Hey Robot! Personalizing Robot Navigation through Model Predictive Control with a Large Language Model

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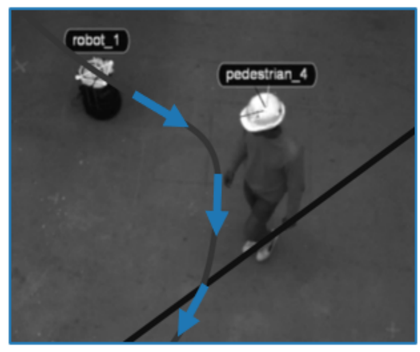
Hey Robot!
Go to the goal!

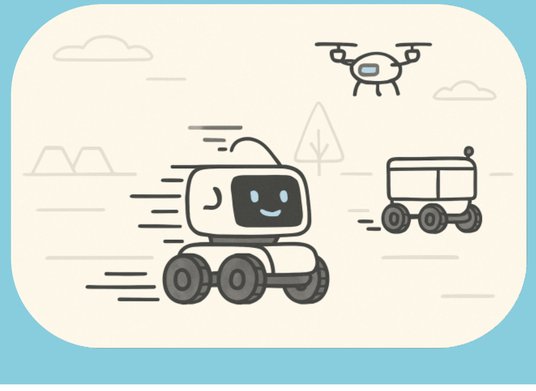


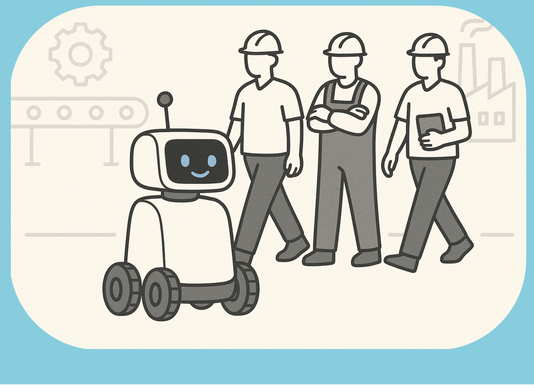
Hey Robot!
Follow the closest Person!

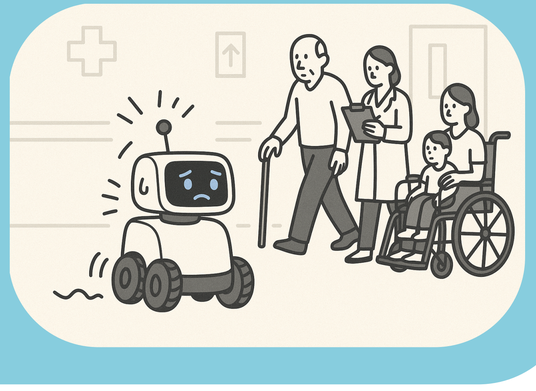
Hey Robot!
Keep a safe distance!

MOTIVATION

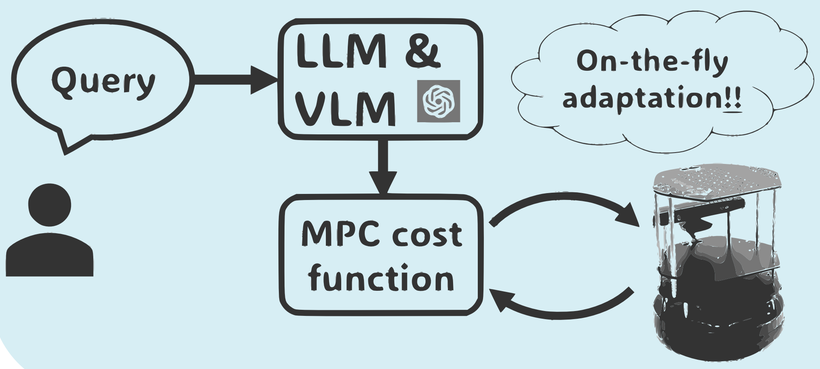
The robot should adapt its behavior depending on the scenario requirements and end-user preferences while keeping the collision avoidance guarantees.







