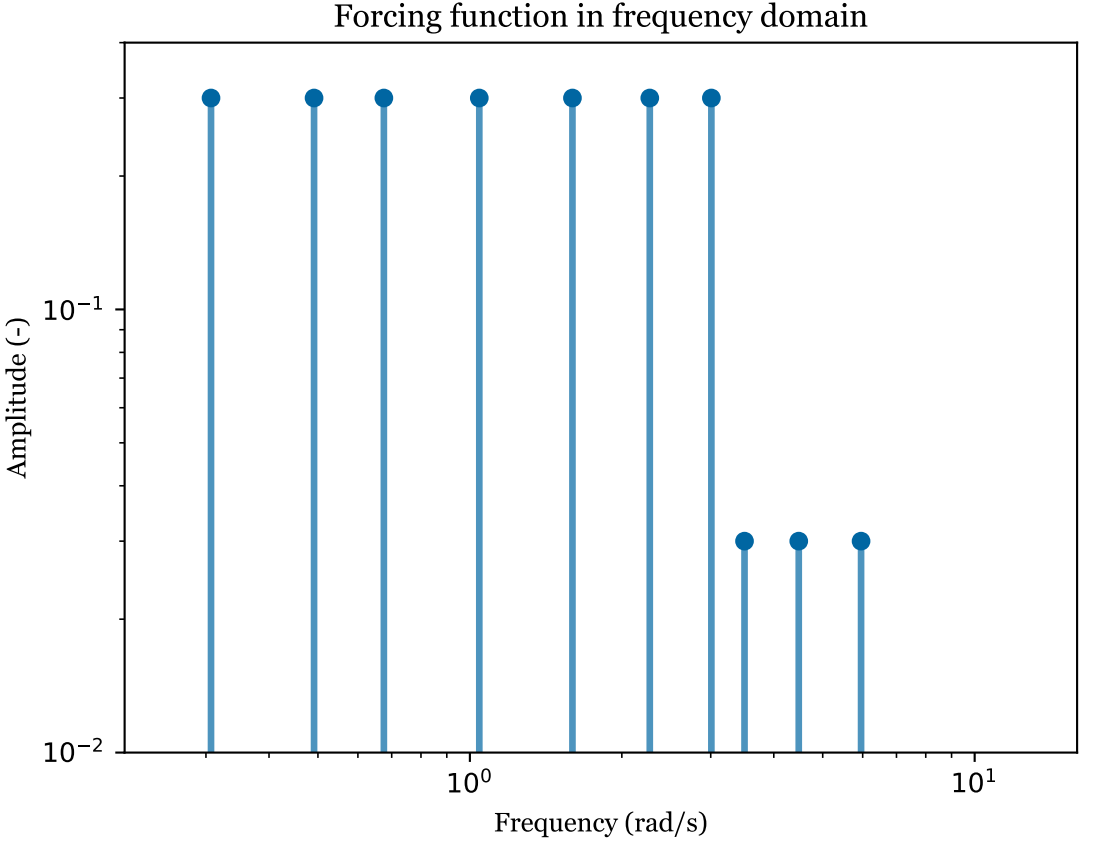
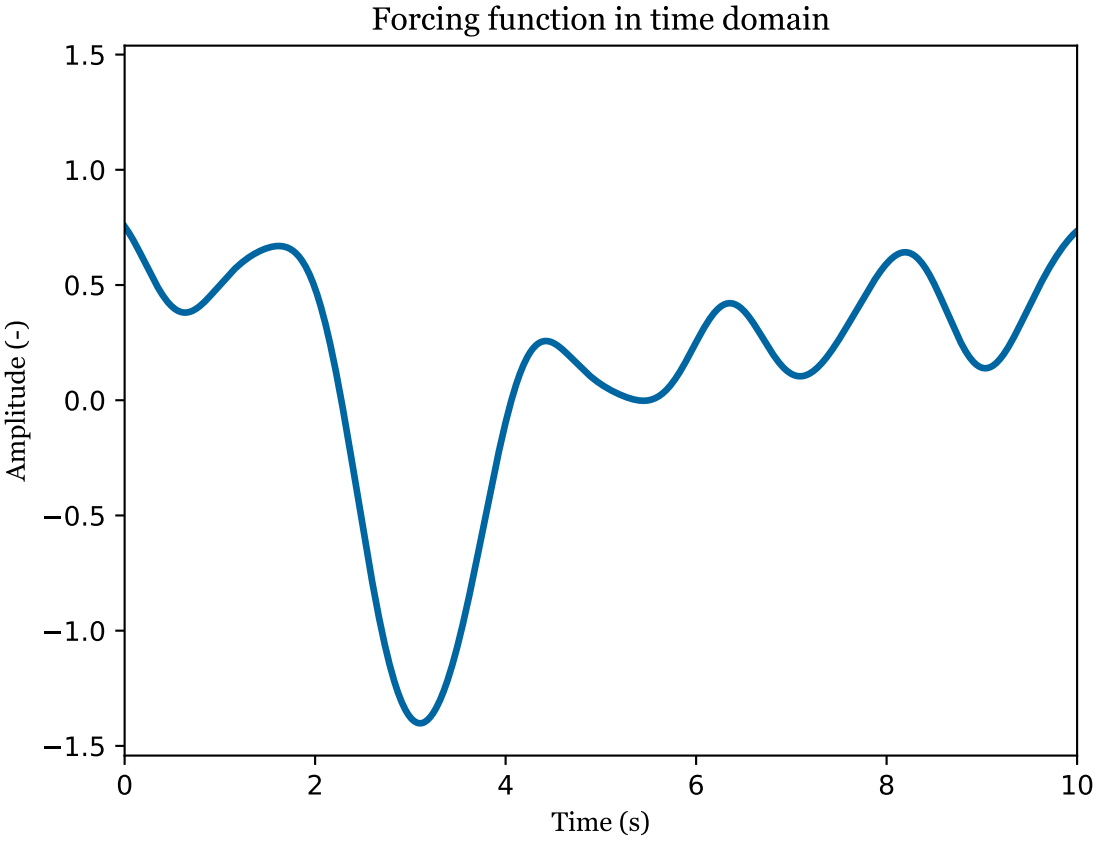
