

AS-84.3144 & AS-84.3143 Field and Service Robotics
08.01.2013 13:00 – 09.01.2013 13:00

Home Exam! You can find the general instructions in the end. In case you are picking up a printed version of this exam, you can leave the class room immediately.

DL of delivery: 09.01.2013 13:00am

Send an electronic version (PDF) to Jari Saarinen (firstname.lastname@aalto.fi)

In case this is impossible, deliver printed version between 12:00-13:00 to 2572 (TUAS/2nd floor/Matthieu Myrsky).

Good Luck!

Task: Trash picking cleaning robot

Your task is to design a robotic cleaning robot system. The task of the robot is to explore a typical office environment and pick up trash from the floor. In this task anything that is on the floor and smaller than 20cm x 20cm x 20cm cube is considered as trash.

The robot platform is Willow Garage's PR2 robot (<http://www.willowgarage.com/pages/pr2/overview>). You can assume that you can control the actuators of the robot and read the sensors. You can also install extra sensors if necessary.

You can assume that the robot has a recharging station in a known location.

You can structure your answer using the following model:

1. Overview – (General description of system)
2. Setup – (What do you need to assume about the environment, how do you need to modify it and what setup steps are needed)
3. Sensor subsystem – (Explain sensors, what sensors do you need, what do they measure)
4. Localization – (How do you keep the robot localized)
5. Motion planning and control – (Explain the motion planning and control subsystem)
6. Work subsystem – (explain how you detect trash, how do you pick them and where do you deposit them)
7. Task management – (Explain your task planner/state machine, how do you decide exploration strategy for the robot)
8. Discussion – (a short conclusion, analyze possible shortcomings of the solution)

FSR 2012 Exam Instructions and tips

The purpose of this exam is to evaluate your understanding of the course topics and especially your skills in applying these for a practical design task. **The assignment is individual and team work is not allowed. Plagiarism will be reported onwards and will result in the rejection of the exam.** Please note that also self-plagiarism is forbidden, that is, the use of text from project documentation is not allowed in your exam solution.

The exam is a design task, where you are asked to present a detailed design of a robotic system for a particular purpose, similar to the course project work. The task description will describe the robotic platform to be used but you are free to propose minor modifications, for example, additional sensors to the platform. If you feel that the task description given is incomplete or ambiguous, you can make your own assumptions. **Report all assumptions made.**

The level of detail in your report should be such that an educated person can implement the design given access to appropriate generally available sources. This means that you will have to explain **How** you solve the problem. If you propose to use existing algorithms, those should be named and appropriate references cited. If you propose to use an own approach, the approach needs to be explained. **Justify your choices.** You can also describe if there are some potential problems or challenges in the design.

The solution to the design task need to be returned as a design document in PDF format. Please include on the cover page your name, student number and the group that you belong to in the project work. If you have done the project work before year 2012, please indicate the year and topic on the cover page.

Hints and tips

- You can use your “specialty” that you have acquired during the project work, but all subsystems need to be explained in your solution.
- Note that you should explain how each algorithm is used. For example, it is not enough to mention that planning is solved using A* algorithm but you should also mention e.g. in which state space the planning is performed, how that model is constructed, etc.
- **Figures are an excellent** way to convey your thoughts to the reader (examiner). The amount of text does not have to be substantial, you just need to be specific.
- Do not expect too much from the reader if you think something is obvious, it might not be for someone else. Consider that the reader is not a specialist of robotics
- **Keep your emphasis on methods and algorithms** necessary for your solution. You don't have to worry about practical implementation and programming issues, such as used programming language, middleware, or communication framework.
- The answer should not exceed 6 pages. Exceeding it is not punished, so don't make your figures smaller for that.
- PR2 uses ROS, however we don't want you to name a number of ROS nodes as your answer. You can, of course, use ROS as a guideline, however, it is more important that you explain what the module does.