Multi-robot navigation in cluttered and dynamic environments

Baltus Terry, Douce Louis-Nicolas and Feyz Sepand
Purpose and general introduction

Our purpose was to implement a formation control collective movement strategy into real e-pucks and test and assess its robustness and performances within complex environments.

Chosen collective movement strategy: **Formation control**
Webots Simulation
Performance metrics

\[ o[t] = \frac{1}{N} \left| \sum_{k=0}^{n} e^{i\psi_k[t]} \right| \]

\[ c[t] = \left( 1 + \frac{1}{N} \sum_{k=0}^{n} \text{dist}(x_k[t], \bar{x}[t]) \right)^{-1} \]

\[ v[t] = \frac{1}{v_{max}} \max\left( \text{proj}_\Phi(\bar{x}[t] - \bar{x}[t-1], 0) \right) \]

Orientation between robots
Distance between robots
Velocity of the team towards the goal direction
A first object (after 7 sec) is encountered and where followers turn around and form the desired formation. Once the formation is formed, a second (after 19 sec), third (after 38 sec), fourth (after 64 sec) and fifth (after 74 sec) object are sequentially encountered before the e-pucks exit the world.

Controller very robust in regards to distance metrics. Reasonable in orientation and speed metrics.
World: Crossing

Figure above shows that our controller provides poor robustness in speed performance during collision but keeps a good overall orientation (especially for team 1). The collision happens after 15 seconds. Most importantly after the collision each team reaches back to their formation.
Conclusion

Simulation
- Goals are achieved
- Robust migratory urge and leader follower
- Issues with PSO on simulation, unoptimized Braitenberg values
- Satisfying metrics results

Real Robots
- Excellent behaviour
- Robust communication migratory and migratory urge
- Suboptimal Braitenberg
Questions?