BASICS of MOBILE ROBOTICS 0 Introduction

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What is a Mobile Robot?

Some definitions:

- A machine that senses, thinks, and acts. (G.A. Bekey, 2005)
- Oxford English Dictionary : “A machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer.”

No general consensus on a clear definition for “mobile robot”

- What does “think” mean?
- What does “complex” mean?

Robots that are not “mobile” will not be tackled in this course, e.g.:

- Industrial robots
- Torsos
- Prostheses

What Kind of Mobile Robots?

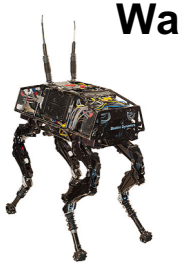
Wheeled Robots

Thymio (EPFL)

Roomba (iRobot)

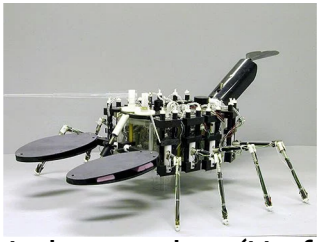
Uranus (CMU)

Walking and Running Robots



BigDog (Boston Dynamics)

Asimo (Honda, Japan)

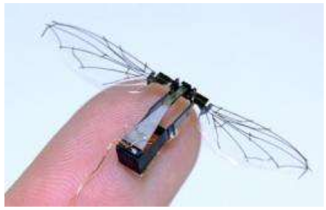


Lobster robot (U of Northeastern USA)

Flying Robots

Hummingbird (AeroVironment)

Dragon fly (WowWee HK)



Micro aerial vehicle, Harvard

Swimming and Crawling Robots

G6 Fish Robot, University of Essex

Penguin Robot (Festo, Germany)

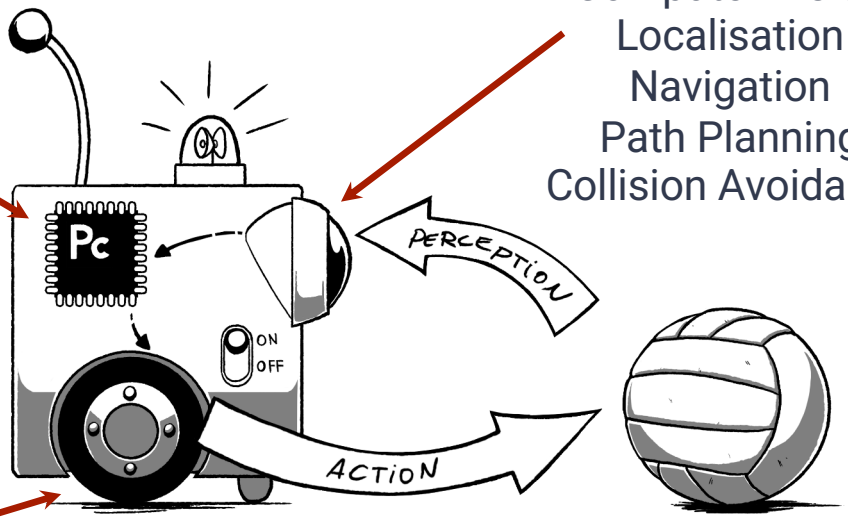
Snake Robot (CMU, USA)

Aspects of Mobile Robotics

System Integration

Processors
Embedded electronics
Architectures
Communication
Programming
Real-time Control

Sensors Integration
Computer Vision
Localisation
Navigation
Path Planning
Collision Avoidance



Mechanics
Actuators
Energy
Locomotion

Course Objectives

1. Get an overview of the mainstream engineering techniques involved in mobile robot development.
2. Get a deeper understanding of a subset of techniques, presented more in detail in the course, addressed in the exercises and revised in the case studies.
3. Acquire hands-on experience in mobile robotics by means of practical laboratories on a real robot and a graded project.
4. Acquire transversal skills in group work
5. Learn to use chatbots as supporting tools

Course Topics (with project)

