable for removing Gaussian noise. - Geometric Mean Filter: • Replaces a pixel value with the geometric mean of its neighborhood. • Retains image detail better than arithmetic mean filtering. • Applications: • Used for smoothing and reducing random noise. - Limitations: • Blurs edges and fine details. • Ineffective against impulsive noise like salt-and-pepper noise. b. Order Statistics Filters - A spatial filter that replaces a pixel value with a value derived from its neighborhood based on a specific order statistic (e.g., median, minimum, maximum). - Median Filter:

	• Replaces each pixel value with the median of its neighborhood. • Highly effective for removing salt-and-pepper noise. - Max Filter: • Replaces each pixel value with the maximum of its neighborhood. • Useful for enhancing bright objects in a dark background. - Min Filter: • Replaces each pixel value with the minimum of its neighborhood. • Useful for enhancing dark objects in a bright background. • Applications: • Noise removal and enhancement tasks where preserving edges is critical. - Limitations: • May not work well with high levels of noise. • Requires proper neighborhood size to avoid over-smoothing. 3. Exercise (5 minutes) – Give numerical on mean filtering and order statistics filtering.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://web.eecs.utk.edu/~hqi/ece472-572/reference/order-statistics.pdf 3. Homework - Write a MATLAB program to perform order statistic filtering on any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 19	Course Name: Digital Image Processing Topic: Adaptive filters, Band reject Filters, Band pass Filters	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the principle and working of adaptive, band reject, and band pass filters. b. differentiate between these filters and their specific applications. c. analyze their performance for image smoothing, noise reduction, and feature extraction.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is the purpose of filtering in digital image processing? Can you think of scenarios where adaptive filtering might be needed (e.g., varying noise levels)? How might band reject and band pass filters be useful in isolating specific frequency components? 2. **Development** (30 minutes) a. 2D Transforms Overview - Introduce the concept of 2D transforms - Discuss their importance in image processing for tasks like filtering, compression, and feature extraction b. Adaptive Filters - Filters that adjust their parameters dynamically based on the characteristics of the local image region. - Used in scenarios where noise or distortion varies spatially across the image. - Local Noise Adaptive Filters: • Modify filter behavior based on local mean and variance. • Effective in regions with non-uniform noise. - Adaptive Median Filters: • Extend the median filter to dynamically adjust the window size for removing noise while preserving edges. - Applications: Medical imaging, surveillance, and any application with spatially varying noise. c. Band Reject Filters - Filters that attenuate or eliminate frequencies within a specific range while preserving others.

	- Ideal Band Reject Filters: • Sharp cutoff frequencies; easy to design but may introduce ringing artifacts. - Gaussian Band Reject Filters: • Smooth transitions between pass and reject bands; reduces artifacts. - Butterworth Band Reject Filters: Adjustable sharpness with less abrupt transitions. - Applications: Removing periodic noise (e.g., interference patterns). Characteristics: Frequency domain representation shows a "notch" in the rejected band. d. Band Pass Filters - Filters that allow frequencies within a specific range to pass while attenuating others. - Ideal Band Pass Filters: • Retains a specific frequency range; sharp transitions. - Gaussian Band Pass Filters: • Smooth transitions for minimal distortion. - Butterworth Band Pass Filters: • Adjustable bandwidth and transition sharpness. - Applications: Feature extraction, edge detection, and isolating specific details. - Characteristics: Frequency domain representation shows the retained frequency band. 3. Exercise (5 minutes) – Give numerical on band reject and band pass filters.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.sciencedirect.com/science/article/abs/pii/S0080878408627532 3. Homework - Write a MATLAB program to apply Adaptive filters, Band reject Filters and Band pass Filters on any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 20	Course Name: Digital Image Processing Topic: Notch Filters, Optimum Notch Filtering	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. Understand the concept and purpose of notch filters. b. Explain how notch filters are used to eliminate specific frequency components. c. Differentiate between basic and optimum notch filtering techniques. d. Apply notch filtering techniques to remove periodic noise in images.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions Have you seen periodic patterns or stripes in images? What do you think causes them? Why might it be important to remove specific frequency components in an image? Can you guess how frequency domain filtering, like notch filters, could help? 2. **Development** (30 minutes) a. Notch Filters - Filters designed to attenuate or completely remove specific frequencies from an image while preserving the rest of the frequency spectrum. - Primarily used for removing periodic noise, such as interference patterns. - Ideal Notch Filters: • Sharp attenuation at specific frequencies. • Simple but can cause ringing artifacts. - Gaussian Notch Filters: • Smooth attenuation, reducing artifacts. - Butterworth Notch Filters: • Adjustable sharpness and smoother transitions than ideal filters. - Frequency Domain Representation: • Visualize the filter as a notch or "hole" in the frequency spectrum at the specified frequencies. - Applications: Removing interference patterns in satellite images, medical images, or printed documents.

