Aalto University
School of Electrical
Engineering

ELEC-E8111 Autonomous Mobile Robots, 5 op
Course introduction

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What do you expect from the course?

What do you expect to learn from the course?

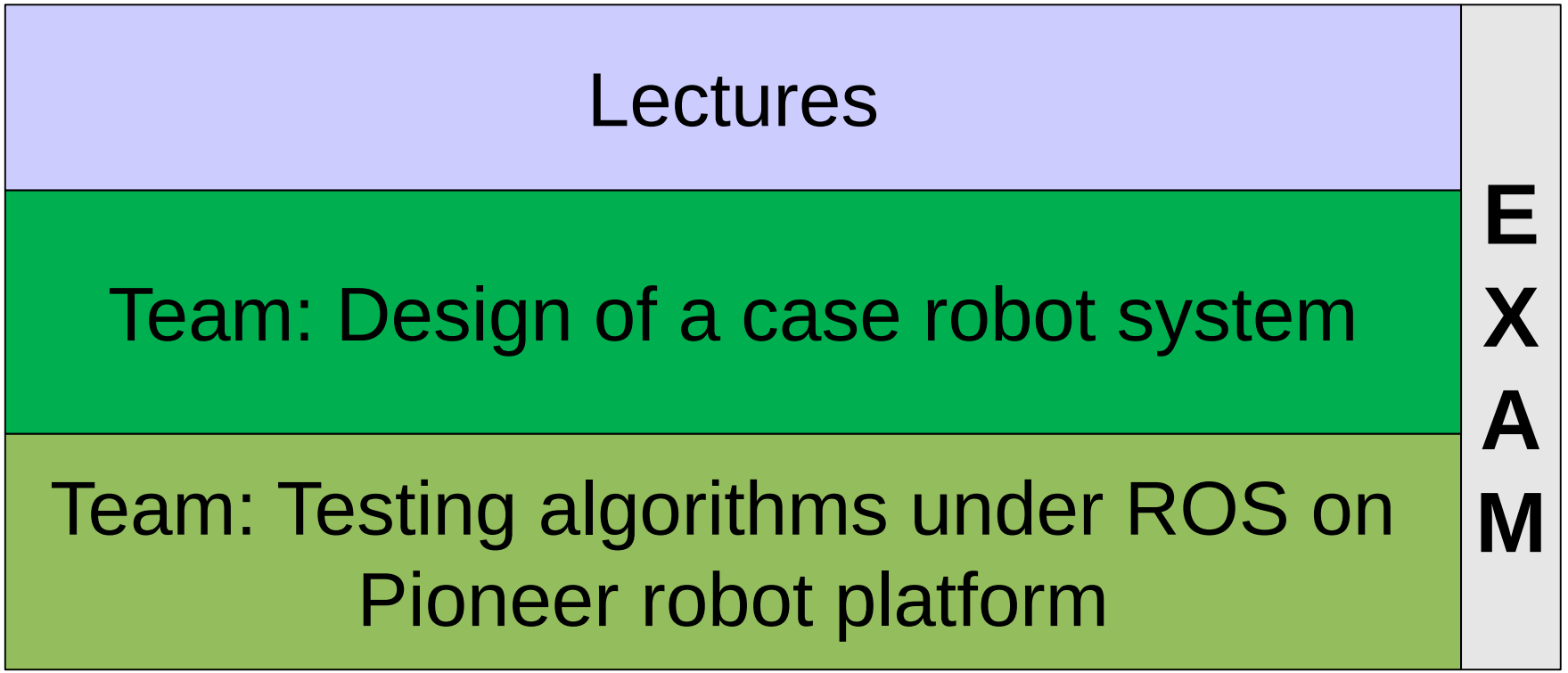
Learning goals – What's the course about?