Week 1	Components of a mobile robot	**Week 8**	Uncertainties
Week 2	Vision	**Week 9**	Localisation 2 + Project week 1 (+ team building)
Week 3	Vision & ANN & ML	**Week 10**	Project week 2
Week 4	Navigation	**Week 11**	Project week 3 + group work check
Week 5	Navigation	**Week 12**	Project week 4 + Project presentations
Week 6	Localisation 1	**Week 13**	Project presentations + group debriefing
Week 7	Uncertainties	**Week 14**	Pr. presentations + Conclusion + Dry Exam

Weekly Course Organisation

- 15:15-16:00 **Case studies** on the topics seen and trained the week before
- 16:15-17:00 **Lecture**
  - One global topic
  - An overview on several techniques related to the topic
  - Some techniques in more detail
  - When needed, one numerical example
- 17:00-19:00 **Exercises** with the Thymio robot
  Assignments on Moodle
  https://moodle.epfl.ch/course/view.php?id=15293

The course is continuously restructured and adapted, so please be patient 🙂 and feedback is always welcome! (see moodle)

Course Organisation

Slides on Moodle: https://moodle.epfl.ch/course/view.php?id=15293

Enrollment: self-enrolment.

Feedback: every week on moodle, anonymous

Case studies: slides presenting the cases on moodle, interactive discussion

Exercises: every week on moodle, solution published Friday morning

Thymio robot: one for each student for the whole semester

Course Organisation

Thymio robot : in the past we asked a 50CHF retainer and we lost money and robots. We will not do that anymore.

We apply a simple rule:

- normally the project grade is published ASAP after the project defenses.
- This year we will not publish the grades until ALL Thymio are back, but we will publish the names of students not returning Thymio.

Distribution of Thymios during the exercises of week 1 and 2.

Course Material

References :

- **Mobile Robots Course** - EPFL - J.-C. Zufferey, Felix Schill, 2013
- **Introduction to Autonomous Mobile Robots** R. Siegwart, I. Nourbakhsh, and D. Scaramuzza, MIT Press, 2011.
- **Elements of Robotics,** M. Ben-Ari, F. Mondada, Springer, 2018. (free download!)
- **Autonomous Robots: From Biological Inspiration to Implementation and Control** G.A. Bekey, MIT Press, 2005.
- **Probabilistic Robotics** S. Thrun, W. Burgard and D. Fox, MIT Press, 2005.
- **Springer Handbook of Robotics** B. Siciliano, and O. Khatib (Eds.), 2nd edition, Springer, 2016.

new Control theory if you missed it until now

“Control systems + TP “ by Colin Jones, on EPFL moodle (lessons 1 to 3 and 7)

https://moodlearchive.epfl.ch/2021-2022/course/view.php?id=13758

Or: “Control of Mobile Robots” by Prof. Magnus Egerstedt - 1.1 to 1.7

https://www.youtube.com/watch?v=aSwCMK96NOw

https://www.youtube.com/watch?v=Nb9YPyVTNgs

https://www.youtube.com/watch?v=yyE0Y9wvmlw

https://www.youtube.com/watch?v=n_N9HS0JY6Q

https://www.youtube.com/watch?v=DJuo9kLdr4M

https://www.youtube.com/watch?v=cQhqx65kLfM

https://www.youtube.com/watch?v=Mk1ygHj4zxw

new ChatBots, should I use them? and how?

Positive use:

- Help going much faster and learn more
- Allow to reach more ambitious goals
- Focus more and more on methods
- It’s becoming a standard

- We have to learn together

Harnessing Rule-Based Chatbots to Support Teaching Python Programming Best Practices

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Abstract. In recent years, the use of chatbots in education has been driven by advances in natural language processing and the increasing availability of digital education platforms. Although the added value of educational chatbots appears promising, researchers have noted that there is a need for empirical studies that explore the effects of incorporating chatbots into different learning scenarios. In this paper, we report on the integration of a rule-based chatbot into an information technology course. We conducted a controlled experiment in which half of the students were able to interact with the chatbot during Python lab sessions while the other half completed the sessions without the chatbot. Our results suggest that educational chatbots powered by short, simple, interactive scripts could have a positive impact on the user experience offered by learning technologies and could be pertinent to educators looking to integrate chatbots into their practice.

