GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2023-2024

Robotics (E019370)

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 2023-2024

A (semester 1)	English	Gent	group work lecture practical	
B (semester 1)	Dutch	Gent	group work	17.5h

Lecturers in academic year 2023-2024

Belpaeme, Tony	TW06	lecturer-in-charge
Sarlette, Alain	TW06	co-lecturer

Offered in the following programmes in 2023-2024	crdts	offering
Bridging Programme Master of Science in Electrical Engineering(main subject Communication and Information Technology)	6	A
Master of Science in Electrical Engineering (main subject Communication and Information Technology)	6	A
Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems)	6	A
Master of Science in Electronics and ICT Engineering Technology(main subject Electronics Engineering)	6	A
Master of Science in Electronics and ICT Engineering Technology(main subject Embedded Systems)	6	A
Master of Science in Electronics and ICT Engineering Technology(main subject ICT)	6	A
Master of Science in Computer Science	6	A
Master of Science in Computer Science Engineering	6	B
Master of Science in Computer Science Engineering	6	A
Master of Science in Electrical Engineering	6	B
Exchange Programme Electronics and ICT Engineering Technology	6	A
Exchange Programme in Computer Science (master's level)	6	A

Teaching languages

English, Dutch

Keywords

Autonomous robotic systems, mobile robots, sensors and actuators, localisation and mapping, complex sensor processing, human-robot interaction, applications of robotics

Position of the course

The field of robotics is a fast-evolving and increasingly prominent application area for artificial intelligence and algorithms. Robotics builds on advanced informatics tools to collect and interpret information from sensors, and to plan and perform actions based on this information. The goal of this course is to give a quick overview of selected hardware (such as sensors, actuators, and mobile computing) to then dive into concepts and methods used to design and program autonomous mobile robotics. The course will focus on sensor fusion, kinematics, dynamics, localisation and mapping, and machine learning. The course will frame the content through the presentation of use cases, such as mobile robots, human-robot interaction, and biologically inspired robots. The theories will be applied during hands-on lab work and a robotics project.

Contents

A selection from the following topics:

- Sensors and actuators for mobile robotics
- Representation of a robotic system and its motion by transformation groups
- Basic information acquisition principles: sensor properties, quantifying information; regularization; data fusion from static to dynamic contexts.
- Direct and inverse kinematics; underactuated systems; planning robot motions and steering with transformation groups, Denavit-Hartenberg formulation
- Robot-internal representations of its environment
- Navigation for autonomous robots: reasoning in a spatial environment, localisation, (simultaneous) localisation and mapping.
- Introduction to advanced information acquisition: computer vision for robotics, information extraction from high-dimensional data based on central model of expectations (a.o. pattern detection, compressive sensing)
- Introduction to machine learning (artificial intelligence): acquiring information on a system's model

Initial competences

Essentials (at BSc level) of computer science, mathematics and control theory, familiarity with programming and algorithmic thinking (e.g. in C/C++, Python or Matlab).

Final competences

1 Understand the breadth and challenges faced in the field of mobile robotics.
2 Have entry-points to the literature and current work about robotics, sensor processing and robot control applied to a variety of autonomous robotic tasks.
3 Understand the assumptions and rationale behind data interpretation, information extraction and artificial intelligence/machine learning applied to mobile robotics.
4 Propose, analyse and compare different hard- and software options for sensing and actuation in mobile robotics.
5 Represent simple motion systems with matrix groups, examine their possibilities and limitations, derive control laws for selected mobile robots.
6 Understand simple planning strategies for mobile robots.
7 Realise and exploit the importance of a full problem formulation, including representation of (expectations about) the environment, for information interpretation by mobile robots.
8 Understand a selection of application domains for mobile robot technology.
9 Understand, appreciate and apply the broad, interdisciplinary perspective on robotics applications, such as human-robot interaction and biologically inspired robots.

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

Group work, Lecture, Practical, Independent work

Extra information on the teaching methods

The course team will offer weekly lectures on a variety of topics relevant to mobile robotics. Lab sessions will be used to establish concepts and tools which will be used in a group project. The group project (3 to 4 students per group) will take the form of a mobile robotics challenge. Please note that the group project requires everyone to bring a laptop on which Ubuntu and ROS have to be installed. The exact versions of these will be communicated by email.

Learning materials and price

Slides about theory and exercises will be made available on the electronic learning platform. The material will be complemented by chapters from text books (such as Dudek or Thrun), academic papers and other references.

References

- G. Dudek and M. Jenkin: Computational Principles of Mobile Robotics, Cambridge University Press, 2010.
- S. Thrun, W. Burgard and D. Fox: Probabilistic Robotics, The MIT Press, 2006
- T. Bräunl: Embedded Robotics, Springer Verlag
- Bartneck, Christoph, Tony Belpaeme, Friederike Eyssel, Takayuki Kanda, Merel Keijsers, and Selma Šabanović. *Human-robot interaction: An introduction*. Cambridge University Press, 2020.
- Review articles from the specialized literature; available on request if necessary.

Course content-related study coaching

Lecturers and teaching assistants are available for additional clarification.

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 possible

Extra information on the examination methods

Formative assessment and summative end-of-term evaluation (through a written examination and project demonstration)

Calculation of the examination mark

Total score = 50% exam + 50% project