	b. Optimum Notch Filtering - Enhances basic notch filtering by optimizing the filter design based on noise characteristics and image properties. - Identify Noise Frequency: analyze the frequency spectrum to locate the noise. - Design Filter: choose appropriate parameters (e.g., bandwidth, sharpness) for minimal image distortion. - Apply Filter: implement the filter in the frequency domain and transform back to the spatial domain. - Advantages: • Minimizes noise while preserving critical image details. • Provides better control over the trade-off between noise removal and detail preservation. - Limitations: Requires careful parameter tuning for optimal results. 3. Exercise (5 minutes) – Give numerical on notch filtering.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - http://engr.case.edu/merat_francis/eecs490f07/lectures/lecture15.pdf 3. Homework - Write a MATLAB program to perform notch filtering on any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 21	Course Name: Digital Image Processing Topic: Inverse Filtering, Wiener filtering	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. Understand the purpose and principles of inverse filtering and Wiener filtering. b. Explain how these techniques are used for image restoration. c. Compare the strengths and limitations of inverse filtering and Wiener filtering.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions Have you encountered blurry or noisy images? What might cause such degradation? How would you approach restoring an image degraded by blur or noise? What challenges do you anticipate when trying to restore a degraded image? 2. **Development** (30 minutes) a. Concept of Image Restoration - Image restoration focuses on reconstructing the original image from a degraded version using a mathematical model of the degradation. - Applications: Medical imaging, satellite imaging, surveillance, and photography. b. Inverse Filtering - A restoration technique that attempts to reverse the degradation process by applying the inverse of the degradation function in the frequency domain. - Steps: • Identify the degradation function (e.g., blur kernel). • Compute the inverse of the degradation function. • Apply the inverse function to the degraded image in the frequency domain. - Advantages: • Simple to implement. • Works well if the degradation function is known and noise is minimal.

	- Limitations: • Highly sensitive to noise; amplifies high-frequency noise. • May fail if the degradation function has zero or near-zero values in the frequency domain. c. Wiener Filtering - A statistical approach to image restoration that minimizes the mean square error between the restored and original images. - Balances the effects of noise suppression and detail preservation. - Steps: • Estimate the power spectral density of the noise and original image. • Apply the Wiener filter in the frequency domain. • Transform the result back to the spatial domain. - Advantages: • Handles noise more effectively than inverse filtering. • Suitable for images with unknown or high levels of noise. - Limitations: • Requires estimates of noise and signal power spectra. • More computationally intensive than inverse filtering. 3. Exercise (5 minutes) – Give numerical on inverse and wiener filtering.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://newion.uwinnipeg.ca/~sliao/Courses/7205/Week09A.pdf 3. Homework - Write a MATLAB program to perform inverse and wiener filtering on any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 22	Course Name: Digital Image Processing Topic: Edge Detection	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept and importance of edge detection in image processing. b. explain different edge detection techniques and their applications. c. analyze and compare the performance of various edge detection methods. d. apply edge detection methods to identify significant changes in images.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is an edge in an image, and why is it important for object recognition and feature extraction? How might different types of noise affect the visibility of edges? Can you think of scenarios (e.g., medical imaging, autonomous driving) where edge detection is critical? 2. **Development** (30 minutes) a. Edge Detection - Edge detection is the process of identifying significant intensity changes in an image, often corresponding to object boundaries or features. - Importance: • Essential for tasks like segmentation, feature extraction, and object recognition. • Helps simplify image analysis by focusing on structural information. - Types of Edges • Step Edge: Sharp changes in intensity. • Ramp Edge: Gradual changes in intensity. • Line Edge: Intensity changes on both sides of a line. b. Edge Detection Techniques - Gradient-Based Methods: Detect edges by calculating intensity gradients. • Sobel Operator: Detects horizontal and vertical edges. Simple and computationally efficient. • Prewitt Operator:

	Similar to Sobel with a simpler kernel. • Scharr Operator: More accurate for detecting fine edges. - Second Derivative-Based Methods: Detect zero-crossings in the second derivative. • Laplacian of Gaussian (LoG): Combines Gaussian smoothing with edge detection. Useful for detecting edges in noisy images. • Difference of Gaussian (DoG): Simplifies LoG by subtracting two Gaussian-smoothed images. - Canny Edge Detection: Multi-step process: • Gaussian smoothing for noise reduction. • Gradient calculation for edge strength and direction. • Non-maximum suppression for thinning edges. • Double thresholding and edge tracking. • Known for accuracy and robustness. -Advanced Methods: Hough Transform: Detects shapes like lines and circles. Edge detection using machine learning algorithms. 3. Exercise (5 minutes) – Give numerical on edge detection techniques.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://cse.usf.edu/~r1k/MachineVisionBook/MachineVision.files/MachineVision_Chapter5.pdf 3. Homework - Write a MATLAB program to perform edge detection in any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 23	Course Name: Digital Image Processing Topic: Edge linking via Hough transform	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept of edge linking and its significance in image processing. b. explain the hough transform and its application in detecting lines, circles, and other shapes. c. analyze the role of the hough transform in linking edge points. d. apply the hough transform for edge linking in real-world scenarios.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is edge linking, and why is it important in feature extraction tasks like object detection? How might broken or incomplete edges affect tasks like shape recognition? Can you think of examples where detecting lines, circles, or other shapes is critical (e.g., lane detection in autonomous vehicles)? 2. **Development** (30 minutes) a. Edge Linking - Edge linking connects edge points to form meaningful shapes or structures in an image. - Essential for accurate object detection and boundary representation. - Helps overcome challenges posed by noise or incomplete edges. b. Hough Transform - A technique that maps edge points in an image to a parameter space, identifying shapes based on the alignment of these points. - Applications: Detecting lines, circles, ellipses, and other shapes in images. Commonly used in applications like lane detection, medical imaging, and document analysis. - Steps of Hough Transform for Line Detection • Edge Detection: Apply an edge detection algorithm (e.g., Canny) to identify edge points in the image. • Transform to Parameter Space: Each edge point votes for potential lines in a parameter space (e.g., ρ, θ for polar coordinates).

	• Accumulator Array: Record votes in an accumulator array for all possible lines passing through the edge points. • Peak Detection: Identify peaks in the accumulator array corresponding to the most likely lines. • Mapping Back: Convert detected lines in the parameter space back to the spatial domain. - Advantages: Robust to noise and partial edges. Effective for detecting well-defined geometric shapes. - Limitations: Computationally intensive for higher-dimensional shapes. Sensitive to parameter tuning (e.g., thresholds). 3. Exercise (5 minutes) – Give numerical on hough transform.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.scaler.com/topics/hough-transform-in-image-processing/ 3. Homework - Write a MATLAB program to perform edge linking via hough transform in any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 24	Course Name: Digital Image Processing Topic: Thresholding	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept and purpose of thresholding in image processing. b. explain different thresholding techniques and their applications. c. analyze the performance of various thresholding methods. d. apply thresholding to segment objects or regions of interest in an image.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What does thresholding mean in the context of image processing? How might thresholding help in tasks like object detection or segmentation? Can you think of real-world applications where separating objects from the background is essential (e.g., medical imaging, document processing)? 2. **Development** (30 minutes) a. Concept of Thresholding - Thresholding is a segmentation technique that converts a grayscale image into a binary image by separating pixels into foreground (object) and background based on a threshold value. - Purpose: Simplifies image analysis by isolating regions of interest. - Applications: Object detection, medical imaging, document processing, and industrial quality inspection. b. Types of Thresholding 1. Global Thresholding: - Uses a single threshold value for the entire image. - Example: Otsu's Method: - Automatically determines the optimal threshold value by minimizing intra-class variance between the foreground and background. - Advantages: Simple and effective for uniform lighting. Limitations: Fails for images with varying illumination. 2. Local (Adaptive) Thresholding:

	- Computes threshold values for smaller regions of the image. - Advantages: Effective for images with uneven lighting or shadows. - Limitations: Requires careful parameter selection (e.g., block size). 3. Multilevel Thresholding: - Segments an image into multiple regions by using multiple threshold values. - Useful for images with more than two intensity levels (e.g., medical images with multiple tissue types). 4. Other Thresholding Techniques: - Mean Thresholding: Threshold value is the mean of the neighborhood pixels. - Gaussian Thresholding: Considers both mean and standard deviation of the neighborhood for setting thresholds. c. Challenges in Thresholding - Noise Sensitivity: Thresholding can misclassify noisy pixels. - Lighting Variations: Global methods struggle with non-uniform illumination. - Edge Ambiguity: Thresholding may fail to preserve smooth boundaries. 3. Exercise (5 minutes) – Give numerical on local and global thresholding techniques.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.di.univr.it/documenti/OccorrenzaIns/matdid/matdid125113.pdf 3. Homework - Write a MATLAB program to perform local and global thresholding in any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 25	Course Name: Digital Image Processing Topic: Region based segmentation, Region growing	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept of region-based segmentation and its importance in image processing. b. explain the region growing technique and its applications. c. analyze the advantages and limitations of region-based segmentation methods. d. apply region growing to segment objects in an image.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What do you think is the significance of segmenting an image into regions? How might grouping pixels with similar characteristics help in object detection and recognition? Can you think of examples where accurate region segmentation is critical (e.g., medical imaging, remote sensing)? 2. **Development** (30 minutes) a. Concept of Region-Based Segmentation - A segmentation approach that partitions an image into regions by grouping pixels with similar properties such as intensity, color, or texture. - Ensures that regions are connected and homogeneous based on predefined criteria. - Applications: Medical imaging (e.g., tumor detection). Object segmentation in scenes or satellite imagery. b. Region Growing - A technique that starts with a seed pixel and iteratively includes neighboring pixels that satisfy a similarity criterion. - Steps: • Seed Selection: Choose initial seed points based on intensity, color, or location. • Growth Criteria: Determine whether neighboring pixels should be included in the region (e.g., intensity difference threshold).