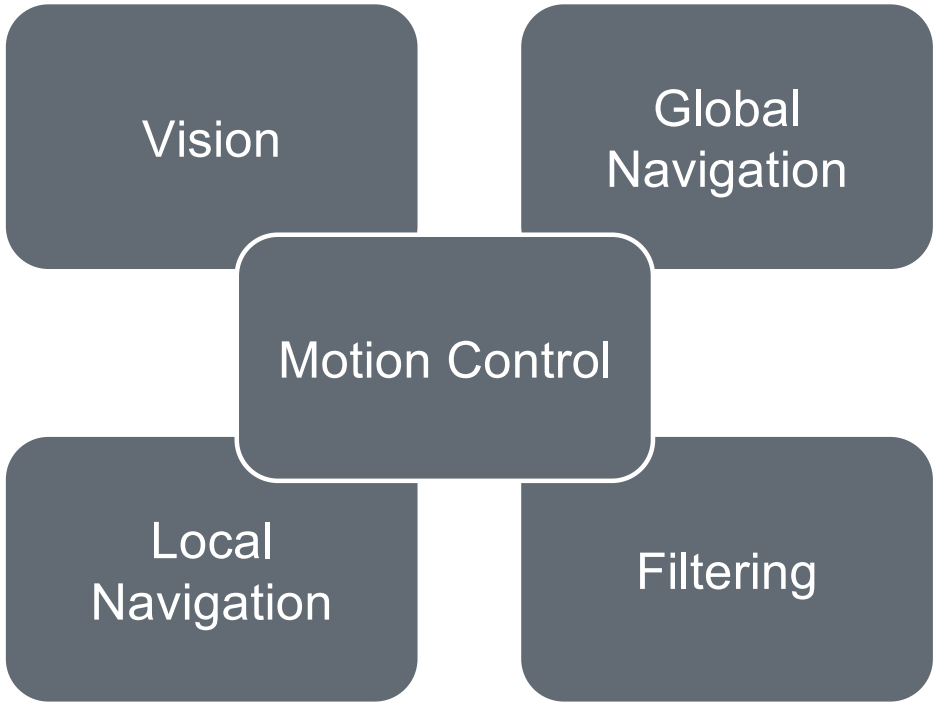
Evaluation (with project)

In 2 parts

- 60% Project on one of the topics seen during the semester + the exercise sessions
- 40% Written take-home exam during the winter examination session
  - Related to the case studies (multiple choice answer + explanation)

