Course Content

Image Processing & Computer Vision

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01 Introduction to Digital Image Processing & Computer Vision
Digital Image, Image Processing origins; Imaging in X-Rays, ultraviolet, visible infrared, visible, microwave, and radio bands; Fundamentals of image processing; Components of image processing systems; Glossary of terms & definitions of Low level processing, Mid level analysis, High level understanding, Pattern recognition, Computer vision, Computer graphics.

02 Digital Image Fundamentals
Visual perception – human eye, brightness adaptation and discrimination, Electromagnetic spectrum; Image sensing and acquisition – single, strip and array sensors, Image formation models; Image sampling and quantization – basic concepts, representation of image, special and gray level resolution, aliasing, zooming and shrinking; Relationships between pixels – nearest neighbor, adjacency, connectivity, regions, and boundaries; Distance measures; Image operations on a pixel basis; Linear and nonlinear operations.

03 Image Enhancement in the Spatial Domain
Gray level transformations - image negatives, log, power-law and piecewise linear transformation functions; Histogram processing- equalization, matching; Enhancement operations - arithmetic, logic, subtraction and averaging; Spatial Filtering – linear & order-statistics for smoothing and first & second derivatives/derivatives for sharpening.

04 Image Enhancement in the Frequency Domain
2-D Fourier transform, its inverse and properties; Discrete and Fast fourier transform; Convolution and Correlation theorems; Filtering in frequency domain - low pass smoothing, high pass sharpening, homomorphic filtering.

05 Image Restoration
Image degradation and restoration processes; Noise models - spatial properties, noise probability density functions, periodic noise, estimation of noise parameters; Restoration in the presence of noise - mean Filters, order - statistics filters, adaptive filters; Linear position - invariant degradations and estimation; Geometric Transformations - spatial transformation, gray-level interpolation.

06 Color Image Processing
Color fundamentals; Color models – RGB, CMY and HIS; Pseudocolor image processing; Full-color image processing - transformations, smoothing, sharpening, segmentation and compression.

07 Wavelets and Multiresolution Processing
Background - Image pyramids, sub-band coding, Haar transform; Multiresolution expansions - series expansions, scaling functions, wavelet functions; Wavelet transforms in one and two dimensions; Wavelet packets.
08 Image Compression 21-24
Measuring information; Fundamentals of coding and inter-pixel redundancy; Image compression models – source and channel encoder/decoder; Error-free compression using variable length, LZW, Bit-Plane, predictive lossless coding; Lossy compression using lossy predictive, transform and wavelet coding; Image compression standards.

09 Morphological Image Processing 25-28
Preliminaries - set theory and logic operations in binary images; Basic morphological operations - opening, closing operators, dilation and erosion; Morphological algorithms - boundary extraction, region filling, extraction of connected components, convex hull, thinning, thickening, skeletons; Extension of morphological operations to Gray-scale images.

10 Image Segmentation 29-36
Detection of discontinuities – point, line and edges; Edge linking and boundary detection - local processing, global processing using Hough transform; Thresholding - local, global and adaptive; Region-based segmentation - region growing, region splitting and merging; Motion detection.

11 Image Representation & Description 37-39
Representations - chain codes, polygonal approximations, signatures, boundary segments, skeletons; Boundary descriptors - shape numbers, statistical moments; Regional descriptors - topological, texture and moments of 2-D Functions

12 Object Recognition 40-42
Patterns and pattern classes; Decision theoretic methods – matching, statistical classifiers, neural network; Structural methods - matching shape numbers, string matching, syntactic recognition of strings and trees; Need of intelligent processing and expert systems.