	• Stop Condition: Stop growing when no more pixels meet the similarity criteria. - Applications: • Segmenting objects with clear boundaries. • Identifying connected components in an image. c. Region-Based Segmentation Techniques - Region Splitting: Divide the image into smaller regions until all regions meet a homogeneity criterion. - Region Merging: Combine adjacent regions that meet the similarity criteria. Used for images with large variations in intensity or texture. - Watershed Segmentation: 3. Exercise (5 minutes) – Give numerical on region slitting and merging technique.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.di.univr.it/documenti/OccorrenzaIns/matdid/matdid125113.pdf 3. Homework - Write a MATLAB program to perform region based segmentation in any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 26	Course Name: Digital Image Processing Topic: Region splitting and merging	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept of region splitting and merging in image segmentation. b. explain how splitting and merging techniques partition and combine image regions. c. analyze the advantages and limitations of region splitting and merging. d. apply region splitting and merging to segment objects in an image.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What is the purpose of splitting an image into regions during segmentation? How might merging help refine or simplify segmentation results? Can you think of real-world scenarios where partitioning and combining regions are essential (e.g., medical imaging, object tracking)? 2. **Development** (30 minutes) a. Concept of Region Splitting and Merging - Region splitting and merging is a segmentation approach that divides an image into smaller regions (splitting) and then combines adjacent regions that satisfy predefined similarity criteria (merging). - Provides a flexible way to handle complex images with varying intensities or textures. - Applications: Segmenting textured objects, detecting regions of interest in medical images, and separating overlapping objects. b. Steps in Region Splitting and Merging - Initialization: Start with the entire image as a single region. - Splitting: Recursively divide regions that do not meet a homogeneity criterion (e.g., intensity variance, color similarity). - Merging: Combine adjacent regions that meet the similarity criterion. - Termination: Stop when no further splitting or merging is possible.

	c. Homogeneity Criteria - Intensity Variance: Measure the variance in pixel intensities within a region. Split if the variance exceeds a predefined threshold. - Color Similarity: Compare color values within a region or between adjacent regions. - Texture Features: Use texture properties to determine region similarity. 3. Exercise (5 minutes) – Give numerical on region splitting and merging techniques.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_COPIES/MARBLE/medium/segment/split.htm 3. Homework - Write a MATLAB program to perform region splitting and merging in any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 27	Course Name: Digital Image Processing Topic: Morphological processing, erosion and dilation	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept and purpose of morphological processing in image analysis. b. explain the operations of erosion and dilation and their effects on binary and grayscale images. c. analyze the applications of erosion and dilation in practical scenarios. d. apply morphological operations to preprocess and analyze images.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What types of structures or shapes can you observe in an image? How might altering these shapes help in image analysis? Can you think of scenarios where removing noise or connecting disjointed objects in an image is essential? What do you think are the benefits of analyzing object shapes and boundaries in an image? 2. **Development** (30 minutes) a. Concept of Morphological Processing - Morphological processing is a technique in image processing based on the shape and structure of objects within an image. - Used for preprocessing, feature extraction, and shape analysis. - Applications: Noise removal, boundary extraction, object detection, and skeletonization. b. Erosion - Removes pixels on the boundaries of objects, shrinking them in size. - Effect: Thins objects by eroding away boundary pixels. Removes small noise components. - Steps: • Place the structuring element on each pixel of the image. • Retain the pixel only if all pixels under the structuring element match. - Applications: Removing small objects/noise. Detaching connected objects.

