Distributed Intelligent Systems

Course Project:

Multi-robot navigation in cluttered and dynamic environments

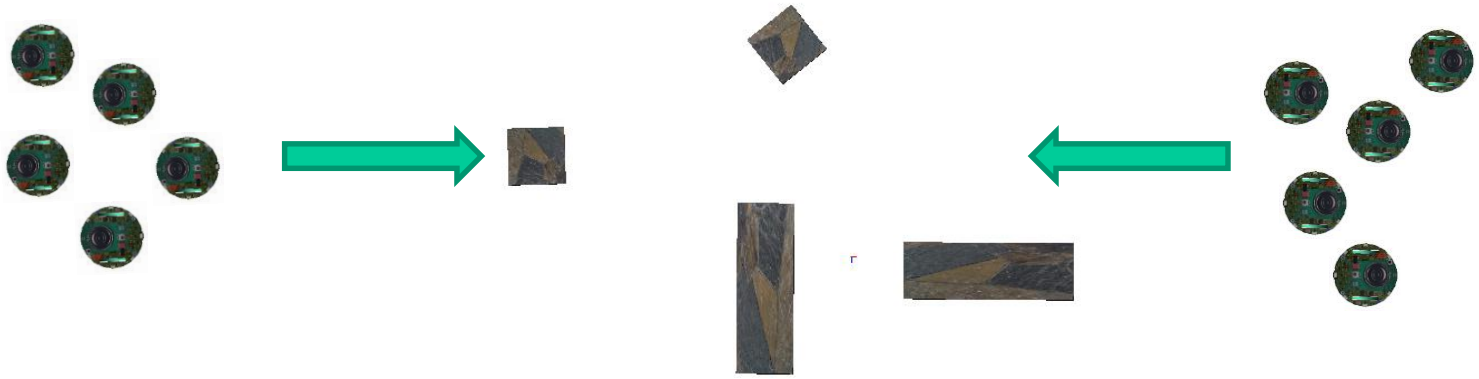
1.04.2021

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:



- 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)

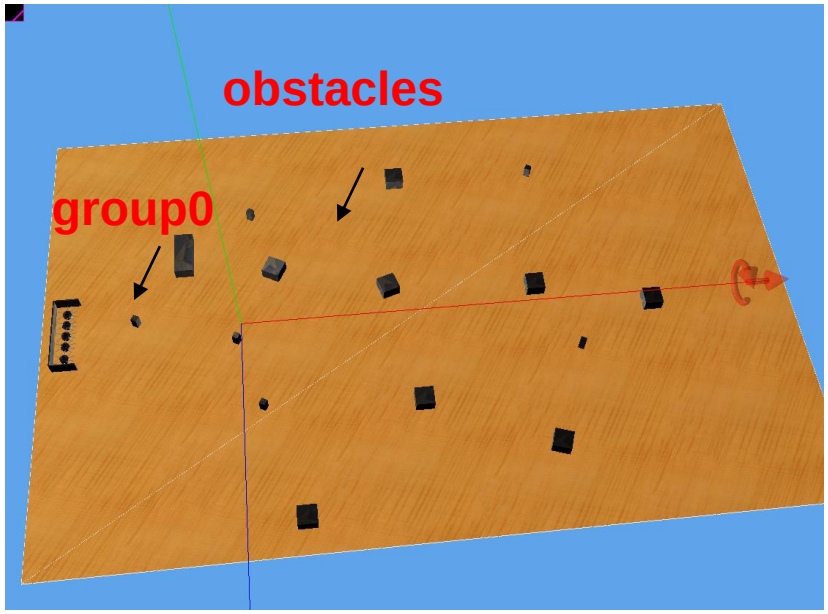
Simulation

- 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.

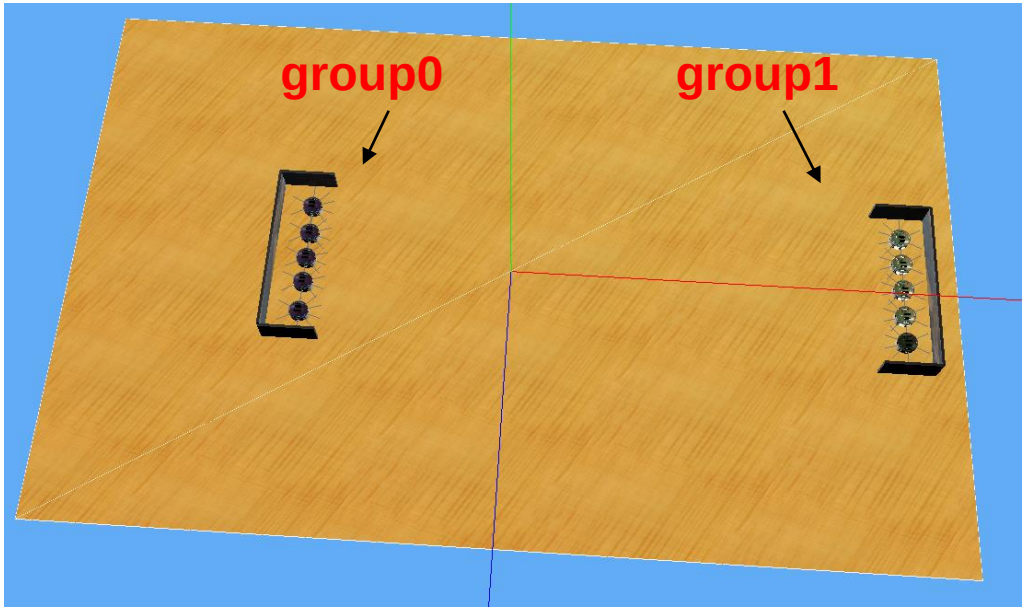
Simulation

- Initial environment for the two scenarios

Scenario 1



Scenario 2



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%)

Assistance

- 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?