Course Specifications

Valid as from the academic year 2024-2025

Computer Vision: Theory and Applications (E061460)

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time 180 h**

Course offerings and teaching methods in academic year 2024-2025

A (semester 2)	Dutch	Gent	lecture	30.0h

Lecturers in academic year 2024-2025

Luong, Hiep	TW07	lecturer-in-charge

Offered in the following programmes in 2024-2025	crdts	offering
Master of Science in Computer Science	6	A
Master of Science in Computer Science Engineering	6	A
Master of Science in Computer Science Engineering	6	A

Teaching languages

Dutch

Keywords

Computer vision, video analysis, object recognition, multi-sensor analysis

Position of the course

The course takes a closer look at a number of modern, widely used techniques in computer vision such as facial recognition, pedestrian and cyclist recognition, the use of intelligent cameras for surveillance and traffic analysis and for autonomous driving. This includes both classical "programmed" algorithms and techniques based on Deep Learning. The emphasis is on reasoning about algorithms, designing original algorithms and acquiring skills for them.
The course includes a comprehensive project, in which students study a computer vision problem in small groups, propose a solution based on a small literature review, and implement and evaluate that solution. The programming environment used is Python, in each case using libraries for computer vision and machine learning, and in some cases a limited amount of c++.

Contents

This is a project course. The students work in a group on a problem from computer vision, e.g. for traffic analysis, autonomous driving, industrial inspection....
The theoretical part gives an overview of the main techniques from the domain and their mathematical description:

1 Introduction: major application domains: autonomous driving, traffic analysis, industrial inspection; basic computer vision problems: object detection, motion analysis, 3D modeling and scene reconstruction.

2 Fundamentals of geometric transformations and imaging: pinhole model, multiview and epipolar geometry, distance estimation; camera calibration, triangulation, camera pose estimation, PnP algorithm, factorization

3 Object characteristics and segmentation: image features (Sift, Surf, Hog...), texture parameters (Gabor, co-occurrence matrices, local binary patterns), segmentation, Hough transformation and RANSAC.

4 Object recognition: Deep Learning (Yolo, faster RCNN, transformers...) and classical feature-based algorithms. AdaBoost; Performance measures for object detection and motion analysis: confusion matrices, ROC curves, F1, Average precision, Amota, track initialization delay....

5 Dynamic analysis: detection and tracking of moving objects, Kalman models and particle filters for trajectory modeling, optical flow and motion estimation;

Multimodal data fusion; calibration of neural networks, radar-video-lidar fusion
6 Multi-view analysis: correspondence analysis (Ransac, Hungarian Algorithm...) multi-camera motion detection, pose estimation and tracking; structure-from-motion

Initial competences

Basic knowledge of Python

Final competences

1 Development of innovative algorithms for computer vision.
2 Formally describing and evaluating an algorithm.
3 Having an overview of basic techniques for computer vision.
4 Selecting reasoned techniques for specific problems.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Lecture

Study material

Type: Slides

Name: Slides Computer Vision
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes

References

- Computer Vision: Algorithms and Applications, Richard Szeliski. The University of Washington, 2022
- Computer Vision: A Modern Approach, Forsyth and Ponce

Course content-related study coaching

The instructors are available for explanation during and after the lectures. Students receive feedback during the project (definition of solution) and after the project (on the submitted report). Students can contact instructors at any time.
The students carry out the project in small groups, each with a specific topic. During periodic contact moments with an assistant, students first present a conceptual approach and solution and receive feedback; halfway through the project, there is an interim contact moment to discuss progress and any issues. The project concludes with a final report that is orally explained to the assistants. In addition, students can always ask questions via email or in person (ad hoc or by appointment).

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Written assessment

Examination methods in case of periodic assessment during the second examination period

Written assessment

Examination methods in case of permanent assessment

Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is not possible

Extra information on the examination methods

- Periodic evaluation: written exam with closed book
- Non-periodic evaluation: At the end of the project, the following must be submitted: software code of the project and an article of 10-12 pages in English describing the project (problem, solution, results). The project is defended in a final presentation, with a live demo and assessment of project reports.

- Second exam opportunity: Not possible for the non-periodic evaluation
- Frequency: one-time project

Calculation of the examination mark

Non-periodic and periodic evaluation. Special conditions: The final score is a weighted average of the project score (1/3) and the exam score (2/3), except if the project score is lower than 8. In that case, the final score is the minimum of (project score, exam score).