Distributed Intelligent Systems

Course Project:

Multi-robot navigation in cluttered and dynamic environments

1.04.2021
Goal

- To implement multi-robot navigation strategies
  - Flocking
  - Formation

- For a multi-robot system
  - Group of e-puck robots

- In simulation
  - Webots
Environments

- Cluttered and dynamic:
  - Static obstacles
  - Different groups crossing each other

- Simplify: two individual scenarios:
  - Static obstacles
  - Different groups crossing each other
Scenario 1: Obstacles

- Maze with obstacles
- The group should be able to navigate around them and regroup
Scenario 2: group collision

- Arena
  - 2 groups
  - Each group starts at opposite ends
Project Phases

1. Localization techniques
   - Odometry
   - GNSS
   - Combo (Kalman filter)

2. Spatial coordination
   - Formation
   - Flocking
   - Study influence of parameters on the performance / Scalability of the group.

3. Parameter optimization
   - PSO (any variant)
Simulation

• Part 1- Localization
  • Open the world localization.wbt. The controller localization_controller contains two pre-programmed trajectories.
  • The provided code only makes the robot move along one of the two trajectories.
  • You should implement localization using
    – Odometry based on wheel encoders
    – Odometry based on accelerometer measurements + wheel encoders for heading
    – GPS only.
    – Kalman filter with GPS and odometry
  • Set GPS update interval is set to 1s (Don’t change it). Make sure your code accounts for this update rate.
Simulation

- Initial environment for the two scenarios

Scenario 1

Scenario 2

obstacles
group0
group1
group0
Ground rules

• No modifications in the simulation world
  – Check with a TA if needed
  – Any modification should be mentioned (e.g. number of robots)

• Use methods learned in the course
  – ex. Kalman filter, PSO, etc.

• Only distributed solutions
  – No communication from the supervisor

• Calculate metrics using the supervisor
  – Implement metrics in a supervisor
  – Statistics: multiple runs, different environments, etc.
Notes

• New environments
  – Feel free to make new worlds and test your methods, but only after it is done in the provided ones.

• Different parameters
  – Evaluate your method with different parameters will be appreciated (e.g. number of robots, localization technique)
Code Evaluation

• Performance evaluation
  – A test environment will be provided
  – The metrics will be calculated in a supervisor
Material to hand in

- **Report**
  - End of the semester
  - Details will be communicated later

- **Code and Webots files**
  - They will be checked by a TA for grading

- **Presentation**
  - Exam period
  - Details will be communicated later
Evaluation

• Initiative, commitment, autonomy, rigorousness (20%)

• Quality of the proposed solution (20%)

• Quantitative performance on distributed metrics, assessed after submission (20%)

• Quality of the report (30%)

• Teamwork (10%)
Assistant

• Last hour of each lab session
  – Please keep lab and project related questions in their respective times

• Discord
  – Voice channels are to communicate with a TA during the project assistance hour.
  – Text channel is for out of hour questions. Feel free to help each other out.
  – The TAs will only answer to the text channel questions according to their availability.
  – No personal assistance is provided outside the lab/project.
QUESTIONS?