Signals, Instruments and Systems 2015-16
Course Projects

1 General information

SIS will involve a 45h course project (this should include reading, implementation, reporting, oral defense of the project, and review of the report of another student team). Students will choose a project from a list of approved topics distributed during the fifth week of the semester. Projects will be carried out in groups of three students (an ad hoc arrangement will be found in case of total number students not divisible by three). Each member of the student team will have to defend part of the project in front of the audience. Every project will be supervised by a member of the support staff (Zeynab Talebpour, Faezeh Rahbar, Felix Schill and Alexander Bahr). Definitive assignment of project topics and team members will be communicated by the end of the seventh week, based on the preferences expressed by the students. Students will be expected to contact their project supervisor as soon as possible to begin planning their work schedule. During the eight week, a kick-off session for the implementation of specific course projects will be organized by each project supervisor and will involve all the teams working on the very same topic.

Students will be required to submit a brief intermediate report on their project progress by the end of the tenth week, showing a clear understanding of the project topic and its related literature, a concrete implementation plan, familiarization with the needed tools, and preliminary implementation results. This will allow their project supervisor to give them feedback in terms of implementation progress, problem and tool understanding, and time planning.

Each student will also be asked to serve as a reviewer for another student project and invited to ask questions during the defense session. Further details on the project report and presentation will be communicated in timely fashion.

2 Topic list

Students should choose three projects of the following list and send an e-mail to steven.roelofsen@epfl.ch with their choice in order of preference (1-3). Note that multiple teams for a given topic are allowed. If students wish to work with specific students in their team, they should all state their preferred two teammates in their e-mail. The deadline for the choice of projects is Thursday April 7, 21h00. Note that from that time we will start assigning projects and students in teams independently whether we received all the preferences or not.

1. Sound detection with the e-puck robot – FS

The goal of this project is to localize a sound source using an e-puck. The e-puck will first listen to the sound from its three microphones, and then will have to obtain the direction of the source using a time or frequency domain method. Using the obtained information, a simple control law needs to be implemented to bring the e-puck towards the sound source. The project is done in two steps: firstly, Webots will be used to design the sound direction acquirement and control of the e-puck. Secondly, the code designed in simulation will be implemented on the e-puck and tested with a real sound source, where you should make your method robust to real conditions. A comparison between the simulation and the real implementation is expected. The performance of your method will be measured by the time the robot takes to achieve the sound source.
2. **Road sign recognition with the e-puck robot** – FR

An e-puck robot is given the task to read and analyze a simple “road sign” (e.g., black stripes on a white background). The e-puck should read the sign with its camera, analyze the picture on board, and decide what action to perform; for instance, turn left if the stripes are horizontal and right if they are vertical.

You will have to carry out the project in two phases. In the first phase you will implement your algorithm with a simulated e-puck and several signs on a Webots environment, and make sure that it works reliably on that environment. For the second phase, you will apply your algorithm to a real e-puck robot, where you will improve your method to cope with real-world phenomena not properly captured in simulation.

The e-puck is already programmed to take a picture and send it to a host PC, and you will also be provided with a simple Matlab script which allows you to visualize the picture taken by the robot. Your algorithm's performance will be tested, in terms of decisional robustness and speed, under fixed constraints (i.e. arena size, path, and sequence of road signs).

3. **Line following using a the e-puck’s camera** – ZT

In this project an e-puck robot is given a task to follow a line drawn on the ground. The robot should detect the line using its built-in camera. The line following behavior is to be continuous and should be robust to obstacles placed on the line. To solve this problem, you will start with Webots, with a simulated robot and camera, to develop your baseline perception to action loop: image acquisition, processing and robot actuation. By processing the camera image, you will detect the direction of the line, which you will be able to follow using a controller for the robot’s differential wheel speeds. Then you will deploy the developed algorithms in the real e-puck. A third stage will be done in Webots, where an obstacle avoidance method needs to be included. You should compare the performance of the baseline method with the other versions (with the noisy real robot, and obstacle perturbation on the line in simulation).

4. **Localizing the maximum in an environmental field using a mobile sensor** – AB

The goal of the project is to program your e-puck such that it finds the maximum in an environmental field (such as the hottest point in a temperature field) first in Webots and then in real hardware. The environmental field is simulated by several e-pucks which are not moving, but blinking with their range sensors. We will provide these stationary, blinking e-pucks (in Webots and as real hardware). In Webots you can ensure that the robot properly determines the blinking frequencies of the e-pucks surrounding it and then chooses the correct direction. Using the real hardware you can fine-tune the corresponding algorithm and adapt it if this becomes necessary due to the additional noise. Your e-puck has to be able to get from any position outside or within the field of blinking e-pucks to the one which blinks the fastest. The performance of your algorithm will be measured by the time it takes to find the fastest blinking e-puck for a given set of initial conditions in a configuration of the blinking robots not known in advance.