Distributed Formations With Non-Cooperative Human Agents

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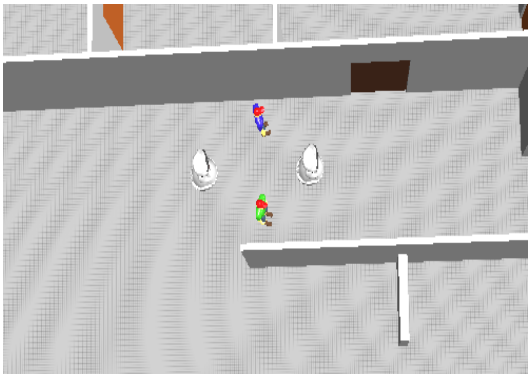
Navigation of mixed formations of humans and robots will become more and more important, as robot will be able to automatize guidance application, in a museum for example. Graph-based control is an efficient way of controlling a formation like that, since it allow a distributed control of the robots and, by adding the humans in the graph, the robots will respond to their behavior. The robots will first arrive to a consensus to reach a common point in space, and then via the addition of bias, they will be able to create a formation. Then they will be aware of the human's presence and adapt their behavior to human movement. The human motion will be modelled according to the social force model developed by Helbing. The robots will have to make sure the humans stay in the formation and, if it is not the case, prevent any escaping, while still assuring a safe interaction.



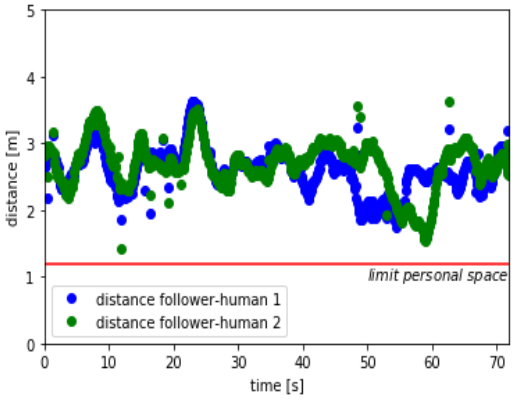
Mixed formation with two robots and two humans

Implementation and testing of different methods will be done with ROS (Robot Operating Software) and with the robot simulator Webots, using Mbot robots.

The leader's main objective will be to reach a certain destination, but, at the same time, assuring that the humans are following it. On the other hand, the follower main job will be to make sure the humans are behaving correctly by staying close to the leader, while having a safe behavior towards the humans, not entering their personal space, for example. We will have to find a compromise between an efficient shepherding of the humans and a non-threatening behavior, so the humans will accept be in a mixed formation.

The leader will mainly focus on the position of the human's center of gravity, the average on their position, and slow down if they are not following it close enough. The follower will look for any attempt of escape from the humans and will repress this behavior by change its bias to a new one closer to the human in order to push him/her back behind the leader.

In order for the follower to avoid entering the human personal space, a zone with a radius of 1.2 meter around the human, we will add the humans in the graph-base formation, so, with a repulsive edges, we will create a repulsive field around the humans.



Distance between the follower and the two humans

We compare the implementation of those methods thanks to relevant metrics, that measure how close the group of human is to the leader and how aggressive the follower's behavior is, by looking at the distance human-follower.