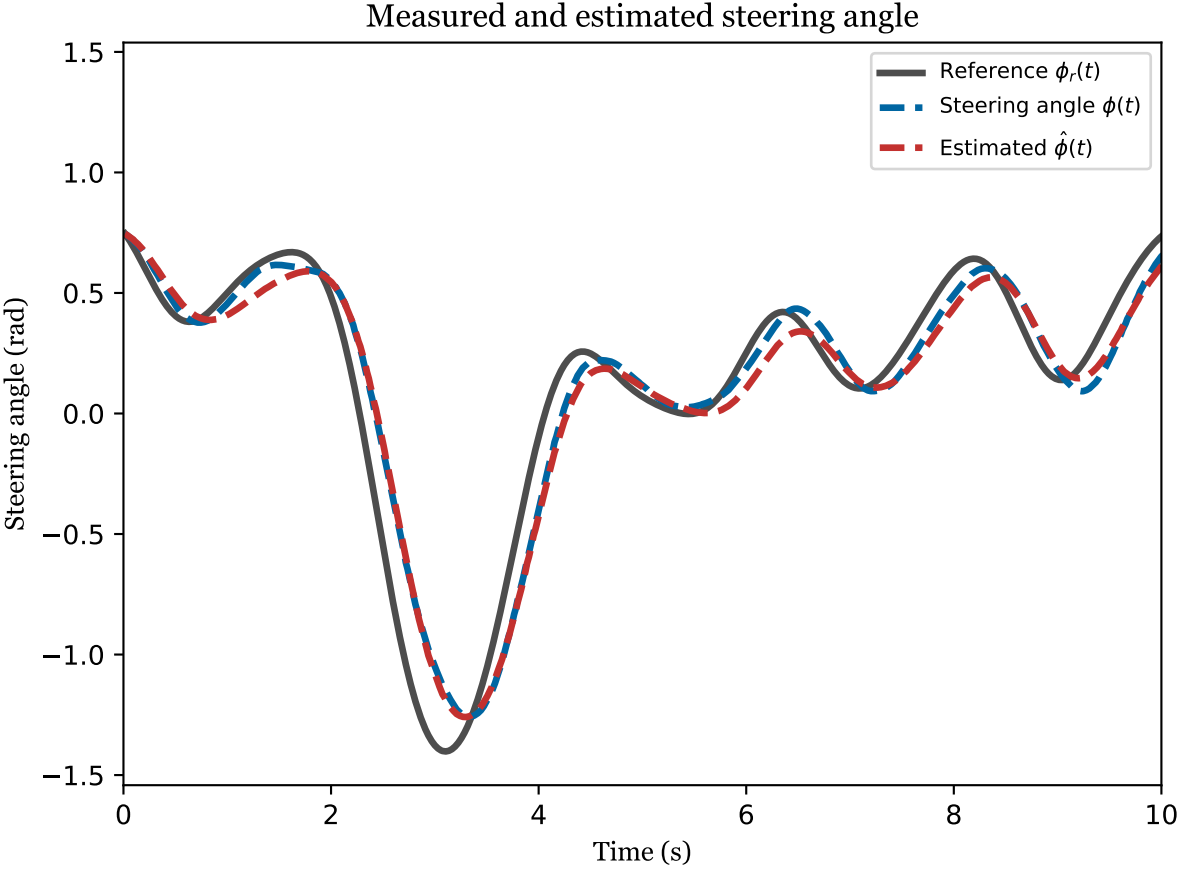
