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# Social awareness in multi-robot systems – An institutional approach to robotic formations

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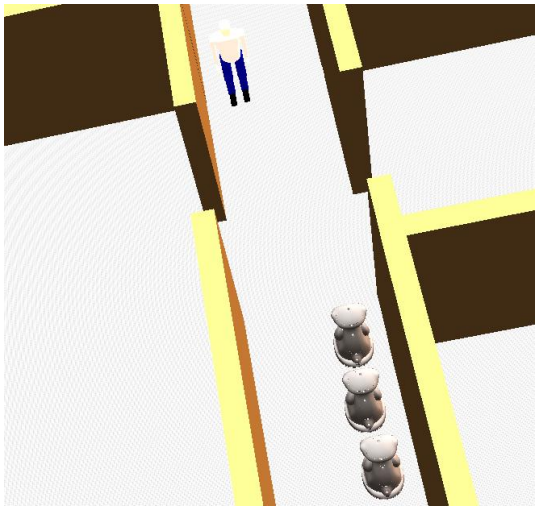
This project approached many different topics in robotics: formation control, human-aware navigation and Institutional Robotics. While the first two topics are well-known and have been studied for a long time, but IR is a novel concept: in Institutional Robotics, Institutions are a part of the environment that all agents share and have to take into account to evolve in it.

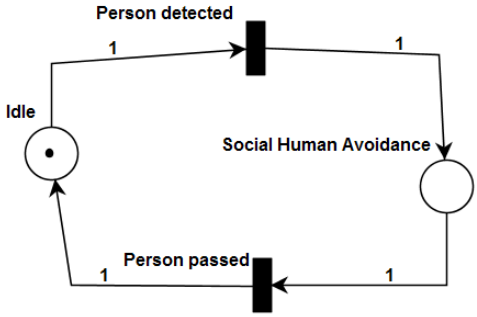
Using MOnarCH robots running the Robot Operating System (ROS), the goal of this project was to design and test a robot controller that would take these three topics into account: using Institutions, make a robot formation evolve adequately in a human-populated environment.



*The corridor-case scenario.*

In the existing formation control code, robots were doing Laplacian control. After analyzing the existing formation control code and the possible situations, I chose a scenario that would be simple enough to test my controller, but also complex enough to see its limits: the corridor-case scenario. In this scenario, the robotic formation has to go along a corridor to go in another room for some reason, and encounters a human going across its trajectory. How should the robots behave? Can they cross safely?

From this scenario, I listed a set of rules that the robots had to respect and a way to make the formation adaptive to the different possibilities (corridor width, distance to the person etc.). To design such an Institutional Controller, I used a high-level representation of my Institutional controller in the form of a Petri Net. Petri Nets are a good way to represent the chain of actions each Institution implies, and also the interactions between different Institutions. Thus, the robots' behavior changes when certain conditions in the environment change.




*The higher layer of the Petri Net Controller*

Tests were directed on Webots, a realistic robotic simulator, using MOnarCH robots and very basic human models (simple Braitenberg) in different variations of this corridor-case scenario (wide corridor, narrow corridor, crossing corridors…). To measure performance, robots needed to accomplish two things: maximize the distance to the person that the robot formation crosses, and minimize the formation error (real robot positions vs. the position they should be according to Laplacian control).

This controller is quite simple and still needs to be improved, but the results are promising. The robots avoid the person and return on their original direction quite smoothly. The simulated human is also not perfect and can be often unpredictable. Tests on real robots were not conducted, but would have been a great complement to this project.