	c. Dilation: - Adds pixels to the boundaries of objects, expanding their size. - Effect: Enlarges objects by adding boundary pixels. Fills gaps or holes within objects. - Steps: • Place the structuring element on each pixel of the image. • Add pixels where any pixel under the structuring element matches. - Applications: Filling small holes or gaps. Connecting disjointed objects. d. Structuring Elements - A predefined shape (e.g., square, circle) used to probe the image. - Importance: The choice of structuring element determines the effect of morphological operations. - Examples: 3x3 square matrix, disk, or custom shapes. e. Combination of Erosion and Dilation - Opening: Combination of erosion followed by dilation. Used to remove noise while preserving object shapes. - Closing: Combination of dilation followed by erosion. Used to fill gaps and smooth object boundaries. 3. Exercise (5 minutes) – Give numerical on edge detection techniques.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.mathworks.com/help/images/morphological-dilation-and-erosion.html 3. Homework - Write a MATLAB program to perform erosion and dilation in any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 28	Course Name: Digital Image Processing Topic: Need for data compression	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept and importance of data compression in digital systems. b. explain the types and benefits of data compression. c. analyze the trade-offs between compression efficiency and quality. d. identify real-world applications where data compression is essential.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions Have you ever noticed the size difference between a RAW and JPEG photo? Why do you think that happens? Why might storage and transmission of uncompressed data be a challenge in digital systems? Can you think of real-world examples where data compression plays a critical role (e.g., video streaming, medical imaging)? 2. **Development** (30 minutes) a. Concept of Data Compression - Data compression reduces the size of data while maintaining its usability, enabling efficient storage and transmission. - Purpose: • To minimize storage space requirements. • To improve transmission efficiency over bandwidth-constrained channels. • To reduce costs in storage and transmission systems. - Types of Data Compression • Lossless Compression: Retains all original data; allows exact reconstruction. Examples: ZIP, PNG. Applications: Text files, medical images, scientific data. • Lossy Compression: Discards some data to achieve higher compression ratios. Examples: JPEG, MP3, MPEG. Applications: Multimedia files (images, audio, video). b. Benefits of Data Compression - Reduced Storage Requirements: Compressing data saves space, especially for large datasets like videos and high-resolution images.

	- Faster Transmission: Smaller files require less bandwidth, enabling faster data sharing over networks. - Cost Efficiency: Saves money on storage infrastructure and bandwidth usage. c. Trade-offs in Data Compression - Lossless vs. Lossy Compression: • Lossless ensures data integrity but achieves lower compression ratios. • Lossy achieves higher compression but at the cost of data quality. - Compression Ratio vs. Quality: • Higher compression ratios may result in quality loss (e.g., visible artifacts in images). - Time and Computational Resources: • Compression and decompression require processing time and computational power. d. Real-World Applications - Digital Imaging: • Medical imaging (e.g., X-rays, CT scans) for efficient storage and sharing. • Photography for optimizing file size (e.g., RAW to JPEG conversion). - Multimedia Streaming: Video and audio compression for platforms like YouTube and Spotify. - Cloud Storage: Compressing files to optimize storage space in cloud services. - Telecommunications: Data compression in SMS, MMS, and internet communications to save bandwidth. 3. Exercise (5 minutes) – Give numerical on data compression.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.geeksforgeeks.org/introduction-to-data-compression/ 3. Homework - Analyze the impact of compression ratios on quality in different data types (e.g., text, images, video Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 29	Course Name: Digital Image Processing Topic: Huffman, Run Length Encoding	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the purpose of entropy-based and run-length encoding techniques in data compression. b. explain the working principles of huffman encoding and run-length encoding (rle). c. analyze the advantages and limitations of these techniques. d. apply these encoding methods to compress data efficiently.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions Have you noticed that some types of data, like text or images, are more repetitive than others? How do you think compression methods exploit this? Why is it important to use different encoding methods for different types of data? Can you think of scenarios where efficient data encoding is crucial (e.g., data storage, transmission)? 2. **Development** (30 minutes) a. Concept of Data Encoding in Compression - Data encoding converts input data into a compact form for efficient storage or transmission. - Purpose: To reduce redundancy and minimize data size while preserving original information. b. Huffman Encoding - A variable-length coding technique based on character frequency. - Working Principle: • Compute the frequency of each symbol in the data. • Build a binary tree (Huffman tree) where: Leaf nodes represent symbols. Branch lengths depend on symbol frequency (shorter branches for frequent symbols). • Assign binary codes to each symbol based on the tree. - Advantages: • Optimal for lossless data compression. • Ensures minimal average code length.

	- Limitations: • Computationally intensive for large datasets. • Inefficient for small, non-repetitive data. - Applications: • Text compression (e.g., ZIP files). • Image compression (e.g., JPEG entropy coding). c. Run-Length Encoding (RLE) - A simple compression technique that encodes consecutive identical data values as a single value and its count. - Working Principle: • Identify consecutive repeated symbols in the data. • Replace the sequence with the symbol followed by the count. • Example: AAAAABBBCC → 5A3B2C - Advantages: • Very simple to implement. • Effective for repetitive data or images with large uniform areas. - Limitations: • Ineffective for non-repetitive or random data. - Applications: • Image compression (e.g., BMP, TIFF). • Fax transmission (e.g., CCITT Group 3/4 standards). 3. Exercise (5 minutes) – Give numerical on Huffman and run length encoding.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://yuriygeorgiev.com/2024/02/03/lossless-compression-huffman-coding-rle/ 3. Homework - Encode the dataset using Huffman Encoding and RLE and calculate the compression ratios. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 30	Course Name: Digital Image Processing Topic: Shift codes and Arithmetic coding	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concepts and purpose of shift codes and arithmetic coding in data compression. b. explain how shift codes and arithmetic coding reduce redundancy in data representation. c. analyze the advantages and limitations of these encoding methods. d. apply these methods to efficiently compress data.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions How do you think encoding schemes like Huffman coding and RLE differ from arithmetic coding? What are the challenges of achieving high compression efficiency for non-repetitive or high-entropy data? Can you think of examples where efficient compression is crucial for storage or transmission? 2. **Development** (30 minutes) a. Shift Codes - A class of prefix-free codes where the binary representation of each symbol is shifted to maintain unique decoding. - Purpose: Provides simple and efficient encoding for certain types of data. - Working Principle: • Assign a binary representation to each symbol. • Shift the binary codes to ensure no two symbols overlap during decoding. - Applications: • Used in scenarios requiring simple and quick encoding/decoding processes. - Advantages: • Simple to implement. • Decoding is fast and efficient. - Limitations: • Not optimal for data with highly variable symbol probabilities. b. Arithmetic Coding

