



Universidad
Zaragoza

MPC Trajectory Tracking for Drone Navigation

AROB Final Assignment

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MRGCV

Escuela de Ingeniería y Arquitectura

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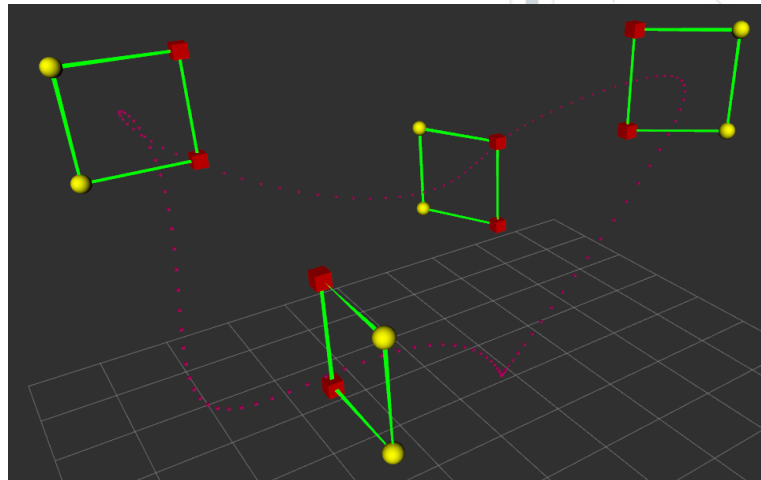
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AROB Final Assignment

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Model Predictive Control (MPC)

- ⊙ **Control strategy for dynamic systems**
- ⊙ **Optimize control actions**
- ⊙ **Predict future over a lookahead horizon**



Designed dartboard target



Algorithm description

◎ **System dynamics:** $x_{k+1} = x_k + \Delta t \cdot u_k$

◎ **Cost function:** $J_k(x_k, u_k) = \sum_{i=k}^{k+N} [w_{\text{position}} \cdot (x_i - x_i^*)^2 + w_{\text{smooth}} \cdot (u_i)^2]$

◎ **Control constraints:** $x_k \in X$; $u_{\min} \leq u_{k+i} \leq u_{\max}$



Implementation details

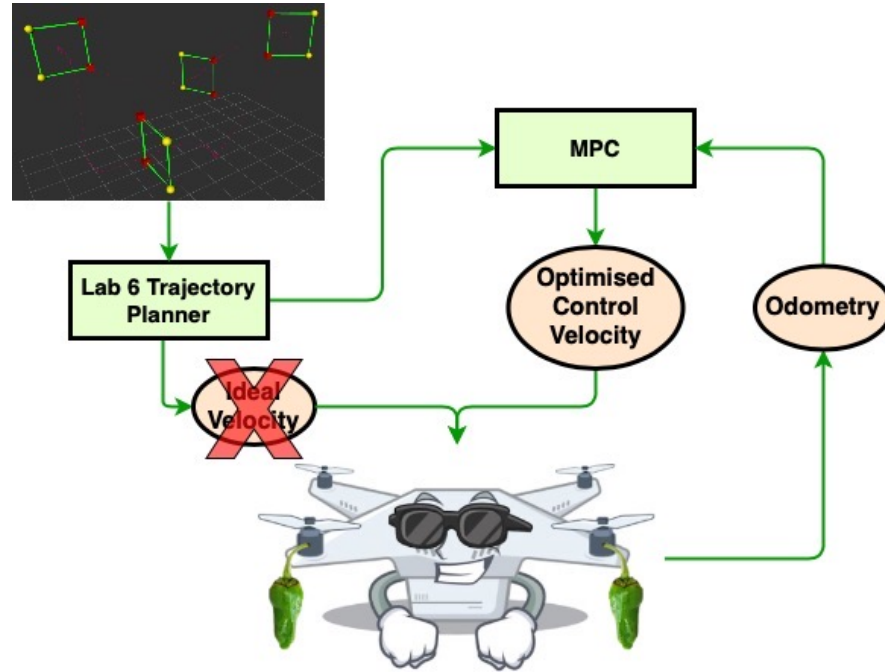
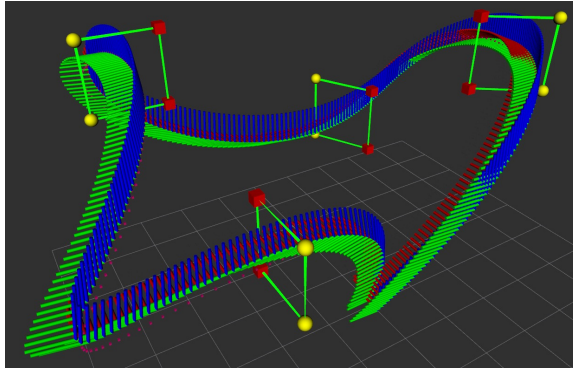


