Lectures for the course: Image Processing (CS 40019)

Week 1

Lecture 1 – 18/07/2016

- Introduction to the course
- Evaluation guidelines

Lecture 2+3 – 19/07/2016

- Basic steps in image processing
- Various modes of imaging
- Levels of image processing from low level to cognitive level

Week 2

Lecture 4 – 25/07/2016

- Image formation in human eye
- Scotopic and photopic vision
- Brightness adaptation
- Weber ratio

Lecture 5+6 – 26/07/2016

- Mach bands
- Optical illusions
- Image sensors
- Image formation on sensors

Week 3

Lecture 7 – 01/08/2016

- Reflectance and illumination levels
- Image representation – gray levels
- Spatial resolution and intensity quantization
- Effect of variation of number of gray levels and spatial resolution
- Isopreference curves

Lecture 8+9 – 02/08/2016

- Interpolation techniques – nearest neighbor, bilinear and bicubic

- Neighbor definition – 4 neighbors, diagonal and 8 neighbors
- Adjacency – 4, 8 and mixed
- Path, connectivity, connected component, connected set, region
- Foreground and background, border
- Distance measures, various distance metrics
- Properties of distance measures
- Array and matrix representation of images
- Arithmetic operations and their applications
- Set operations
- Logical operations
- Spatial operations
- Affine transforms
- Basic concept of image transform
- Matrix representation of transforms and processing

Week 4

Lecture 10 – 08/08/2016

- Intensity transformations
- Image enhancement
- Basic intensity transformations – log, inverse log, power law, gamma correction
- Piecewise linear transformations – contrast stretching, intensity level transformation, bit plane slicing
- Histogram processing – equalization

Lecture 11+12 – 09/08/2016

- Histogram matching
- Local histogram processing
- Using histogram statistics for image enhancement
- Spatial filtering basics – correlation and convolution
- Generating spatial filter masks
- Averaging masks
- Order statistic filters
- Sharpening filters – Laplacian and derivative
- Unsharp masking and highboost filtering
- Gradient mask, Sobel operator
- Composite spatial enhancement

Week 5

Lecture 13 – 16/08/2016

- Periodic and aperiodic signals

- Fourier series
- Impulse function – Continuous and discrete
- Sifting property of impulse functions
- Impulse train
- Fourier transform
- FT of impulse train
- Convolution
- Sampling and FT of sampled function
- Under sampling and over sampling
- Nyquist rate
- Recovering signal from samples
- Aliasing

Week 6

Lecture 14 – 22/08/2016

- More on aliasing
- Function reconstruction from sampled data
- DFT of one variable
- DFT and IDFT
- DFT notations
- DFT periodicity and convolution
- Relation between sampling and frequency intervals
- DFT example

Lecture 15+16 – 23/08/2016

- Class test held
- IDFT example
- Extensions to functions of two variables
- 2-D sifting property
- 2-D continuous FT
- 2-D sampling
- Aliasing in images
- Aliasing artifacts – Jaggies, Moire patterns

Week 7

Lecture 17 – 29/08/2016

- 2D DFT properties
- Translation and rotation
- Periodicity

- Centering the transform
- Symmetry
- Fourier spectrum and phase angle
- 2D Convolution
- Zero-padding to prevent wraparound errors

Lecture 18+19 – 30/08/2016

- Fundamentals of frequency domain filter design
- LPF
- HPF
- Homomorphic filtering
- Band pass, band reject and notch filters

Week 8

Lecture 20 – 05/09/2016

- Color image processing
- Human color vision
- Color models
- Addition and subtraction of colors
- RGB and CMYK
- CIE chromaticity diagram
- RGB color cube
- Safe colors

Lecture 21+22 – 06/09/2016

- HSI color space
- HSI and RGB inter-conversion
- Pseudocolor image processing

Week 9

Lecture 23 – 12/09/2016

- Class test 1 scripts shown and feedback given

Week 10

Mid sem exam held

Week 11

Lecture 24 – 26/09/2016

- Color image processing

Lecture 25+26 – 27/09/2016

- Color image processing contd.
- Introduction to image compression

Week 11

Lecture 27 – 03/10/2016

- Different types of redundancy
- Entropy
- Variable length coding
- Fidelity criteria
- Lossy vs Lossless compression
- Huffman coding
- Run length coding

Lecture 28+29 – 04/10/2016

- Arithmetic coding
- LZW coding
- Block transform coding
- Walsh Hadamard transform
- Discrete Cosine transform
- Error and choice of transform

Week 12

Lecture 30 – 17/10/2016

- Sub image size selection
- Bit allocation
- Zonal and threshold coding based quantization
- Mid sem scripts shown and feedback given

Lecture 31+32 – 18/10/2016

- Basic JPEG compression technique
- Different modes of JPEG operation\
- Examples of JPEG coding

- Predictive coding
- Motion compensation
- Motion compensated video encoder
- Introduction to MPEG
- I, P and B frames

Week 13

Lecture 33 – 24/10/2016

- Morphological image processing
- Reflection and translation
- Structuring element
- Erosion and Dilation
- Opening and Closing
- Basic applications

Lecture 34+35 – 25/10/2016

- Opening and Closing examples
- Properties and applications
- Hit-or-miss transformation
- Boundary extraction
- Region/hole filling
- Connected component extraction
- Convex hull
- Thinning
- Dates for term project report and demo announced

Week 14

Lecture 36 – 31/10/2016

- Skeletonization
- Gray scale morphology
- Gray scale dialation and erosion
- Gray scale opening and closing
- Morphological smoothing
- Morphological gradient
- Top hat/Bottom hat transformation
- Granulometry
- Textural segmentation

Lecture 37+38 – 01/11/2016

- Introduction to segmentation
- Principal approaches
- Desirable properties of first and second order derivatives
- Detection of discontinuities
- Point, line and edge detection
- Gradient magnitude and direction
- Sobel operator
- Edge linking and boundary detection
- Hough transform

Week 15

Lecture 39 – 07/11/2016

- Thresholding
- Baseline algorithm
- Otsu's method
- Handling of noise
- Edge processing for thresholding

Lecture 40+41 – 08/11/2016

- Fukunaga's method for multi-modal thresholding
- Variable thresholding
- Region based segmentation
- Region growing
- Region splitting/merging
- Watershed algorithm for segmentation
- Region Representation and Description
- Border following
- Chain code representation
- Principal component analysis

Week 16

Lecture 42 – 14/11/2016

- Term project demo held