	- A variable-length coding technique that represents an entire message as a single number in the range [0, 1). - Purpose: Achieves near-optimal compression by leveraging symbol probabilities. - Working Principle: • Assign probabilities to symbols based on their frequency in the dataset. • Partition the range [0, 1) into intervals proportional to symbol probabilities. • Encode the message as a single value within the range of the corresponding intervals. - Advantages: • More efficient than Huffman coding for data with unequal symbol probabilities. • Scales well for large datasets. - Limitations: • Computationally intensive. • Requires high precision arithmetic for encoding and decoding. - Applications: • Used in image and video compression standards (e.g., JPEG2000, H.264). 3. Exercise (5 minutes) – Give numerical on shift codes and arithmetic codes.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.cs.cmu.edu/~aarti/Class/10704/Intro_Arith_coding.pdf 3. Homework - encode the dataset using arithmetic coding and compare the results with a basic shift coding approach. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 31	Course Name: Digital Image Processing Topic: JPEG standard	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the principles and workflow of the JPEG compression standard. b. explain the different steps involved in the JPEG compression and decompression process. c. analyze the trade-offs between compression ratio and image quality in JPEG. d. identify the advantages, limitations, and applications of the JPEG standard.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions Have you noticed the size difference between RAW and JPEG images? How does this affect storage and sharing? Why might it be important to balance image quality and file size in compression? Can you list applications where JPEG is commonly used (e.g., photography, web graphics)? 2. **Development** (30 minutes) a. Overview of JPEG Standard - JPEG (Joint Photographic Experts Group) is a widely used image compression standard for reducing file sizes while maintaining acceptable image quality. - Purpose: To efficiently compress continuous-tone images (e.g., photographs) for storage and transmission. - Applications: Digital photography, web images, email attachments, and image archiving. b. Steps in JPEG Compression - Color Space Conversion: • Convert the image from RGB to YCbCr color space. • Separate luminance (Y) and chrominance (Cb, Cr) components. - Downsampling: • Reduce the resolution of the chrominance components (e.g., 4:2:0 subsampling) since the human eye is less sensitive to color details. - Block Splitting:

	• Divide the image into 8x8 blocks for processing. -Discrete Cosine Transform (DCT): • Transform each block into the frequency domain. • Separate low-frequency (important for image content) and high-frequency (less critical) components. - Quantization: • Reduce precision of high-frequency components by dividing by a quantization matrix. • Controls the compression level and affects image quality. - Entropy Coding: • Use Huffman coding or arithmetic coding to compress the quantized coefficients. c. Steps in JPEG Decompression - Decode the entropy-coded data. - Dequantize the frequency coefficients. - Apply the Inverse DCT (IDCT). - Combine blocks and upsample chrominance components. - Convert back to the RGB color space. d. Advantages: - Significant reduction in file size. - Adjustable compression ratio to balance quality and size. - Compatibility with most devices and software. e. Limitations: - Lossy compression leads to quality degradation at high compression levels. - Artifacts like blockiness and color banding in highly compressed images. f. Applications of JPEG - Photography: Storing and sharing images with manageable file sizes. - Web Graphics: Optimized images for faster loading times. - Email Attachments: Compressing images for efficient transmission. 3. Exercise (5 minutes) – Give numerical on DCT and quantization steps of JPEG compression.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html

	- https://ieeexplore.ieee.org/abstract/document/838192/ 3. Homework - Write a MATLAB program to perform JPEG compression on any image and evaluate the compression ratio Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 32	Course Name: Digital Image Processing Topic: MPEG	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the principles and importance of the MPEG (Moving Picture Experts Group) standard for video compression. b. explain the key components and techniques used in MPEG compression. c. analyze the trade-offs between compression efficiency and quality in MPEG. d. identify real-world applications of the MPEG standard in video streaming and storage.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions Have you streamed videos on platforms like YouTube or Netflix? How do you think these platforms efficiently manage video storage and transmission? Why might compressing video data be more complex than compressing images? Can you think of other real-world applications where video compression is essential? 2. **Development** (30 minutes) a. Overview of MPEG Standard - MPEG is a family of video compression standards developed by the Moving Picture Experts Group for efficient storage and transmission of video data. - Purpose: To reduce the size of video files while maintaining acceptable quality for playback. - Applications: • Video streaming platforms (e.g., YouTube, Netflix). • Video conferencing tools. • Digital television and Blu-ray discs. b. Key Components of MPEG Compression 1. Temporal Redundancy Removal: - Exploits similarities between consecutive frames in a video. - Frame Types: I-Frames (Intra-Coded Frames): Independently compressed using techniques similar to JPEG. Serve as reference points in the video.