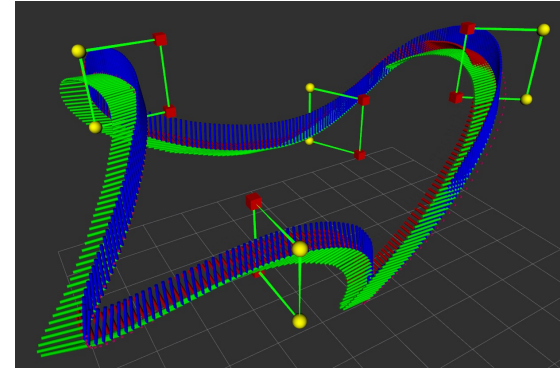
Illustration graph of the quadrotor control system



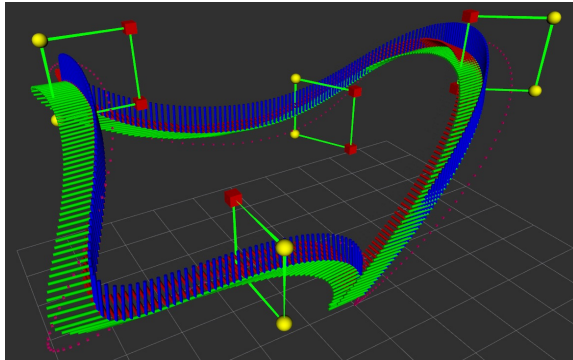
Experimental results



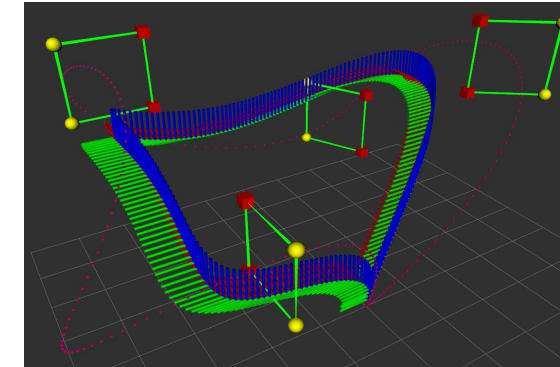
No MPC



$(0.75 - 0.25)$



$(0.5 - 0.5)$



$(0.25 - 0.75)$

$(w_{position} - w_{smooth})$



Experimental results

(w_pos - w_v)	Error[m]	Step error[m]	Vel error[m/s]	Time[s]
No MPC	8.0889	0.0326	7.0613	24.9368
(0.75 - 0.25)	2.4091	0.0194	5.3150	24.9397
(0.5 - 0.5)	5.8632	0.0469	7.6018	25.1042
(0.25 - 0.75)	10.6128	0.0964	9.7271	25.4176

Weights comparison results

Max velocity	Error[m]	Step error[m]	Vel error[m/s]	Time[s]
1	31.4173	0.1415	15.5301	45.7745
1.5	6.7631	0.0430	8.1169	31.1102
2	2.4091	0.0194	5.3150	24.9397
2.5	2.5891	0.0223	8.1924	22.9216

