DOCTORAL SCHOOL OF INFORMATICS
COMPLEX EXAM SUBJECT

Image Processing (recommended subject)

Goals of 3D computer vision. Modeling of spatial objects. Scene reconstruction from images and other modalities (shape from X). Motion analysis, motion-based reconstruction. Structure from motion. Recognition, detection, position estimation, texture analysis.

Mathematical background: numerical methods, Affine transformations, projective geometry, Linear algebra, singular value decomposition. Principal Component Analysis (PCA). Probability theory. RANSAC, Least Median of Squares, Least Trimmed Squares. Kalman-filtering.

Digital image processing. Resolution and scale, scale space. Camera models: orthogonal, perspective, weak-perspective cameras. Intrinsic and extrinsic parameters, camera calibration.

Local image features, lines, curves. Detection of edges, lines and corners. Canny edge detection, Hough transformation. Active contours.

Stereo vision, correspondences. 3D reconstruction, sparse matching. Feature matching: correlation-based methods, epipolar geometry, fundamental matrix. Estimation of fundamental and essential matrices. Occlusion and noise handling. Robust methods, rectification, dense matching. Triangulation, Projective, affine and metric reconstruction.

Special reconstruction methods: shape from shading, photometric stereo, shape from texture. Active methods. Shape from contours. Reconstruction by Structured light and laser. Range images, Point registration, ICP algorithm and its robust variants.

Motion analysis: motion of rigid objects. Optical flow, normal flow. Constraints for motion. Estimation of optical flow. Motion tracking based on feature points. Kanade-Lucas-Tomasi (KLT) tracker. Motion-based object reconstruction, Tomase-Kanade factorization. Kalman filter.

Recognition, invariants, appearance-based methods, visual eigenspaces, model-based recognition and positioning, alignment of points and lines, position estimation in perspective and weak-perspective cases.

Industrial computer vision application: installation, quality control. Reverse engineering, medical image processing (MRI, CT). Attention and security. Human motion detection and modeling, traffic control, intelligent robots and vehicles, realistic modeling of artistic objects.

Literature

E.Trucco, A.Verri, Introductory Techniques for 3-D Computer Vision, Prentice Hall, 1998.

M.Sonka, V.Hlavac, R.Boyle, Image Processing, Analysis and Machine Vision, PWS Publishing, 2nd edition, 1999.

R.Hartley, A.Zisserman, Multiple View Geometry in Computer Vision, Cambridge University Press, 2000.

L.S.Shapiro, Affine Analysis of Image Sequences, Cambridge University Press, 1995.

A.Blake, M.Isard, Active Contours, Springer-Verlag London, 1998.

R.M.Haralick, L.G.Shapiro, Computer and Robot Vision, Addison-Wesley, volumes I-II, 1992-1993.

B.Jahne, Digital Image Processing, Springer, 1997 (vagy későbbi kiadás).

P.J.Rousseeuw, A.M.Leroy, Robust Regression and Outlier Detection, John Wiley & Sons, 1987.

A.K.Jain, R.C.Dubes, Algorithms for Clustering Data, Prentice Hall, 1988.