Distributed Intelligent Systems
Course Project

1 General information

Distributed Intelligent Systems involves a 60-h course project (this includes reading, implementation, reporting, and oral defense of the project). In this edition, there will be a single topic for all students, and all teaching assistants will serve as project supervisors.

Projects will be carried out in groups of four (default) or three 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 teams will be organized based on the preferences expressed by the students during Week 4 to 6. The oral defense of the project will be carried out individually and take place during the exam session, with the modalities expressed in the course syllabus.

In the lab session of Week 6 (April 1), there will be a kickoff session of 1h during which the details of the project topic and organization will be presented while the material will be made previously available on Moodle. This session serves as the official start of the project period, until the end of the semester when the project report together with further implementation material (e.g., code) will have to be submitted. Additional details about the project reporting will be communicated in timely fashion.

During the course project period, the last hour of each lab session will be dedicated to project supervision. Two supervisors will be available on the Discord server of the course to answer students' questions. No further office hours will be made available. However, there will be a text channel on Discord where students can ask questions and help each other. Assistants will also address the messages when they are available.

2 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 simulated 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 to: (i) avoid obstacles within the arena while retaining a given loose or tight collective aggregation; and (ii) maintain a given loose or tight aggregation while two different groups of robots cross each other moving in opposite directions.

The above behaviors should be achieved by using two collective movement forms covered in the course: flocking and motion in formation. The robots are equipped with infrared proximity sensors to detect nearby obstacles, as well as infrared emitters and receivers that will be used to acquire the relative range and bearing measurements between the robots. The messages transmitted between robots also contains robot IDs, 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, how precisely are specific positions maintained in a formation-based movement, and how fast is the team going towards a specific goal or direction.

This project is divided into three tasks, each of them pursuing different though coupled objectives. The first task will be concerned with the implementation and performance evaluation of multiple localization techniques for individual robots. It should be carried out using the Webots worlds provided and students should leverage the localization knowledge acquired through Lab 3. The techniques should involve odometry-only localization, GNSS-only localization, and any fusion of these two signals through appropriate method seen in the course (e.g., Kalman filtering). The second task will be concerned with the implementation of spatial coordination solutions. It should be carried out through the use of infrared channels reproducing range and bearing functionalities and students should leverage the collective movement knowledge acquired through Lab 4. One flocking and one formation algorithm should be proposed and thoroughly evaluated as a function of the group size and the localization capabilities of the robots. The implemented algorithms will be certainly characterized by a number of parameters, initially chosen manually based on an iterative process. The third task will be concerned with the optimization of such parameters through a method seen in the course (e.g., Particle Swarm Optimization). The objective of this task would be to enhance the flocking and formation performance of the previously handcrafted solutions.

For simplicity, the performance of the simulated multi-robot systems will be evaluated in two distinct scenarios: one with a single 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 which should be implemented in a supervisor code in Webots.

The students will be provided with the necessary material in the project kickoff session. The Webots environments can be changed at will, to evaluate the performance of the method in different scenarios. However, one or multiple test environments will be distributed at the end of the project in which the performances of the proposed algorithm should be assessed.

3 Student teams

Group	Name	Sciper
1	Pangaud Roxane	283177
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	Bergamo Gregoire	274547
	Feppon Nicolas	249799
	Evann Courdier	291613
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	Félicia Zhang	284334
	Paul Juillard	288519
	Minh Tri Pham	326543
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	Olivér Facklam	259413
	María José Medina Hernández	331238
	Nathan Holzapfel	272296
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	Marcel Dubach	263557
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	Sizey Eliott	287767
	Leuenberger Merlin	284710

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	Tifanny Pereira	289149
	Lavinia Schlyter	284566
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	Goumaz Yannick	262414
	Cordey Loïc	258335
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	Chang Chun	322252
	Haohong Wang	323576
	Yexinlei Yang	331125
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	Matthias Franke	336222
	Mahmoud Said	309264
	Matthieu Ehlers	336217
11	Joachim Honegger	331126
	Cosme Jordan	275046
	Sepide Azhdari	309075
	Arthur Pochon	269765
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	Jonas Perolini	283887
	Utku Norman	292915
	Deblina Bhattacharjee	298265
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	Yujie He	321657
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	Nicola Santacroce	286331
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	Gaspard Besacier	283398
	Alexandre Clivaz	287897
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	Nicolas Marbot	275467
	Suermondt Xavier	273917
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	Marin Beaussart	292488
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	Titouan Renard	272257
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