Maximum velocities comparison results



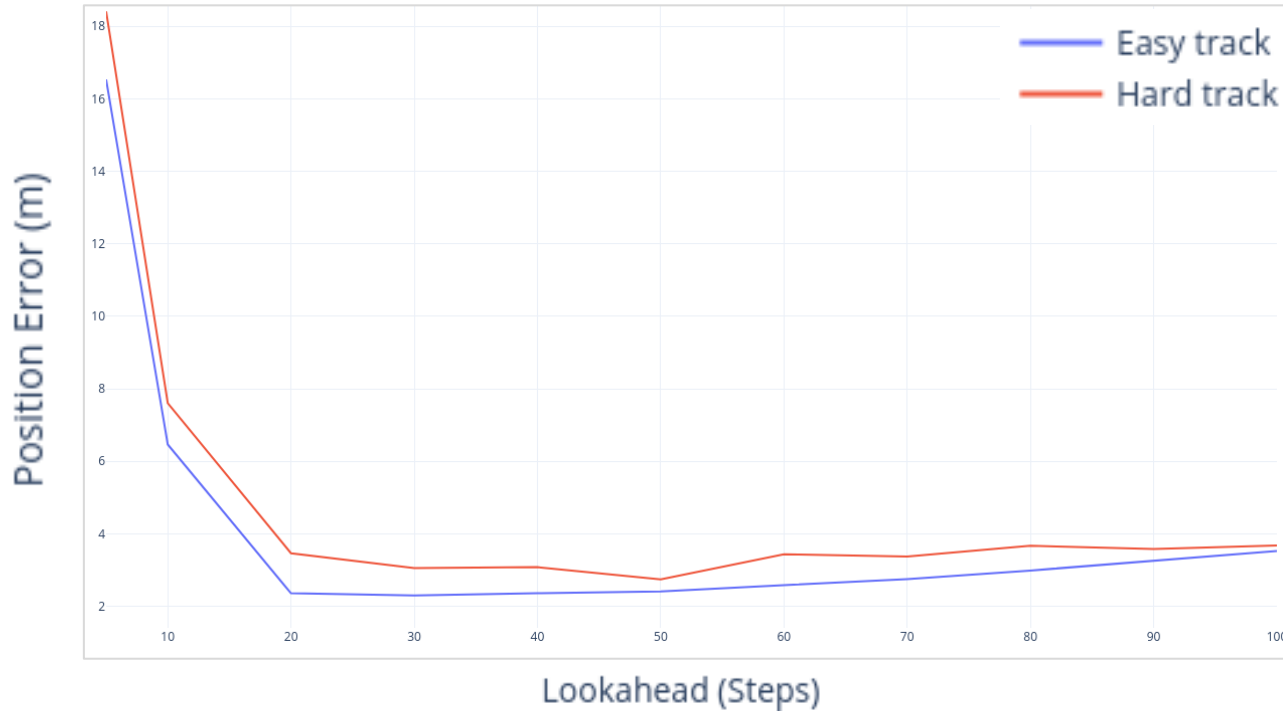
Experimental results

Lookahead [steps]	Error[m]	Step error[m]	Vel error[m/s]	Time[s]
20	2.3572	0.0155	9.1086	24.7955
40	2.3564	0.0166	8.3000	24.9747
60	2.5812	0.0222	4.7674	24.9378
80	2.9517	0.0298	4.7724	24.9691
100	3.5227	0.0424	6.8287	24.4751

