Image Processing

Eötvös Loránd University, Budapest, Hungary, 2005 – 2007 Fall, Spring
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This is a graduate-level introductory course to image processing. We cover basic methods suchs as filtering, compressing, denoising, Fourier transformation, and discuss applications in AI, computer vision, and pattern recognition. The course project assignments require programming in Matlab, C++, or Java.

Frequency domain

Fourier transformation. 2-dim Fourier transformation. Wavelets. Discrete wavelet transformation. Discrete cosine transformation.

Compression and Denoising

Jpeg compression. Principal component analysis. Oja rule. Kernel PCA. Median flitering.

Filtering

Edge detection: Sobel, Prewitt, Roberts, Laplacian, Canny, zero-cross methods.
Optic flow. Kanade-Lucas-Tomasi (KLT) feature tracker.
Hough transform. Log-polar transformation. Scale invariant feature transform (SIFT).
Corner detection.

Active contour models

B-splines. Snake models. Energy functions. MCMC methods. Importance weighted resampling.
Parameter learning of AR dynamics. The Condensation algorithm.

Mutual information and dependence estimation

Copula methods. Nonparametric statistical methods for dependence estimation.
Euclidean graph optimization. Image registration with mutual information.
Independent component analysis. Edge detection using ICA.

Matrix Factorization

Nonnegative Matrix Factorization. Euclidean and KL objective. Algorithms and their convergence.
NMF components on face datasets. NMF, PCA, and ICA components on natural images.

Boosting

Boosting weak classifiers. Haar features. Adaboost. Cascade architecture.
The Viola-Jones detector. Face detection. Eye detection. Eigenfaces.

Support Vector Machines

Introduction to kernel machines and SVMs.
Image classification.

Hidden Markov Models

Parameter estimation of hidden Markov models (HMM).
Facial expression recognition using HMM and PCA/ICA.

Texture synthesis

Markov Random Fields.
Image quilting.
Wavelet based methods.