	- P-Frames (Predictive Frames): Encodes differences from the nearest previous frame. - B-Frames (Bidirectional Predictive Frames): Encodes differences from both previous and next frames. 2. Spatial Redundancy Removal: - Compresses individual frames by removing redundancies within the frame. - Uses Discrete Cosine Transform (DCT) to transform spatial data into the frequency domain. 3. Motion Compensation: - Predicts and encodes frame changes caused by motion. - Encodes motion vectors for blocks that change between frames. 4. Entropy Coding: - Uses variable-length coding (e.g., Huffman coding) to further compress the transformed data. 5. Quantization: - Reduces precision of less important data to achieve higher compression ratios. c. Steps in MPEG Compression - Input Video Processing: Divide video into frames and classify as I, P, or B frames. - Frame Compression: Apply spatial compression using DCT and quantization for I-frames. Encode motion vectors and residual data for P- and B-frames. - Entropy Coding: Apply Huffman or arithmetic coding for final compression. d. Advantages: - Achieves high compression ratios for large video files. - Maintains acceptable quality for playback. - Compatible with most devices and formats. e. Limitations: - Computationally intensive encoding and decoding. - Lossy compression may result in visible artifacts at high compression levels. 3. Exercise (5 minutes) – Give numerical on MPEG compression techniques.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.sciencedirect.com/science/article/abs/pii/B9780750689755000078

	3. Homework - Write a MATLAB program to perform MPEG compression Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 33	Course Name: Digital Image Processing Topic: Boundary representation, Regional Descriptors	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept of boundary representation and regional descriptors in image analysis. b. explain different techniques for boundary representation and their importance. c. analyze regional descriptors and their role in characterizing image regions. d. apply boundary representation and regional descriptor methods to extract and analyze object features.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions How would you differentiate objects in an image using their boundaries or regions? Why might boundary and region properties be critical in object recognition tasks? Can you think of applications where analyzing boundaries and regions is essential (e.g., medical imaging, robotics)? 2. **Development** (30 minutes) a. Concept of Boundary Representation - Boundary representation focuses on representing the shape and structure of an object by its edges or contours. - Purpose: To simplify object recognition and shape analysis by focusing on external boundaries. - Applications: Object detection, shape recognition, and contour-based image segmentation. b. Techniques for Boundary Representation 1. Chain Codes: - Represent boundaries as sequences of directional moves along the edge. - Advantages: Compact representation. - Limitations: Sensitive to noise and resolution. 2. Polygonal Approximation: - Approximates boundaries using straight-line segments. - Applications: Shape simplification and vector representation. 3. Boundary Descriptors:

	- Use features like curvature, length, and orientation to characterize boundaries. - Examples: Fourier descriptors for frequency-based boundary representation. c. Concept of Regional Descriptors - Regional descriptors are used to characterize the properties of entire image regions instead of just their boundaries. - Purpose: To provide comprehensive information about the area, shape, texture, and intensity of regions. - Applications: Texture analysis, object classification, and region-based segmentation. d. Types of Regional Descriptors 1. Simple Descriptors: - Area: Number of pixels in the region. - Centroid: Geometric center of the region. 2. Shape Descriptors: - Perimeter: Length of the boundary enclosing the region. - Compactness: Ratio of area to perimeter, indicating shape regularity. 3. Texture Descriptors: - Measure texture properties like smoothness, coarseness, and regularity. - Examples: Gray Level Co-occurrence Matrix (GLCM) for texture analysis. 4. Statistical Descriptors: - Mean, variance, and higher-order moments of pixel intensities within the region. 3. Exercise (5 minutes) – Compute and compare boundary length, area, and compactness for different regions.
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://course.ccs.neu.edu/com3371/week7/notes7.pdf 3. Homework - Compute and display descriptors like area, centroid, perimeter, and compactness for a segmented region. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	2. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 34	Course Name: Digital Image Processing Topic: Topological feature, Texture	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept of topological features and texture in image analysis. b. explain techniques for extracting topological features and analyzing textures. c. analyze the importance of topological features and texture in characterizing and distinguishing image regions. d. apply methods to extract topological and texture features from images.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions What aspects of an image help us identify objects besides their boundaries or regions? How might properties like connectivity, holes, or surface patterns contribute to distinguishing objects? Can you think of applications where texture analysis is crucial (e.g., material inspection, medical imaging)? 2. **Development** (30 minutes) a. Concept of Topological Features - Topological features describe the structural and connectivity properties of objects in an image. - Purpose: To provide geometric and structural insights about objects, focusing on their spatial arrangement. - Applications: Network analysis, medical imaging (e.g., vessel connectivity), and object counting. b. Types of Topological Features 1. Euler Number: - Represents the number of connected components minus the number of holes in an object. - Applications: Distinguishing shapes with different connectivity or holes. 2. Connectivity: - Describes how pixels or regions are connected. - Types: 4-connectivity, 8-connectivity (binary images). 3. Homology Groups: - Describe higher-order structures, such as loops or voids.