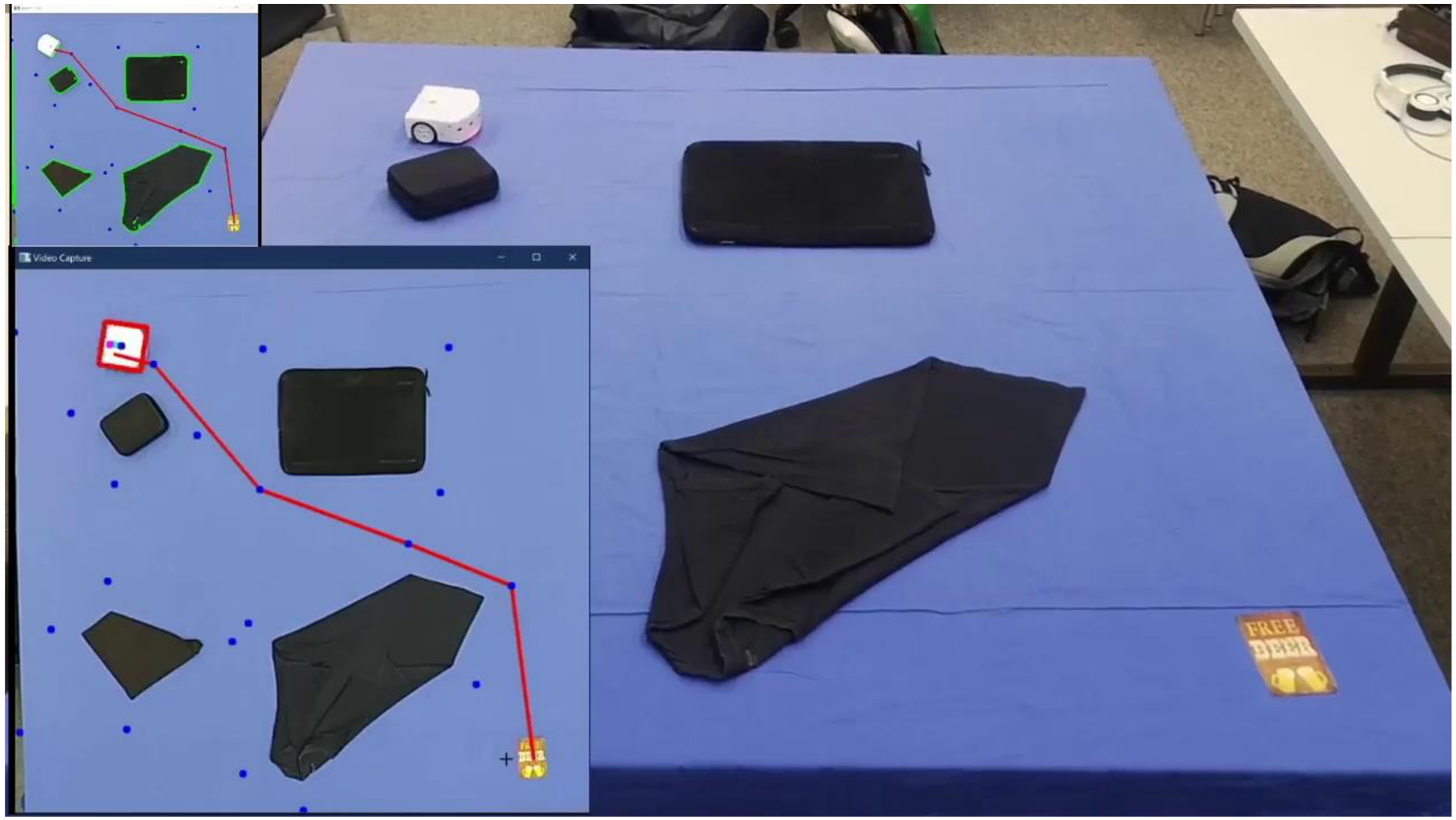
Project Information

- Groups of 4 students (randomized!)
- Presentations weeks 12 & 13 & 14
- 4 weeks without exercise sessions (weeks 9-12) to work on it, note that there will be a full lecture week 9 and a case study week 10.
- TAs available from 17:15 - 19:00 on Tuesdays
- Please use the forum, to allow everybody to benefit from the response.
- Training / development of group working skills (+ evaluation of impact)



Components that are required for the project

Examples from Autumn 2019-2020



https://www.youtube.com/watch?v=UDhiHllIJEQ

Core Robotics Labs at EPFL

STI-LIS (Prof. D. Floreano): Flying robots, swarm robotics, bio-inspired A.I.

STI-LASA (Prof. A. Billard): Machine learning, imitation, humanoids

STI-BioRob (Prof. A. Ijspeert): Bio-inspired locomotion, biomedical robotics, industrial robotics

STI-Mobots (Prof. F. Mondada): Robot design, miniature mobile robots, educational robotics

STI-RRL (Prof. J. Paik): Robot design, foldable robots STI-MICROBS (Prof. S. Sakar): Microrobotics

STI-MICROBS (Prof. M. Sakar): MicroBioRobotic Systems Laboratory

STI-CREATE (Prof. J. Hughes): fabrication and computational design tools

ENAC-DISAL (Prof. A. Martinoli): Collective systems

ENAC-VITA (Prof. A. Alahi): Visual Intelligence for transportation