Course project presentation

Multi robot navigation in cluttered and dynamic environments

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Presentation overview

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1. Introduction
1. Introduction

Two main parts:

1. Simulation on Webots
2. Real world experiment

Using e-puck robots
2. Strategies implemented
2.1 Reynolds’ rules

**Alignment:** attempt to match velocity (speed and direction)

**Cohesion:** attempt to stay close to nearby flockmates

**Separation:** avoid collisions with nearby flockmates
2.2 Braitenberg neural network for obstacle avoidance

Neurons with 16 connections in total

https://en.wikipedia.org/wiki/Braitenberg_vehicle
Neural network picture taken from course 4 of Prof Martinoli
2.3 Metrics used to assess the performance

\( o[t] \): orientation metric
\( c[t] \): cohesion metric
\( v[t] \): velocity metric

\[ p[t] = o[t] \cdot c[t] \cdot v[t] \]
\[ p_{\text{overall}}[t] = \sum p[t] / t \]
2.4 Specific improvements:

General performance
- Absolute migratory urge adaptation
- Local migratory urge adaptation

Obstacle avoidance situations
- for the crossing
- for non-moving objects
2.4 Specific improvements:

- Absolute migratory urge adaptation
2.4 Specific improvements:

- Local migratory urge adaptation
2.4 Specific improvements:

- Obstacle avoidance
3. Simulation results
3.1 Provided maps
3.2 Two additional maps
Some metric values from the four maps stated before
4. Real World Experiment Results
4.1 Differences with simulation

- Selector of the e-pucks as Robot ID
- Get neighbor’s selector when communication successful
- Flock Crossing: only consider own’s flock selectors
- Use agendas to coordinate the actions and compute relative speed
- Calibration of IR sensors

Reynolds Rules:
- Divide migration weight by 8
- Initial forward speed

Braitenberg:
- Matrix weights adapted to fit on real robots:
  \{-10, -10, -5, 3, 3, 5, 10, 10, 10, 10, 5, 3, 3, -5, -10, -10\}
- Smaller Threshold for obstacle avoidance: 50
4.2 Main Results

- Single Robot:
  - Good obstacle avoidance + Migration

- Several Robots:
  Issues:
  - Hard to progress as a flock
    - Consider robots within the flock as obstacles
    - Lose communication
4.3 Improvements

- Increase cohesion and reduce dispersion rules
- Decrease influence of Braitenberg weights
- Increase obstacle avoidance threshold
- Assign single role to robot with selector: sender or receiver
- Leader/Follower approach may work better
5. Conclusion
5. Conclusion

- Simulation on Webots
- Simulation vs real world
  - Different challenges
  - Improvements
Questions ?