From the trajectory servoing control design in §II.C

$$\omega = \boldsymbol{L}^2(\boldsymbol{q}^{\mathcal{C}}, \boldsymbol{s})^{\dagger}\left(\boldsymbol{L}^1(\boldsymbol{q}^{\mathcal{C}^*}(t), \boldsymbol{s}^*(t))\nu^*(t) - \boldsymbol{L}^1(\boldsymbol{q}^{\mathcal{C}}, \boldsymbol{s})\nu + \boldsymbol{L}^2(\boldsymbol{q}^{\mathcal{C}^*}(t), \boldsymbol{s}^*(t))\omega^*(t) - \lambda \boldsymbol{e}\right), \quad (1)$$

there is a control gain $\lambda$ affecting the tracking performance. We perform a set of simulations to tune the control gain that can give the best performance. Five evaluation metrics: average lateral error (ALE), terminal error (TE), normalized path difference area (NPDA), angular normalized control effort (ANCE) and angular control smoothness (ACS). The outcomes in the following tables are the averages over all trajectory templates. The details about how to obtain these metrics can refer to another supplemental material in the same directory.

# 1 Short distance trajectory servoing

In Table.1, the first three rows evaluate the accuracy of trajectory tracking. The last two imply the performance of control signal. When $\lambda = 7$, the tracking accuracy is the best. Angular control effort has similar value to the lowest. The higher the control gain is, the less smoothness it has. Therefore, for short distance trajectory experiments, we chose $\lambda = 7$ to obtain the best accuracy and slightly sacrifice smoothness.

Table 1: Control gain $\lambda$ tuning over short distance trajectories

| $\lambda$ | 1 | 3 | 5 | **7** | 9 | 11 |
|---|---|---|---|---|---|---|
| **ALE** | 3.19 | 1.21 | 1.48 | **0.96** | 1.38 | 1.13 |
| **TE** | 5.85 | 2.86 | 3.18 | **2.40** | 2.98 | 2.69 |
| **NPDA** | 2.56 | 0.93 | 1.13 | **0.74** | 1.03 | 0.82 |
| **ANCE** | 0.06 | **0.06** | 0.07 | 0.07 | 0.12 | 0.13 |
| **ACS** | **0.464** | 0.644 | 0.903 | 1.265 | 1.753 | 2.208 |

# 2 Long distance trajectory servoing

From Table 2, we process the same procedure as previous section to tune the control gain for long distance trajectory servoing. $\lambda = 5$ is chosen.

Table 2: Control gain $\lambda$ tuning over long distance trajectories

| $\lambda$ | 1 | 3 | **5** | 7 | 9 | 11 |
|---|---|---|---|---|---|---|
| **ALE** | 11.18 | 10.20 | **4.52** | 5.02 | 9.74 | 10.26 |
| **TE** | 16.50 | 15.41 | **8.23** | 8.89 | 14.95 | 15.30 |
| **NPDA** | 14.54 | 12.08 | **5.94** | 6.22 | 10.52 | 10.67 |
| **ANCE** | 0.04 | 0.04 | **0.04** | 0.04 | 0.05 | 0.05 |
| **ACS** | **0.209** | 0.377 | 0.565 | 0.774 | 0.981 | 1.193 |