ELEC-E8111 Course Robot Project 2019

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General information

- Done in teams of four or five students.
  - Erasmus students may take the full course, with projects too.
- You may form your own teams. Select a team leader.
  - You may use the MyCourses forum to discuss and form teams.
- The team leaders reserve the lab times in MyCourses.
- The whole project and its success depends on the team.
- It is hard to reorganize the teams after the course has started.
- Start early, preferably now.

Two subtasks:

1) Design of a case robot system

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

1. Indoor: Room service delivery robot in a hotel.
2. Indoor: Inspecting drone for an industrial plant, for example a paper mill.
3. Outdoor: Autonomous ro ro freight e-ferry for fixed routes in the local sea area of Helsinki
4. Outdoor: Autonomous mobile robot for cleaning glass facades of high buidings.

2) Testing algorithms under ROS on Pioneer robot platform

Implementation with ROS/Pioneer, introduced in a separate slide set.

Indoor: Room service delivery robot in a hotel.

- Quick delivery of ordered items for room service (i.e. breakfast, warm late meal, cold champagne or wine, etc ordered objects).
- Robot must be able to move in all floors and is able to use elevator with wireless link.
- Collision avoidance with interior and humans.
- The logistics is based on standard logistic boxes, which can be insulated for warm or cold foods or drinks.
- The map of the hotel is given.
- Ordering and paying is done via room bill and is not considered here.

Indoor: Inspecting drone for an industrial plant, for example a paper mill.

- Safety is absolutely important, the drone should not collide with humans or equipment.
- Sufficient positioning inside a large halls should be solved and presented
- Multi-robot system, flexibility in scheduling and task allocation. How to coordinate the system, control architecture.
- How to solve the needed efficient communication for transmitting video and other perception information.
- For battery management there should be reliable system.
- The basic 3D CAD structure of the hall and process equipment is given. However, there are AGV and humans moving.

Outdoor: Autonomous mobile robot for cleaning glass facades of high buildings.

- Operation must be safe for human inhabitants and building itself.
- The robot cannot carry all the washing liquids and battery capacity. Supporting infrastructure is needed, which can be utilized for positioning and safety.
- The locomotion of the platform must be solved so that the orthogonal force needed in the washing operation can be realized.
- The positioning of the robot platform in the wide facade must be solved.
- The façade map is given, which contains the local 3D-structures and details, so that suitable machine perception can be utilized
- How to cope with the weather conditions, particularly wind?

Outdoor: Autonomous ro-ro freight e-ferry for fixed routes in the local sea area of Helsinki (max 10 nautical miles)

- No human passengers, unmanned operation, just cargo.
- Implementation of safe autonomous departing, cruising and docking from one docking to another. Ferries are operating between the fixed sites equipped with the needed docking machinery, not designed here.
- How to cope with weather conditions, what kind of supporting infrastructure is needed? How to decide if it is safe to dock?
- Routes can be varying, order of sites vary according to the orders.
- Automatic logistic system takes care of safe loading and unloading standard logistic packages, not designed here.
- Operation must be safe for other vessels, especially in the busy harbor area. How to react in the unpredictable situations?

In the design task

You can freely select, but the design should be realistic and feasible:

- The robot platform
- The perception and measurement devices
- Way of operation
- Algorithms, described at schematic level
- Human Robot Interface
- Required contents defined in a separate document.
- The design report can be at most 10 pages.

Subtask 2: Testing algorithms under ROS on Pioneer robot platform

1) Explore and map with SLAM an unknown area

- Easiest on the basis of Sick -laser scanner, but you can use RGB-D camera (Kinect type) as well.
- While mapping you can control the motion of the robot by manual controls
- Occupancy grid map is suitable for this case
- As base node Gmapping is used

2) Plan the collision free path of the robot from the current pose to the given pose using some of the algorithms of path planning.

- You should to use configuration space for path planning.
- As base planning node the ROS navigation stack is used.

Subtask 2: Testing algorithms under ROS on Pioneer robot platform

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.

Robot

- Pioneer P3-DX
- Motor controller, differential drive
- Encoders to calculate odometry
- 2D Sick Laser scanner
- Asus Xtion camera (Kinect type RGB+D)
  - Provides depth information
- Controlled by using ROS (Robot Operating System)

Practical Issues

- Robot situates in room 2552
- Reserve always time for your team in MyCourses
- First session two hours, extra time slots can be reserved.
- Power and recharging
  - Always keep the robot connected to the charger when possible
- More practical things in ROS tutorial.

Timetable

- Testing algorithms under ROS/Pioneer starts on Monday, March 18
- The 1st exam will likely be on Tuesday, April 10; The 2nd exam two weeks after that
- Design of a case robot system, DL Sunday April 14, 21:00
- Testing algorithms under ROS on Pioneer robot platform, DL for reports Sunday April 14, 21:00

Important

- You are dealing with real, complicated mechanical device that can break. Please respect that!
  - If something happens, please contact assistants immediately
- Some important things:
  - If you don't know how to do something – ask
  - If you don't understand the answer - ask again
  - DO NOT BREAK THE ROBOT
- During experiments, Andrei can be found in room 2567