Distributed Intelligent Systems
Course Projects

• General information

Distributed Intelligent Systems involves a 45h course project (this includes reading, implementation, reporting, oral defense of the project, and reviewing the report of another student team). All teaching assistants will serve as project supervisors. For this edition, the project topic will be unique for all students. Detailed information will be communicated during the eighth week, at the dedicated kick-off session. Projects will be carried out in groups of four (default) or three (if needed) students belonging as much as possible to different teaching sections or programs (possibly, at least two different sections will have to be represented in the team). The student teams will be organized during the seventh week, based on the preferences of the students. Each of the team members will have to defend part of the project in front of the audience. During the course project period, all project supervisors will make available one dedicated office hour per week. No further office hours will be made available upon request for the course project. Some team aggregation per office hour will take place during the seventh week in order to ensure a proper workload allocation for teaching assistants and feasible attendance for the students. Each student team will have to submit a preliminary report by the end of week 10 (November 23th), where they have to present a brief description of the project, some preliminary results, and their workplan until the end of the project (2 pages max.).

Each student team will also be asked to serve as a reviewer for another team and invited to ask questions during the defense session. Reviewers will receive the technical report of another team one or two days before their defense.

The final course project report will be due by the thirteen week of the semester while the oral defense of the project will happen during the last week of the semester, during lecture and exercise hours of the course. On that week, each student team will also have to test the performance of their solutions in a testing environment provided by the project supervisors. Additional details about the project defense and reporting will be distributed in timely fashion.

1 – Project description: Multi-robot navigation in cluttered and dynamic environments

This project aims to implement a navigation strategy for a multi-robot system formed by a group of e-pucks moving throughout an environment. This environment is composed by an enclosed arena with static obstacles and multiple, isolated, groups of robots. Each group of robots must be able 1) to avoid obstacles within the arena while retaining the collective formation, and 2) to maintain collective formation while two different groups of robots cross each other moving in opposite directions.

The above behaviors should be achieved by using one of the strategies for collective movement given in this course. Here, the infrared sensors (acting as both emitters and receivers) will be used to acquire the relative range and bearing measurements between the robots, as well as to detect the presence of nearby obstacles. The range and bearing measurements also allow the extraction of robot IDs, so it is easy for the robots to uniquely identify each team-member and also other robots that do not belong to their own group. The performance of the team of robots will be measured in terms of how cohesive the team remains over time, how aligned are the robots velocities, and how fast is the team going towards a goal direction (i.e. migration urge).

This project is divided into two parts. Firstly, the chosen collective movement strategy should be implemented in simulation, using Webots. In this part, the effect that the parameters of the implemented controllers and the group size have on the performance of the robot team should be analyzed. Secondly, the implemented robot controllers should be implemented in the real e-pucks. Note that the range and bearing sensors on the real robots have range limitations. Students are free to explore any optimization algorithms for the parameters of the implemented controllers in order to enhance the performance of their solutions.

For simplicity, the performance of the team will be evaluated in two isolated scenarios (one with one robot group and static obstacles, and another with two robot groups moving in opposite directions). In each scenario, the performance of the group will be evaluated according to a set of metrics provided a priori. In simulation, the performance should be monitored through the use of a supervisor. The solution chosen to be implemented in the real e-pucks should be compared with the results obtained in simulation. Note that, with the real e-pucks, the performance metrics will be noisy and subjected to occlusions between the robots or obstacles. Therefore, simple visual feedback on the real experiments can be used.

The students will be provided with some tools in the project kickoff session, such as the Webots environments, and the drivers for the proximity sensors used to obtain range and bearing measurements with the real e-pucks. The default number of robots forming a group in simulation is 5 (but more can be added). The number of robots forming a group in the real environment will be limited to 3. The Webots environments can be changed at will, but a test environment, provided by the project supervisors for the testing day, will be used to evaluate the performance of the solution. The e-pucks will be supplied by DISAL but the students will have to create the real environment by using objects that they see fit.

[1] Reynolds, C. (1987). Flocks, herds and schools: A distributed behavioral model. In Proceedings of the 14th annual conference on computer graphics and interactive techniques (SIGGRAPH ’87) (pp. 25–34). New York: ACM Press

[2] Turgut, Ali E., et al. "Self-organized flocking in mobile robot swarms." Swarm Intelligence 2.2-4 (2008): 97-120.

[3] Falconi R., Gowal S., and Martinoli A., Graph Based Distributed Control of Non-Holonomic Vehicles Endowed with Local Positioning Information Engaged in Escorting Missions, Proc. of the IEEE Int. Conf. on Robotics and Automation, 2010, Anchorage, AK, U.S.A., pp. 3207-3214.

[4] Pugh J., Raemy X., Favre C., Falconi R., and Martinoli A., A Fast On-Board Relative Positioning Module for Multi-Robot Systems. Special issue on Mechatronics in Multi-Robot Systems, IEEE Trans. on Mechatronics, 14(2): 151-162, 2009.

2 – Groups:

Group 1: Yassine Ahaggach, Ait Bouhsain Smail, Malo Simondin and Charles Coster

Group 2: Louis de La Rochefoucauld, Adrien Lüthi, Quentin Vingerhoets and Marc Uran

Group 3: Mathilde Rüfenacht, Mahmoud Zgolli, Bassel Belhadj, Maxim Pavliv

Group 4: Michael Perret, Mickaël Salamin, Zeki Doruk Erden

Group 5: Antoni Bigata, Maxime Boutot, Bastian Schnell, Jonathan Regef

Group 6: Marc Jollès, Jean Duquenne, Fabrice Guibert and Thomas Garcia

Group 7: Louis Munier, Sarah Bonaly, Julien Calabro, Mohammed-Ismail Ben Salah

Group 8: Valentin Borgeaud, Loïc Niederhauser, Cleres David Moritz

Group 9: Chiara Ercolani, Jean-Baptiste Magnin, Benjamin Lei, Johann Franziskakis

Group 10: Mathilde Bensimhon, Hugo Grall Lucas, Daniel Almeida Dias, Pauline Maury Laribière

Group 11: Alexis Dewaele, Yoann Lapijover, Bruno Borges Da Costa, Camilla Carta

3 – Office hours (priorities):

Mon 13:00-14:00 (Faezeh Rahbar, office: GR A2 475): Groups 4, 7, 8

Tue 13:00-14:00 (Duarte Dias, office: GR A2 455): Groups 1, 5, 9

Thu 14:30-15:30 (Anwar Quraishi, office: GR A2 445): Groups 3, 6, 10

Fri 13:00-14:00 (Ali Marjovi, office: GR A2 475): Groups 2, 11