10CS762 / 10IS762 : Digital Image Processing

COURSE OUTCOMES

At the end of the course student will be able to

1. Know the basics of fundamental steps in digital image processing and its applications
2. Perform image enhancement and using pixel based, frequency based and morphological transformations techniques.
3. Apply boundary and region based segmentation to extract region of interest
4. Apply digital image processing techniques to solve some of real world problems

DETAILED SYLLABUS

Background

i. Introduction
ii. History and Applications
iv. Fundamental stages
v. Referred books
vi. Tools for implementation

UNIT-I: Digitized Image and Its properties

1.1 Basic concepts
- 1.1.1 Image functions
- 1.1.2 The Dirac distribution and convolution
- 1.1.3 The Fourier transform

1.2 Image digitization
- 1.2.1 Sampling
- 1.2.2 Quantization
- 1.2.3 Color images

1.3 Digital image properties
- 1.3.1 Metrics & Topological properties of digital images
- 1.3.2 Histograms
- 1.3.3 Visual perception of the image
- 1.3.4 Image Quality
- 1.3.5 Noise in images

UNIT–II: Image Preprocessing

2.1 Introduction to Pre-processing

2.2 Pixel brightness transformations
- 2.2.1 Position dependent brightness correction
- 2.2.2 Gray scale transformation
- 2.2.3 Histogram Equalization

2.3 Geometric transformations
- 2.3.1 Pixel co-ordinate transformations
- 2.3.2 Brightness interpolation
- 2.3.3 Nearest Neighbour interpolation
- 2.3.4 Linear interpolation
- 2.3.5 Bi-cubic interpolation

2.4 Local Preprocessing
- 2.4.1 Image smoothing
- 2.4.2 Averaging
- 2.4.3 Averaging with limited data validity
- 2.4.4 Averaging according to inverse gradient
- 2.4.5 Averaging using a rotating mask
- 2.4.6 Median smoothing

2.5 Edge detectors
- 2.5.1 Laplace operator
- 2.5.2 Roberts operator, Prewitt, Robinson, Kirsch operator
- 2.5.3 Marr-Hildreth Edge Detection: Zero crossings of the second derivative
- 2.5.4 Scale in image processing
- 2.5.5 Canny edge detection
- 2.5.6 Parametric edge models
- 2.5.7 Other local pre-processing operators
- 2.5.8 Adaptive neighbourhood pre-processing

UNIT-III: Segmentation – 1

3.1 Thresholding
- 3.1.1 Threshold detection methods
- 3.1.2 Optimal Thresholding, Multi Spectral Thresholding
- 3.1.3 Thresholding in hierarchical data structures

3.2 Edge based Segmentation
- 3.2.1 Edge image Thresholding
- 3.2.2 Edge relaxation
- 3.2.3 Border Tracing
- 3.2.4 Border Detection using Border Location Information
- 3.2.5 Region Construction from Borders
- 3.2.6 Border detection as graph matching
- 3.2.7 Hough transform
- 3.2.8 Border Detection as Graph searching
- 3.2.9 Border Detection as Dynamic Programming

UNIT-IV: Segmentation – 2

4.1 Region based segmentation
- 4.1.1 Region merging
- 4.1.2 Region splitting
- 4.1.3 Splitting and merging
- 4.1.4 Watershed segmentation
- 4.1.5 Region growing post-processing

4.2 Matching
- 4.2.1 Matching criteria
- 4.2.2 Control strategies of matching

UNIT-V: Image Enhancement

5.1 Image enhancement in the spatial domain
- 5.1.1 Background
- 5.1.2 Some basic gray level transformations
- 5.1.3 Histogram processing
- 5.1.4 Enhancement using arithmetic and logic operations
- 5.1.5 Basics of spatial filtering
- 5.1.6 Smoothing spatial filters
- 5.1.7 Sharpening spatial filters

5.2 Image enhancement in the frequency domain
- 5.2.1 Background
- 5.2.2 Introduction to the Fourier transform and the frequency domain,
- 5.2.3 Smoothing using Frequency-Domain filters
- 5.2.4 Sharpening using Frequency Domain filters
- 5.2.5 Homomorphic filtering

UNIT- VI: Image Compression

6.1 Image compression Fundamentals
- 6.1.1 Coding Redundancy
- 6.1.2 Interpixel Redundancy
- 6.1.3 Psychovisual Redundancy
- 6.1.4 Fidelity Criteria

6.2 Image compression models
- 6.2.1 The Source Encoder and Decoder
- 6.2.2 The Channel Encoder and Decoder

6.3 Elements of information theory
- 6.3.1 Measuring Information
- 6.3.2 The Information Channel
- 6.3.3 Fundamental Coding Theorems
- 6.3.4 Using Information Theory

6.4 Error-Free Compression
- 6.4.1 Variable-length Coding
- 6.4.2 LZW Coding
- 6.4.3 Bit-Plane Coding
- 6.4.4 Lossless Predictive Coding

6.5 Lossy compression.
- 6.5.1 Lossy Predictive Coding
- 6.5.2 Transform Coding
- 6.5.3 Wavelet Coding

UNIT –VII: Shape representation

7.1 Region identification

7.2 Contour-based shape representation and description
- 7.2.1 Chain codes
- 7.2.2 Simple geometric shape representation
- 7.2.3 Fourier transforms of borders
- 7.2.4 Boundary description using segment sequences
- 7.2.5 B-spline representation
- 7.2.6 Other contour-based shape description approaches
- 7.2.7 Shape invariants

7.3 Region based shape representation and description
- 7.3.1 Simple scalar region descriptors
- 7.3.2 Moments
- 7.3.3 Convex hull
- 7.3.4 Graph representation based on region skeleton
- 7.3.5 Region decomposition
- 7.3.6 Region neighborhood graphs

7.4 Shape classes

UNIT- VIII Morphology

8.1 Basic morphological concepts

8.2 Morphology principles

8.3 Binary dilation and erosion
- 8.3.1 Dilation, Erosion
- 8.3.2 Hit-or-miss transformation
- 8.3.3 Opening and closing

8.4. Gray-scale dilation and erosion
- 8.4.1 Top surface, umbra, and gray-scale dilation and erosion
- 8.4.2 Umbra homeomorphism theorem
- 8.4.3 Properties of erosion and dilation, opening and closing
- 8.4.4 Top hat transformation

8.5. Morphological segmentation and watersheds
- 8.5.1 Particles segmentation, marking, and watersheds
- 8.5.2 Binary morphological segmentation
- 8.5.3 Gray-scale segmentation, watersheds

Text Books

1. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", 2nd Edition, Thomson Learning, 2001. (Chapters 2, 4.1 to 4.3, 5.1 to 5.4, 6, 11.1 to 11.4, 11.7)
2. Rafel C Gonzalez and Richard E Woods, "Digital Image Processing", 3rd Edition, Pearson Education, 2003. (Chapters 3.1 to 3.7, 4.1 to 4.5, 8.1 to 8.5)

Reference Books

1. Anil K Jain, "Fundamentals of Digital Image Processing", PHI, 1997, Indian Reprint 2009.
2. B. Chanda, D Dutta Majumder, "Digital Image Processing and Analysis", PHI, 2002.

Course Website

http://moodle.vcetputtur.ac.in/course/view.php?id=162

www.techjourney.in