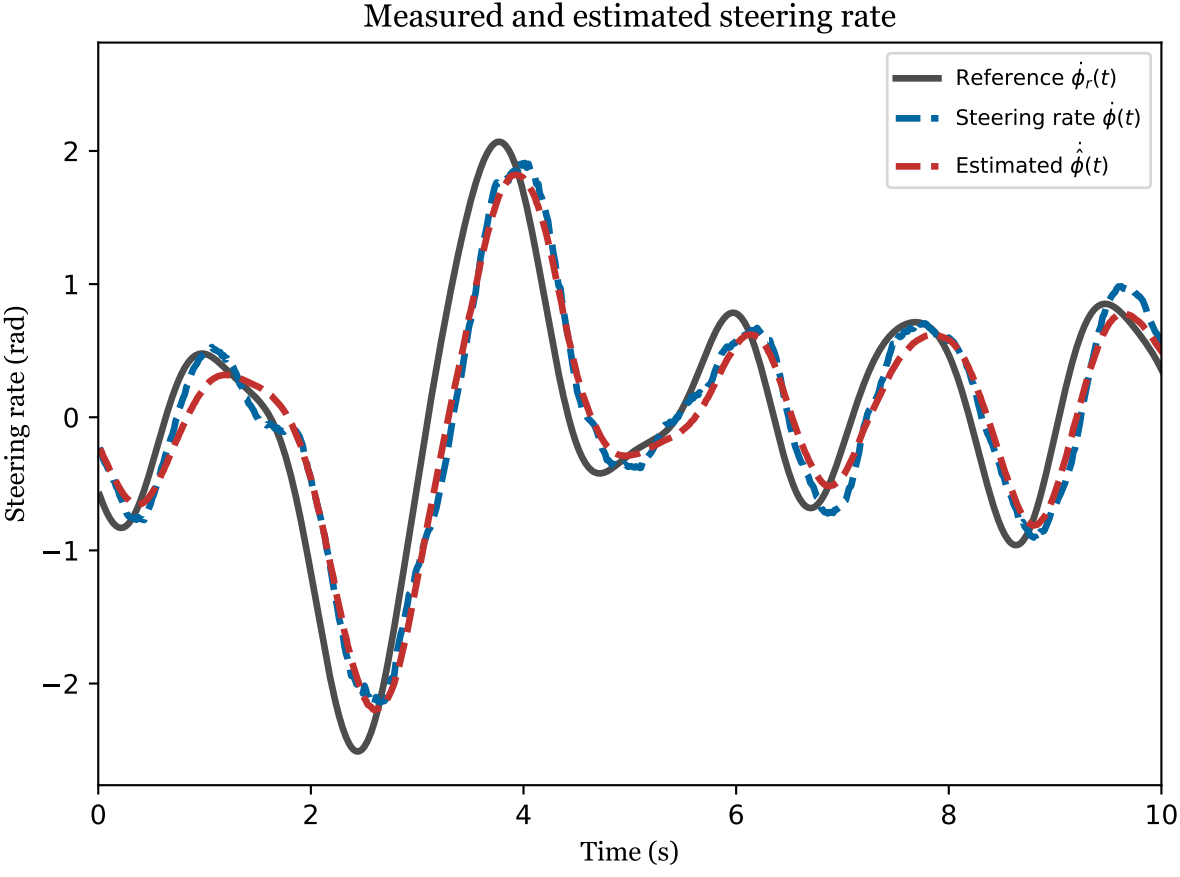
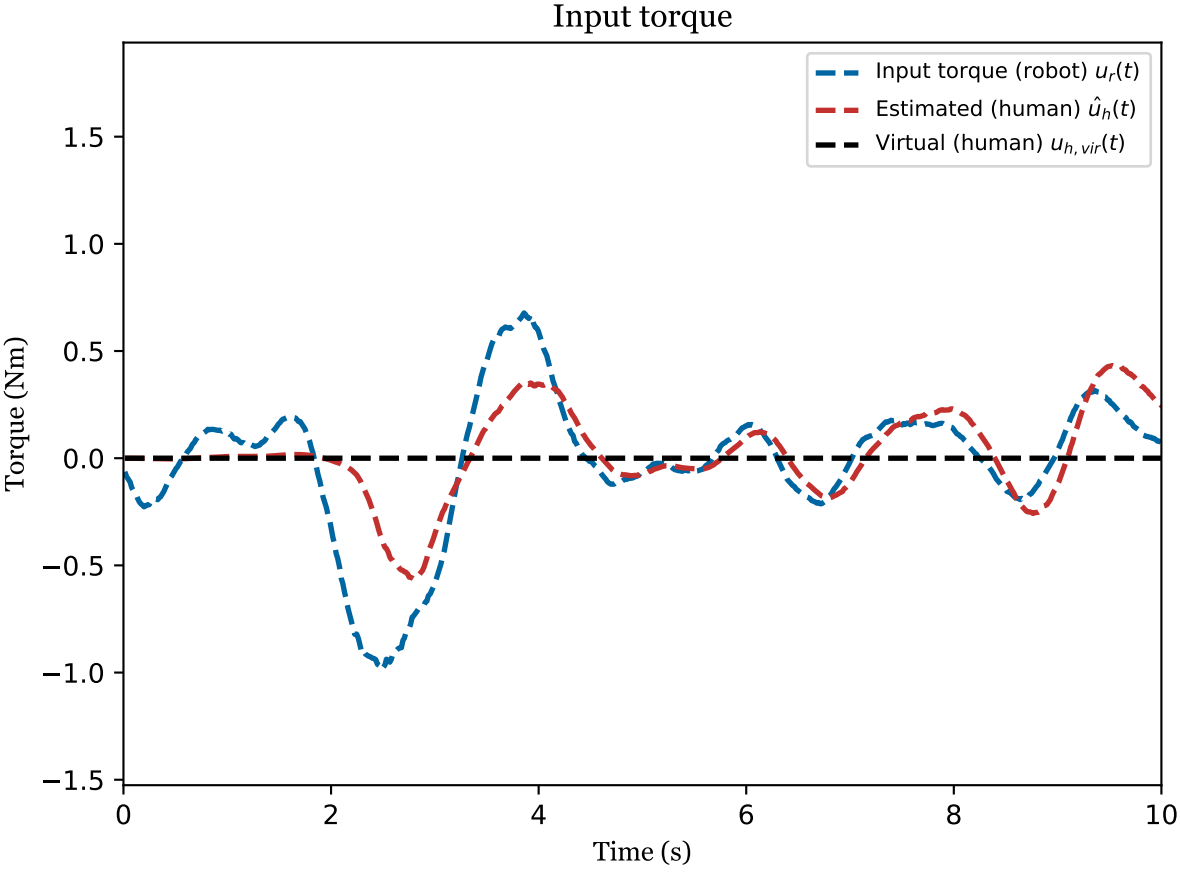
