



## 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 imaging 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 stereovision & Multiview (4 lectures)

- Introduction to Mutli-view Geometry, Stereovision,
- Two view geometry: Epipolar geometry, 3D reconstruction ambiguities.

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- 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 stereovision & 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/TP] Lectures (10h), tutorials (10h) and lab sessions (10h).

**Form(s) of Assessment:** Midterm exam (20%), Final exam (30%), Lab work (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:

alain.tremeau@univ-st-etienne.fr

Office hours: Monday to Thursday 9 to 17hrs, or by appointment