	- Applications: Topological data analysis. c. Concept of Texture - Texture refers to the spatial arrangement of intensity or color variations in an image. - Purpose: To characterize surfaces and patterns in images. - Applications: Material classification, medical imaging (e.g., tumor texture analysis), remote sensing, and industrial quality inspection. d. Types of Texture Features 1. Statistical Texture Features: - First-Order Statistics: • Mean, variance, skewness. • Measure intensity distributions in the image. - Second-Order Statistics: Gray Level Co-occurrence Matrix (GLCM): • Quantifies pixel pair relationships at defined distances and angles. • Extract features like contrast, homogeneity, and energy. 2. Spectral Texture Features: - Fourier Transform: Analyzes frequency components to identify repetitive patterns. - Gabor Filters: Extract texture details at specific scales and orientations. 3. Model-Based Texture Features: - Markov Random Fields (MRFs): Models spatial relationships to describe texture. - Fractal Dimension: Characterizes complexity in textures. 3. Exercise (5 minutes) – Give numerical to extract Euler number and connectivity from binary images
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.sciencedirect.com/science/article/abs/pii/0146664X78900485 3. Homework - compute topological and texture features and analyze their effectiveness in distinguishing objects. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents

Lesson Plan No. 35	Course Name: Digital Image Processing Topic: Recognition based on matching	Course No.: ECE-801B

Objectives	At the end of the lesson the student shall be able to: a. understand the concept of object recognition through matching. b. explain different techniques used for matching-based recognition. c. analyze the importance of feature matching in real-world applications. d. apply matching algorithms to recognize objects in images.
Teaching Aids (if any)	a. Chalk & Talk b. Presentation
Teaching Development	1. **Introduction** (5 minutes) - Ask questions Have you seen facial recognition systems or fingerprint scanners? How do you think these systems identify patterns or objects? What is the significance of matching features between images for object recognition? Can you list some applications of matching-based recognition in real-world scenarios (e.g., surveillance, autonomous vehicles)? 2. **Development** (30 minutes) a. Concept of Recognition Based on Matching - Recognition based on matching involves comparing features or patterns in an image with a known template or model to identify objects. - Purpose: To determine the presence, location, or identity of objects in an image. - Applications: Biometrics (e.g., face, fingerprint recognition), object tracking, industrial inspection, and augmented reality. b. Techniques for Matching-Based Recognition 1. Template Matching: - Compare image regions with a predefined template to find a match. - Methods: • Correlation-based matching. • Mean-squared error (MSE) minimization. - Applications: Simple object detection with fixed templates (e.g., logo recognition). - Limitations: Sensitive to rotation, scale, and occlusion. 2. Feature-Based Matching: - Detect and match key features between images. - Steps:

	• Feature Detection: Detect keypoints using algorithms like SIFT (Scale-Invariant Feature Transform) or ORB (Oriented FAST and Rotated BRIEF). • Feature Description: Extract descriptors that represent the features (e.g., histogram of gradients). • Feature Matching: Match descriptors using distance metrics (e.g., Euclidean distance). - Applications: Robust object recognition in varied conditions (e.g., image retrieval, 3D reconstruction). - Advantages: Handles variations in scale, rotation, and lighting. 3. Histogram-Based Matching: - Match images based on histograms of intensity, color, or texture distributions. - Applications: Texture classification, scene recognition. c. Challenges in Matching-Based Recognition - Noise and Distortion: Affects matching accuracy. - Occlusion: Partial visibility of objects. - Variability: Changes in scale, rotation, or lighting. 3. Exercise (5 minutes) – Compute and compare histograms of two images
Closure	1. Summarize the Lesson Learning Outcomes and get affirmation from students on these. 2. Suggested Reading - https://archive.nptel.ac.in/content/storage2/courses/117104069/chapter_7/7_17.html - https://www.kth.se/profile/tony/page/image-based-matching-and-recognition 3. Homework - Write a MATLAB program to perform region splitting and merging in any image. Spend 5 minutes to wrap up and consolidate the learnings
Evaluation	1. Reflective Questions (What, Why, How?). Allow students to answer and discuss. Spend 5 minutes to evaluate student assimilation of the lesson contents