Lookahead steps comparison results



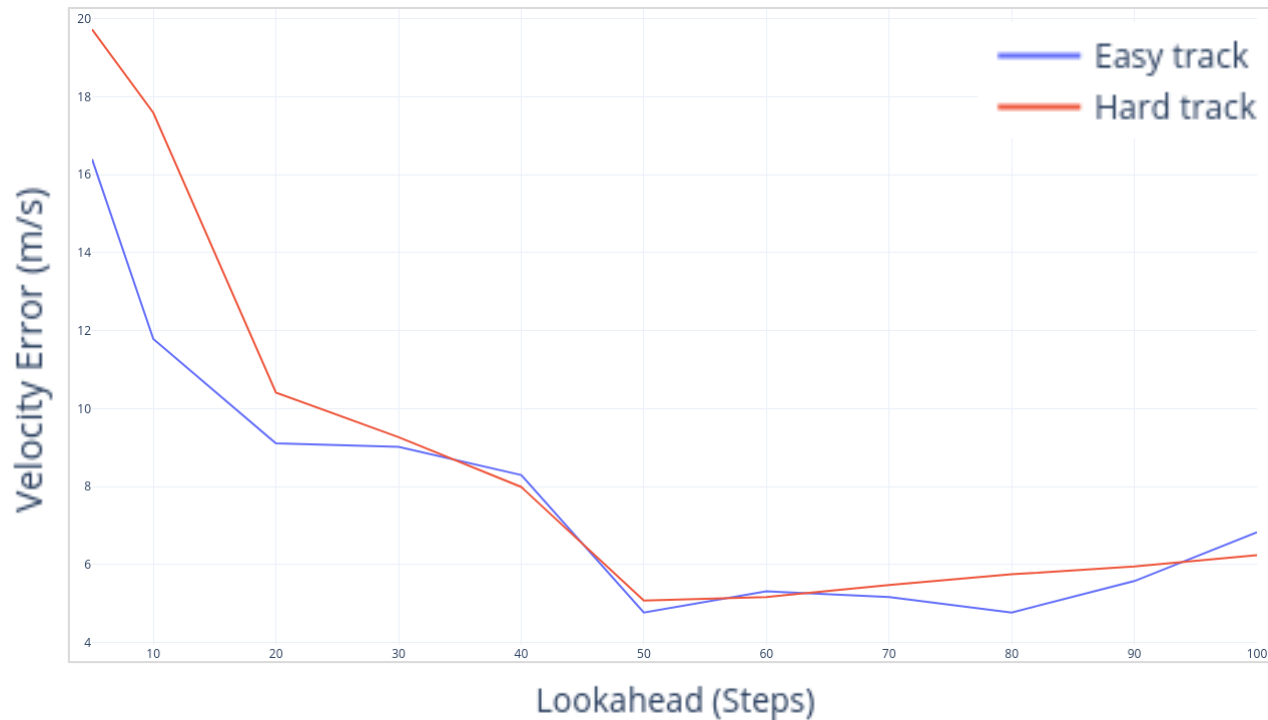
Experimental results



Position error through lookahead timesteps



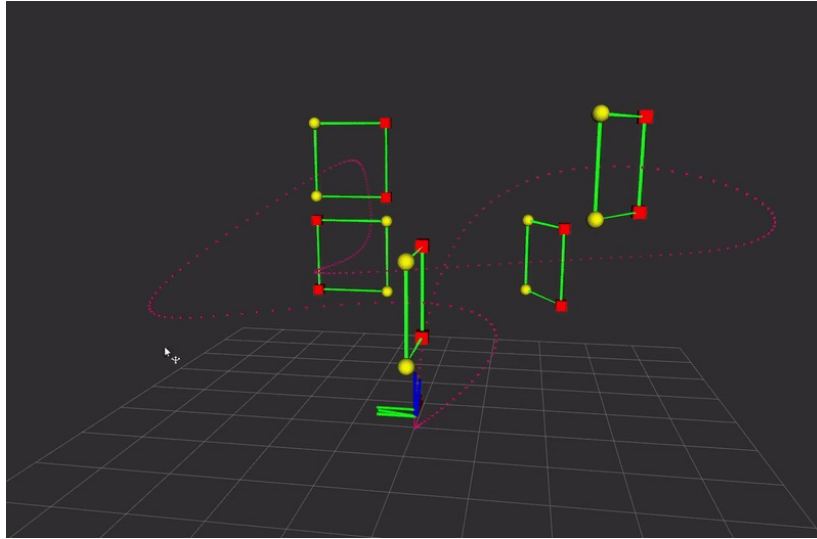
Experimental results



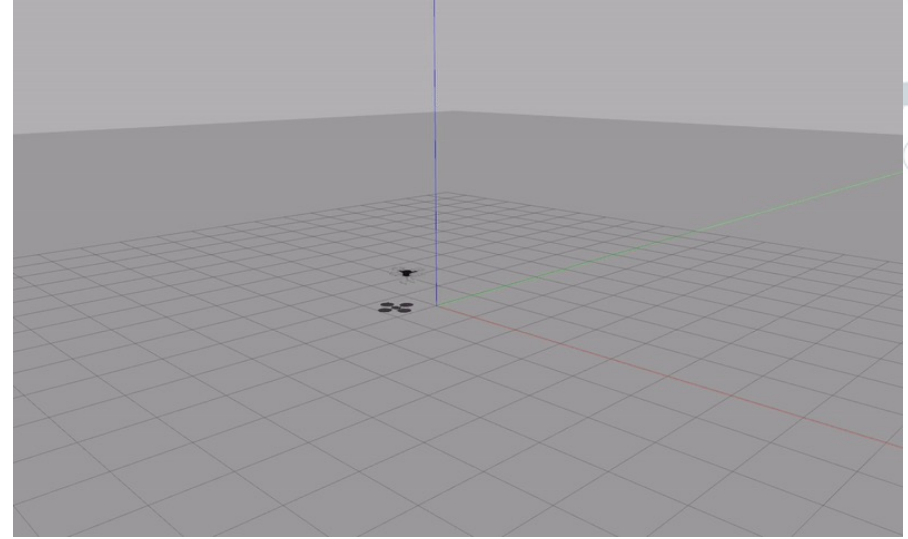
Velocity error through lookahead timesteps



Experimental results



Hard gates circuit simulation (RVIZ)



Hard gates circuit simulation(Gazebo)