OVERVIEW



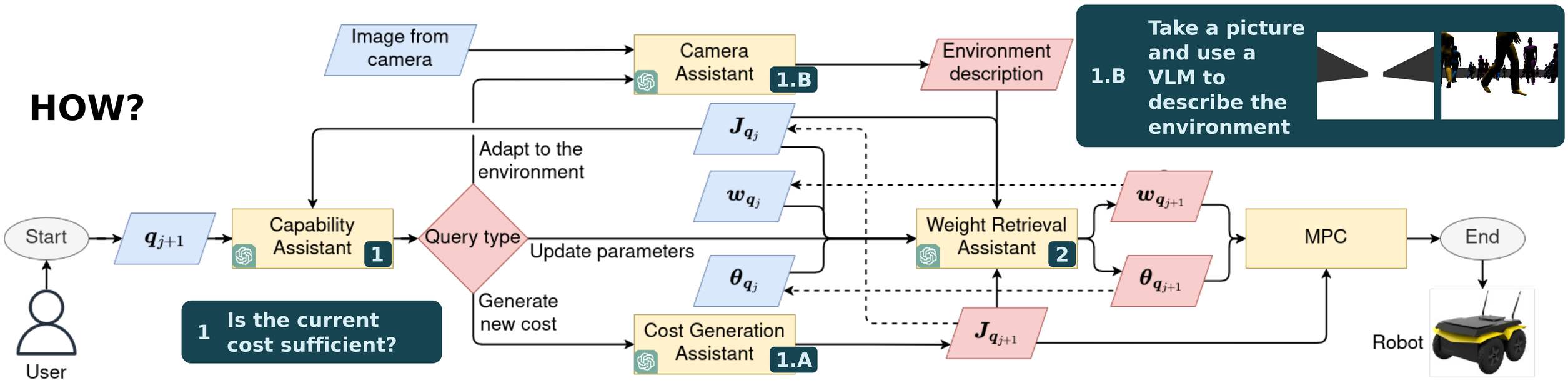
The LLM directly generates Python code for the cost function and tunes its weights and parameters

$$\min_{\boldsymbol{x}\in\mathbb{X},\boldsymbol{u}\in\mathbb{U}} \sum_{k=0}^{N_k} J_{\mathbf{q}_j}(\boldsymbol{x}_k, \boldsymbol{u}_k, \boldsymbol{w}_{\mathbf{q}_j}, \boldsymbol{\theta}_{\mathbf{q}_j})$$

The constraints remain unchanged

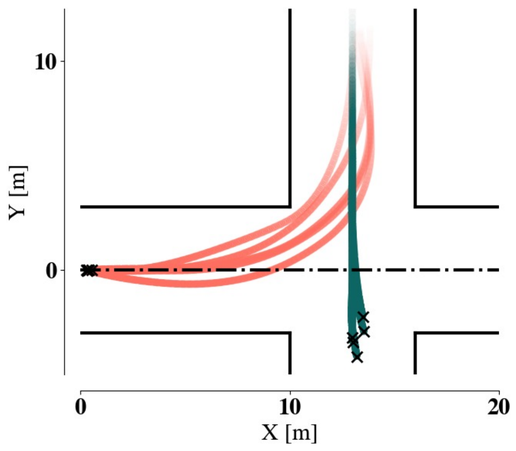
$$\begin{aligned} \text{s.t.} \quad & \boldsymbol{x}_{k+1} = f(\boldsymbol{x}_k, \boldsymbol{u}_k)\ \forall k, \\ & \boldsymbol{x}_0 = \boldsymbol{x}_{init}, \\ & g(\boldsymbol{x_k}, \boldsymbol{\theta}_k) \leq 0\ \forall k. \end{aligned}$$

HOW?

