**COURSE DESCRIPTION TEMPLATE**

**Course name:** **Computer vision** **Course code: CV**
**Course level:** Master **ECTS Credits:** 5.00

**Course instructors: Alain Trémeau**

**Education period (Dates):** from February to june
**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.

**Course outline:**

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

**Practical Laboratory Sessions**:

- Camera calibration and auto-calibration
- Two-View calibration and acquisition
- Computation RGB-D from Kinect camera
- Stereovision from Kinect cameras
- 3D Reconstruction using Two-View Geometry and acquisition
- 3D processing using Point Cloud Library (http://pointclouds.org/)

**Teaching methods:**

Lectures and lab classes.

**Form(s) of Assessment: Form(s) of Assessment:**

- Midterm exam
- Laboratory work report grading
- Final exam

**Examination:** Midterm exam (20%) – Final exam (30%) – Laboratory 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:**


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