Image Processing - I
(AY: 2022 - 2023)

References:

A. R. C. Gonzalez and R. E. Woods: Digital Image Processing, Prentice Hall, 2018.
B. Maria Petrou and Costas Petrou: Image Processing: The Fundamentals, John Wiley & Sons, Ltd, 2010.
C. B. Chanda and D. Dutta Majumder: Digital Image Processing and Analysis, Prentice Hall of India, New Delhi, 2000.
D. A. Rosenfeld and A. C. Kak; Digital Picture Processing, 2nd ed., (Vol. 1 and 2), Academic Press, New York, 1982.
E. Maria Petrou and Sei-ichiro Kamata: Image Processing: Dealing with Texture, John Wiley & Sons, Ltd, 2021.

Topics	Sub-topics	References	Lectures
Introduction	Definition of an image Image processing to computer vision History of digital image processing Applications of digital image processing Key stages in digital image processing	A, Ch. 1	2
Image formation	Digital image acquisition Image formation model Digitization - sampling and quantization Three way representation of digital images Dynamic range and image contrast	A, Ch. 2	2
	Resolution of an image Spatial and intensity resolution Isopreference curve	A, Ch. 2	1
	Operator for image processing Point spread function and its properties Stacking operator Separable transform	B, Ch. 1	1
Enhancement	Basics of intensity transformation and spatial filtering Neighbours of a pixel Enhancement - basics transformation functions Contrast stretching, intensity-level slicing, bit-plane slicing	A, Ch. 3	2
	Histogram, histogram equalisation	A, Ch. 3	2

	Histogram specification, local contrast enhancement	A, Ch. 3	2
	Noise in image Fundamental of spatial filtering Order-statistic / rank order filter - median, max, min, mid-point, mode, α-trimmed. Weighted versus unweighted filter	A B, Ch. 4.2	2
	Low-pass filtering High-pass filtering Linear spatial filtering Convolution and correlation Separable kernels	A	2
	Smoothing - box filter, Gaussian filter Weights of Gaussian filter	A, Ch. B, Ch. 4.2	2
	Sharpening Derivatives of a digital function Second-order derivative - Laplacian First-order derivative - Prewitt, Sobel	A, Ch.	2
Edge detection	Fundamental of segmentation Adjacency, connectivity, regions, boundaries Point and line detection	A, Ch. 10	2
	Edge detection Derivation of Sobel operators Non-maxima suppression	B, Ch. 6.2	2
	Linking edge points Local processing Global processing - Hough transform	A, Ch. 10	2
	Laplacian of Gaussian Marr-Hildreth algorithm for edge detection Difference of Gaussians	A, Ch. 10	2
	Canny edge detection algorithm Three criteria Derivative of Gaussians Hysteresis edge linking	A, Ch. 10 B, Ch. 6.2	2
Segmentation	Pixel classification Grey level thresholding Global/local thresholding Optimum thresholding - Bayes analysis	A, Ch. 10.3 B, Ch. 6.1	2
	Otsu thresholding Multiple thresholds	B, Ch. 6.1 A, Ch. 10.3	1

	Region growing, homogeneity property Region splitting and merging Quad tree, quad regions/images Top-down and bottom-up approaches	C	1
Compression	Image compression Predictive versus transform compression Lossy versus lossless compression RMSE, PSNR, error image Block truncation compression Huffman coding, transformed coding, run-length coding	C, Ch. 8	2
Color image processing	Primary and secondary colors Radiance, luminance, brightness Hue, saturation, intensity Chromaticity diagram, color gamut Color model: RGB, CMY, CMYK, HSI Conversion of one model to another	A, Ch. 6	2
	Information content of an image Multispectral images Principal component analysis Pseudo color, intensity slicing, smoothing, sharpening, segmentation	B, Ch. 7 A, Ch. 6	2
Registration	Image registration Monomodal, multimodal, modality to model Feature space, search space, search strategy Extrinsic versus intrinsic feature-based versus intensity-based Local versus global Local registration: tie points, transformation, interpolation Global registration: translation, scaling, rotation	D, Ch. 9	2
	Moments, central moments, principal axis Interpolation - bilinear Similarity metric: cross-correlation, sum of absolute differences, mutual information	D, Ch. 12	2
Image features	Texture - stationary versus non-stationary Rolling bins in histogram Gradient magnitude histogram Orientation histogram Run-length matrix	E	2
	Grey level co-occurrence matrix Haralick's textural features		2

	Local binary patterns, rotation invariant LBP Connected component labeling		

Class Assignment [5]:

Regular class assignments are available at Assignments.pdf

Programming Assignment [10]:

You may use any programming language to implement the following:

- Generate a histogram equalised image from a grayscale image.
- Perform 2-D convolution between a grayscale image and a 2-D kernel (such as box-filter, Gaussian filter, Laplacian, Prewitt and Sobel).
- Generate a two-tone image from a grayscale image using Otsu thresholding approach.
- For a color image, convert RGB to HSI and HSI to RGB.

Project Assignment [15]:

Any paper related to image processing and published in IEEE-TIP, IEEE-TMI, IEEE-TPAMI or similar venue during the last 5-10 years may be considered for the project. The presentation of the project must highlight the following:

- Definition of the problem
- Objective of the work
- Algorithm(s)
- Implementation details
- Performance on benchmark data
- Conclusion and future direction

Important Dates:

- The date of presentation of the project assignment is **April 27, 2023**.
- The deadline for the submission of all assignments is **April 28, 2023**.
- Please submit your assignment to **ipcourse.assignments@gmail.com**