A Novel Framework for Multi-Agent Navigation in Human-Shared Environments

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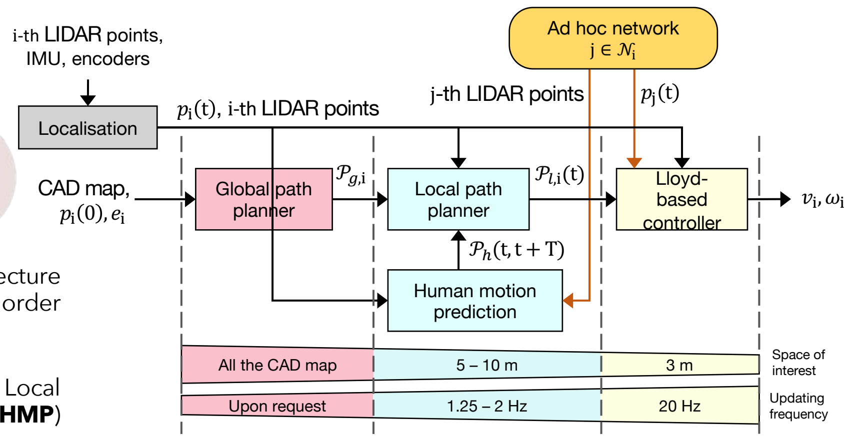
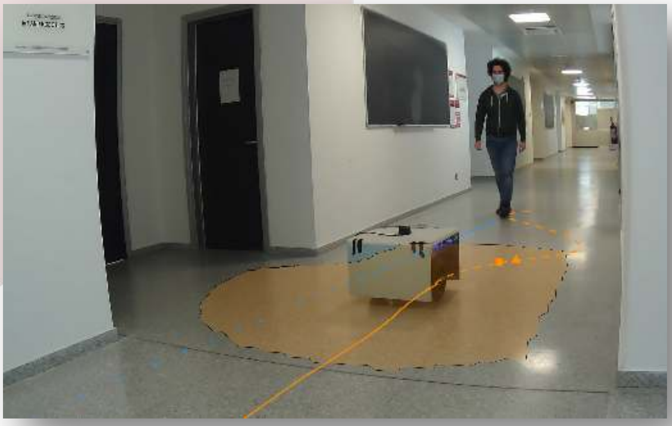
We define five requirements for robots navigation in human-shared environments:

R1: Robustness and safety in navigation.
R2: Socially-aware motion planning.
R3: Multi-agent coordination.
R4: Dynamic environment.
R5: Computation efficiency.

Our proposal [1] identifies a hierarchical architecture composed by three layers that work together in order to satisfy the requirements **R1** - **R5**.

We called the layers: Global path planner (**GPP**), Local path planner + Human motion prediction (**LPP-HMP**) and Lloyd-based controller (**LB**) .



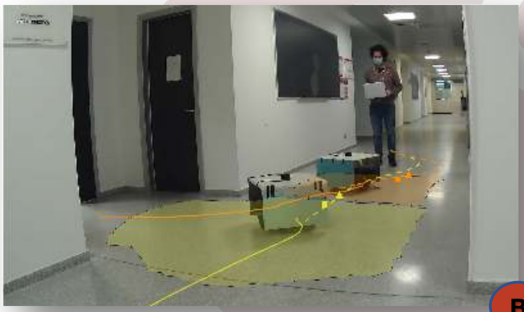


We depict a scenario where the i-th robot detects the human being presence and act consequently.

- The **GPP** computes a path $\mathcal{P}_{g,i}$ accounting for the CAD map, starting from $p_i(0)$ towards the final goal position e_i (at the end of the corridor);
- The **HMP** computes the future human path $\mathcal{P}_h(t, t+T)$ (blue asterisks);
- The **LPP** generates $\mathcal{P}_{l,i}(t)$ (dashed orange line);
- The **LB** generates its "safe zone" (orange area) and computes v_i, ω_i based on the information from the upper layers.

The triangle point is the information that the **LB** receives from the **LPP**, the square point is the one that the **LB** computes and decides to follow. The solid orange line depicts the past followed path.

A



B

Second scenario with multi-agent robots and a static human being.

- The **GPP** generates the paths $\mathcal{P}_{g,i}$ at the beginning of the mission (*Figure A*: dashed yellow and orange lines);
- The **LPP** generates $\mathcal{P}_{l,i}(t)$ for the two agent (*Figure* B: dashed yellow and orange lines; the solid yellow and orange lines are the past followed paths).
- The **LB** takes into account also the presence of the other robots and modifies accordingly its safe region (*Figure B*: yellow and orange areas). Then it computes v_i, ω_i based on the information from the upper layers.

[1] M. Boldrer, A. Antonucci, P. Bevilacqua, L. Palopoli, and D. Fontanelli, "Multi-agent navigation in human-shared environments: a safe and socially-aware approach," *Robotics and Autonomous Systems*, Submitted.

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