Computer Vision

Course level: Master [M1] **Track(s):** [MLDM]

ECTS Credits: 4

Course instructors: [Alain Trémeau]

Education period: [2nd] semester **Language of instruction:** English

Expected prior-knowledge: [Matrix algebra, Fundamentals of Image Processing, Fundamentals of Human Vision and Perception]

Aim and learning outcomes:

- Learn fundamentals of 2D and 3D geometrical computer vision techniques.
- Be able to compare these techniques and to master the main techniques used in this field.

Syllabus:

1. Introduction to computer vision (1 lecture)

- Introduction to computer vision: what is computer vision? Examples and applications.
- Notations and definitions: 3D Euclidean space, Cartesian coordinates frames and homogeneous coordinates
- Image formation: Projective geometry, Camera models, Pinhole camera model

2. Recovering 3D from images (2 lectures)

- Visual cues, perception of objects and scenes. Shape from X.
- Fundamentals of objects perception and recognition. Categorization.
- The Marr paradigm and scene reconstruction, Model-based vision. Gestalt cues.
- Other paradigms for image analysis: bottom-up, top-down, neural network, feedback.
- Pixels, lines, boundaries, regions, and object representations. "Low-level", "intermediate-level", and "high-level" vision.
- Object recognition model-based methods
- Appearance-based methods. Invariant features
- From scenes to objects, emergent features, scene categorization.
- The importance of the context.

3. Recovering 3D from stereovison & Multiview (4 lectures)

- Introduction to Mutli-view Geometry, Stereovision,
- Two view geometry: Epipolar geometry, 3D reconstruction ambiguities.
- Computation of the Essential Matrix and Fundamental Matrix (linear methods, iterative methods, robust methods), Structure computation, Rectification methods.
- Camera Geometry and Single View Geometry, Calibration and auto-calibration in Stereovision
- Depth from Triangulation, Two-View Geometry, N-View Geometry, Depth estimation and 3D reconstruction
- Primitive description from lines, edges, corners, interest points,
- Correlation methods, energy minimization methods
- Recovering camera and geometry up to ambiguity (affine approximation, Algebraic methods, Factorization methods)

4. Shape from stereovison & N-views, Shape from Motion (1 lecture)

- Multi-view geometry: computational models, auto-calibration.
- Introduction of Motion Field, Optical Flow. Motion Analysis. Motion detection.

☐ Shape from motion, Structure from Motion, Factorization methods **Organisation and timetable:** [Volume CM/TD] Lectures (24h), Exercises (18h).

Form(s) of Assessment: Intermediate exams (50%), Final exam (50%).

Literature and study materials:

- - R. Hartley et A. Zisserman, Multiple view geometry in computer vision, vol. 2. Cambridge Univ Press, 2000.
- - Ma, Soatto, Kosecka and Sastry. Gavin Brelstaff, An invitation to 3D vision » edited by CRS4 - Pula (CA) Sardinia Italy
- - Richard Hartley and Andrew Zisserman Multiple view geometry in computer vision,
- - O. Faugeras, Three-dimensional computer vision: a geometric viewpoint. the MIT Press, 1993

Additional information/Contacts:

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