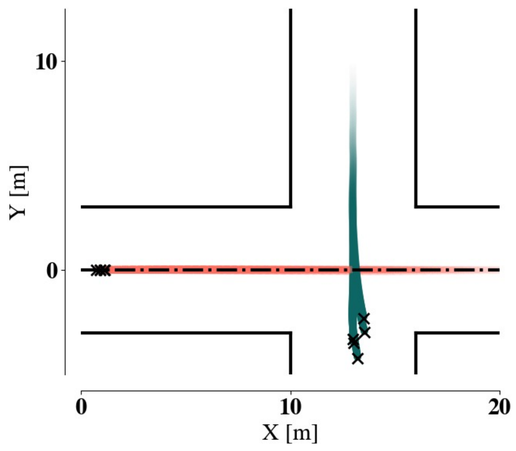


RESULTS

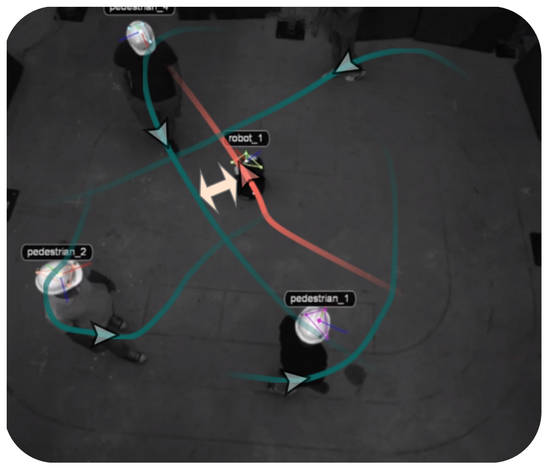
In a crowded corridor-like scenario, the robot must follow a reference path with the following additional queries	Col. rate	Dur. [s]	Path len [m]	Min Dist. [m]	v [m/s]	a [m/s^2]	ω [rad/s]
a) (No other queries)	**0.00**	14.1 (0.8)	34.99 (0.32)	0.22 (0.04)	2.49 (0.12)	0.51 (0.09)	0.18 (0.04)
b) Drive quickly.	**0.00**	**13.7** (1.1)	34.77 (0.42)	0.19 (0.06)	**2.56** (0.17)	0.59 (0.14)	0.18 (0.05)
c) Drive carefully.	**0.00**	24.1 (0.7)	33.30 (0.20)	0.15 (0.04)	**1.38** (0.04)	0.13 (0.05)	**0.05** (0.02)
d) You are navigating through a factory without humans.	**0.00**	13.8 (0.8)	35.03 (0.57)	0.33 (0.05)	2.55 (0.12)	0.56 (0.09)	0.20 (0.07)
e) You are navigating through a hospital.	**0.00**	23.6 (0.9)	33.28 (0.11)	0.25 (0.06)	1.41 (0.05)	**0.10** (0.05)	**0.05** (0.02)
f) Try to keep a distance of at least 1.5m from pedestrians.	**0.00**	19.8 (5.6)	**31.09** (6.75)	**1.16** (0.20)	1.74 (0.59)	0.38 (0.17)	0.16 (0.06)



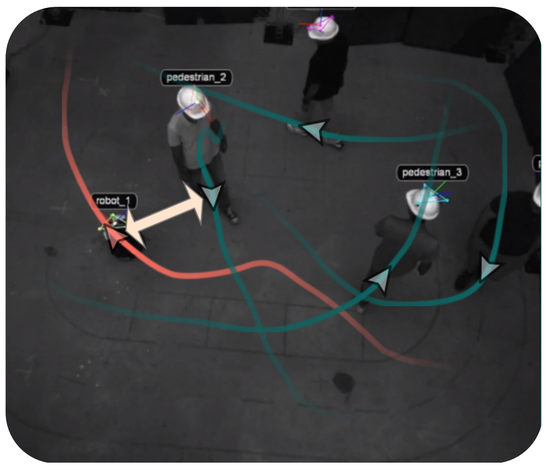
Follow the closest person



Follow the reference path



Go to the goal



Increase distance to people

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