- Understand the main challenges in mobile robotics
- Understand what are mobile robots made of
  - Sub-systems (perception, mobility, navigation, planning, power, …)
  - Basic approaches and terminology for each sub-system
  - Methodology and algorithms in mobile robotics
- Learn the characteristics in three applications areas
  1. Indoor mobile service robot
  2. Field Robot: Outdoor semiautonomous vehicle / heavy duty machine UGV
  3. Autonomous traffic vehicle
- Not processing, manipulation and grasping

Prerequisities

- Robotics basics (coordinate transformations, kinematics)
- Control engineering basics (feedback, state estimation)
- Machine vision basics
- Math (probability, matrix algebra)
- Matlab

Teaching


Lectures
Team: Design of a case robot system
Team: Testing algorithms under ROS on Pioneer robot platform
EXAM

Teaching

Follow Mycourses!

- Lectures: the concepts, terminology and algorithms. Feb 26- Mar 28
  - On Tuesday 14:15 - 16:00, room TU2/2005 (TU2), TUAS, Maarintie 8.
  - On Wednesday 12:15 - 14:00, room TU2/2005 (TU2), TUAS, Maarintie 8

Lectures (estimate)

Nro	topics
1	Course introduction and arrangements Introduction to mobile robots
2	Robot control system architecture Reactive robotics
3	Team works: 1) Design of a case robot system 2) Testing algorithms under ROS/ Pioneer Introduction to ROS Locomotion, Kinematics, and Low level Motion Control
4	Sensing and perception, overview. - Kalman-filter based traditional vehicle localization
5	SLAM = Simultaneous Localization and Mapping Extended Kalman Filter SLAM (EKF SLAM)
6	Particle filter and Fast SLAM
7	Graph SLAM
8	Satellite Positioning - GNSS technologies
9	Pose Estimation, Inertial Navigation Systems (INS), Inertial Measurement Unit (IMU)
10	Visual localization and object recognition
11	Graph based Path and Motion Planning, Indoor A*. Path and Motion Planning, Outdoor D*
12	Outdoor Path and Motion Planning Motion Control

Design of a case robot system

In design tasks, four application cases given, each team of 4 students selects one, extra functionality can be freely added:

1. Indoor (2018) : Cleaning robot for cinemas (needs climbing stairs as well).
2. Indoor (2018) : Drinks order and delivery robot at restaurant.
3. Outdoor (2018) : Autonomous freight trucks for fixed routes on highways between terminals.
4. Outdoor (2018) : Autonomous ferry between Suomenlinna and Helsinki Market Place (Kauppatori).

You can get extra points by design rated as excellent

Testing algorithms under ROS on Pioneer robot platform

- Done in groups of 4 students
  - Groups self-organization as you like, Team leader

1) Explore and map with SLAM an unknown area
2) Plan the collision free path of the robot
3) Implement and test motion control with ROS
4) Document the experiments and show the final operation of the robot

- **You can get extra points by demonstrating other different SLAM and/or path planner algorithms.**

Grading and evaluation

CHANGED FROM LAST YEAR!

- To pass
  - Normal Exam, testing understanding
  - Pass, possibly extra points if well done, of Team works: Design task and ROS/Pioneer, testing ability to apply
- Grading
  - Basic Grading on the basis of the Exam, max 36 points
  - Team: Design task, 3 points up to about 50% of one grade improvement
  - Team: ROS/Pioneer, 3 points up to about 50% of one grade improvement

Workload estimate

- Lectures 24 h
- Working at home with lecture material 24 h
- Team: Design task, 26 h
- Team: ROS/Pioneer, 26 h
- Reading for exam 35 h
- Total 135 h

Material

- Lectures and all other material in Mycourses
- Alonzo Kelly, CMU, *Mobile Robotics: Mathematics Models and Methods,* Cambridge University Press, 2014
- Trun & al, *Probabilistic robotics*, MIT Press 2005.
- Siegwart, Nourbakhsh, *Introduction to Autonomous Mobile Robots,* MIT Press (2nd ed.)
- Choset & al, *Principles of Robot Motion*, MIT Press 2005

Teachers

- Lecturers
  - Prof Arto Visala (arto.visala@aalto.fi)
  - Research Fellow Dr Mika Vainio (mika.vainio@aalto.fi)
  - Dr Kshitij Tiwari, (kshitij.tiwari@aalto.fi)
- Team work:
  - Design of a case robot system
  - Testing algorithms under ROS/ Pioneer

Course assistants
- Dr Mika Vainio (mika.vainio@aalto.fi)

Questions?