Image Processing

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What?

- An image is a 2-D function f(x,y):
  - x, y: spatial coordinates
  - f(x,y): intensity / grey level
- If x, y and f are discrete: Digital Image
  - Digitization of x, y: Spatial Sampling
  - Digitization of f(x, y): Quantization
- If f(x, y) is:
  - 0 / 1: Binary/ Bilevel Image
  - [0, 255]: Gray Scale / B/W Image
  - <[0, 255], [0, 255], [0, 255]>: Color or Multi-spectral Image
- DIP: processing of digital images by digital computers
  - Images in visual / optical band
  - May be beyond these bands in special circumstances

(x,y): Pixel

- Gamma Rays to Radio Waves
- Ultra-sound, Electron Microscopy, …
- Synthetic Images – Visualized Information

Why?

- Enhancing visual perception of a human being
- Automating various tasks through enabling machine's understanding of environment
- Efficient storage and transmission

DIP relates deeply to other areas

- Pattern Recognition
- Computer Vision
- Artificial Intelligence
- Computer Graphics

Objectives of this course

- 1st level course on Image Processing.
- Assumptions:
  - Linear Algebra, Probability and Statistics, Coordinate geometry and transformations, and Programming.
    - An assignment centering on these topics will be floated within a week and you have to submit by two weeks. This is a part of TA evaluation.
- Major themes:
  - Digital Image: Representation and Acquisition, Digital Image: Geometry in a discrete grid, Digital Image: A function over space, Image transforms and compression, Image restoration, Segmentation, Feature extraction and end analysis.

Syllabus

- Digital Image: Representation and Acquisition
  - Image formation, Human visual system, Perception and representation of colors.
- Digital Image: Geometry in a discrete grid
  - Discrete spatial occupancy, Neighborhood, Paths, Distance functions, Shape representation: Contours, Chain codes, Polygons, Medial axis transform, Skeletonization, Morphological operations
- Digital Image: A function over space
  - Histogram analysis, Pixel mapping, Contrast enhancement, Gradient computation, Convolution and correlation, Linear and nonlinear filtering, Image sharpening, Gray level morphology
- Image transforms and compression
  - Linear combination of a set of basis functions, Orthogonal expansion, Fourier Transform, Transformation in discrete domain: DFT, DCT, Multiresolution representation: Wavelets, JPEG lossy and lossless compression, JPEG2000 compression

Syllabus (contd.)

- Restoration
  - Degradation model, Weiner filters, Restoration from Motion Blur an Defocusing, Additive noise removal,.
- Segmentation
  - Analysis of histograms for bilevel thresholding, Gaussian Mixture Model and Expectation Maximization Algorithm for multi-level thresholding, Mean-shift algorithm.
- Feature extraction and end analysis
  - Region and Texture descriptors: HOG, LBP, Moments, Co-occurrence matrix, classification and regression, Artificial Neural Networks.

Text and reference books

- Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Addison Wesley, 1992.
- Anil K. Jain, "Fundamentals of Digital Image Processing", Prentice-Hall, Inc., 1989.
- William K. Pratt, "Digital Image Processing", 2nd Edition, Wiley & Sons, Inc., 1991.
- Computer vision: A modern approach: Forsyth and Ponce, Pearson (Indian Reprint).
- Image and video processing in the compressed domain: Jayanta Mukhopadhyay, CRC Press, 2011.

Assignments and evaluation

- Implementation using Python and its packages
- Three to four in numbers:
  - The first one on fundamentals.
  - Others on solving a few interesting problems.
- Moodle based submission.
- Penalty for copy cases: -10 for each irrespective of the role of students.
- Penalty for proxy attendance: -5
  - Inform your absence before the class or immediately after being absent
- Distribution: Mid Semester:30, End Semester: 50 Assignment: 20
- Relative grading to be followed.

Class slots

CS40019	IMAGE PROCESSING	1	MON(10:00-10:55) , WED(08:00-08:55) , WED(09:00-09:55)	CS107

Thank You