GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Intelligent Robot Manipulation (E019380)

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

Credits 3.0 **Study time 90 h**

Course offerings and teaching methods in academic year 2026-2027

A (semester 1)	English	Gent	seminar	15.0h
			lecture	15.0h

Lecturers in academic year 2026-2027

wyffels, Francis	TWO6	lecturer-in-charge
Verleysen, Andreas	TWO6	co-lecturer

Offered in the following programmes in 2026-2027	**crdts**	**offering**
Master of Science in Computer Science Engineering	3	A

Teaching languages

English

Keywords

robotic manipulation, sensors and representations for robots, planning, control, collaborative robots

Position of the course

Please mark: this course has a numerus clausus. The number of students admitted to this course per academic year is limited to 12. The students are selected on a random basis. Prospective students must add the course to their curriculum in Oasis no later than September 20 (12:00 pm). After that, the 12 places will be assigned randomly to the students who have subscribed to the course before this deadline. The list of selected students will be published no later than September 23.
The faculty's student administration organises the random selection. The students must comply to the initial competences of the course. If not selected, the course will be removed from the curriculum by the faculty's student administration.
Today, robotic manipulators are used for all kinds of repetitive tasks in industrial applications. However, applying robots in small businesses or homes is much harder. Major obstacles of robot manipulators in small-scale contexts are safety, dynamic environmental factors, extremely high task variability, etc. This course discusses the fundamental and practical challenges of deploying robotic manipulators in small-scale dynamic environments. We discuss various theoretical aspects, which are then explored in a real-world setting. For this, students will work on a physical setup with a collaborative robotic manipulator. Upon completing this course, students can deduce the theoretical concepts in integrating intelligent robotic arms for challenging tasks, such as folding laundry or order picking, and put them into practice on physical setups.

Contents

The course provides an overview (theory and practice) of the various aspects of intelligent robotic manipulation systems:
1 Application of intelligent robot manipulation
2 The robot manipulator in its environment: mathematical representations and transformations, kinematics
3 Planning and control
4 Multimodal sensing, object detection and localisation
5 Simulators for robot manipulation

6 Bridging the SIM2REAL gap: learning from synthetic data
7 A control (eco)system for robots
8 System integration of intelligent robot manipulators

Initial competences

- Programming in Python and algorithmic thinking (e.g., course Programming);
- basic understanding of electrical circuits, the temporal behaviour of electronic systems at different levels (e.g., digital electronics);
- operations with matrices and geometric transformations (e.g., course geometry and linear algebra);
- basic understanding of classical mechanics (e.g., course Physics I);
- partial derivatives and functions of several variables.

Final competences

1 Understanding the challenges involved with the integration of intelligent collaborative robotic manipulators.
2 Understanding the mathematical representations and transformations involved in the context of robotic manipulation.
3 Understanding the different components of a robotic manipulator system.
4 Be able to apply the various components of a robotic manipulation system on a (real-world) physical (robot)platform.
5 Be able to apply the different components of a robotic manipulation system to new contexts.

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

Seminar, Lecture, Practical

Extra information on the teaching methods

Theory and practicals alternate in blocks of two hours. The theoretical sessions take place in odd-numbered weeks, while practicals occur in even-numbered weeks. Attendance during the practicals is compulsory. The practicals take place in the robot lab of IDLab-AIRO. You will use a collaborative robot platform in small groups during most lab sessions. We can deviate from this regime for practical reasons (e.g., too many students for a limited number of robot manipulators).

Study material

Type: Slides

Name: Course slides Intelligent Robot Manipulation
Indicative price: Free or paid by faculty
Optional: no

Type: Software

Name: AIRO Mono Repo (open source python package)
Indicative price: Free or paid by faculty
Optional: no

References

- Russ Tedrake, Robotic Manipulation Perception, Planning, and Control, 2022
- John Craig, Introduction to robotics, mechanics and control, 2017

Course content-related study coaching

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

- end-of-term evaluation: written examination with closed book
- continuous assessment: assessment of the lab reports

Calculation of the examination mark

Total score = 70% of the end-of-term evaluation score + 30% of the continuous assessment (both both examination periods).