MICRO-507

Legged robots

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Cursus	Sem.	Type
Mechanical engineering	MA1, MA3	Opt.
Microtechnics	MA1, MA3	Opt.
Robotics	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	1 weekly
TP	1 weekly
Number of positions	

Summary

The course presents the design, control, and applications of legged robots. It gives a review of different types of legged robots (including two-, four- and multi-legged robots), and an analysis of different control methods for legged locomotion.

Content

The course presents the design, control, and applications of legged robots. It gives a review of different types of legged robots (including two-, four- and multi-legged robots), and analysis of different control methods for legged locomotion. It also trains students in making critical analysis of key articles in the field, and in designing their own models and locomotion controllers for legged robots in simulation.

CONTENT

- History of legged robotics, including two-, four-, and multi-legged robots
- Review of mechanical structures of legged robots, passive and dynamic walkers
- Background concepts: dynamic versus static stability, different stability criteria (e.g. Zero-Moment Point ZMP, capturability, ...), energy consumption, cost of transport (COT), state estimation.
- Simple models of locomotion: rimless wheel, inverted pendulums, linear inverted pendulum (LIP), spring-loaded inverted pendulum (SLIP), template versus anchor models
- Analysis of different control approaches: trajectory-based methods, virtual leg control, virtual model control, hybrid-zero dynamics, optimal control, planning approaches, approaches based on reinforcement learning, and bioinspired approaches.
- Critical literature review and presentation: Students will read several important articles in the field, and present them to the class.
- Numerical exercises: The course will also involve numerical exercises in which students will develop their own controllers for simulated legged robots (with weekly sessions with assistants and the professor).

Keywords

Legged robots, control of locomotion

Learning Prerequisites

Required courses

Recommended courses

- Mobile robots
- Model predictive control

Learning Outcomes

By the end of the course, the student must be able to:

- Identify a suitable type of legged robot for a given application
- Argue about the validity of existing controllers from the literature
- Design their own controllers
- Test the controllers in simulation
- Assess / Evaluate the controllers performance and limits
- Make
- Carry out
- Analyze

Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Access and evaluate appropriate sources of information.
- Make an oral presentation.
- Write a literature review which assesses the state of the art.
- Identify the different roles that are involved in well-functioning teams and assume different roles, including leadership roles.

Teaching methods

Lectures, student presentations of articles, develop controllers for simulated robots

Expected student activities

Reading and presenting an article
Developping controllers for simulated legged robots

Assessment methods

Written exam, student presentation and project.

Supervision

Office hours	No
Assistant.e.s	Yes
Forum	Yes

Resources

Virtual desktop infrastructure (VDI)

No

Bibliography

See Moodle

Notes/Handbook
See Moodle

Moodle Link
- https://go.epfl.ch/MICRO-507