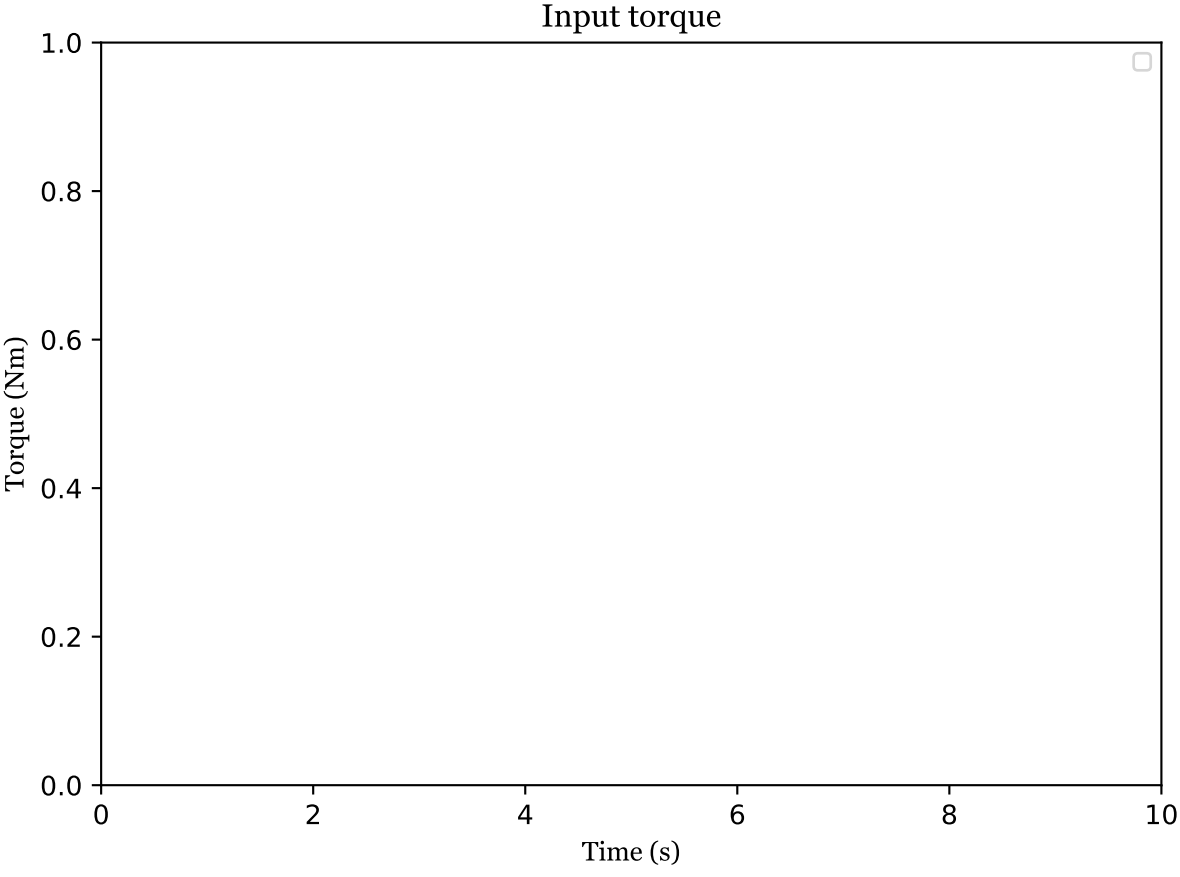

Forcing function in frequency domain
Amplitude (-)
10^{-1}
10^{-2}
10^{0}
10^{1}
Frequency (rad/s)

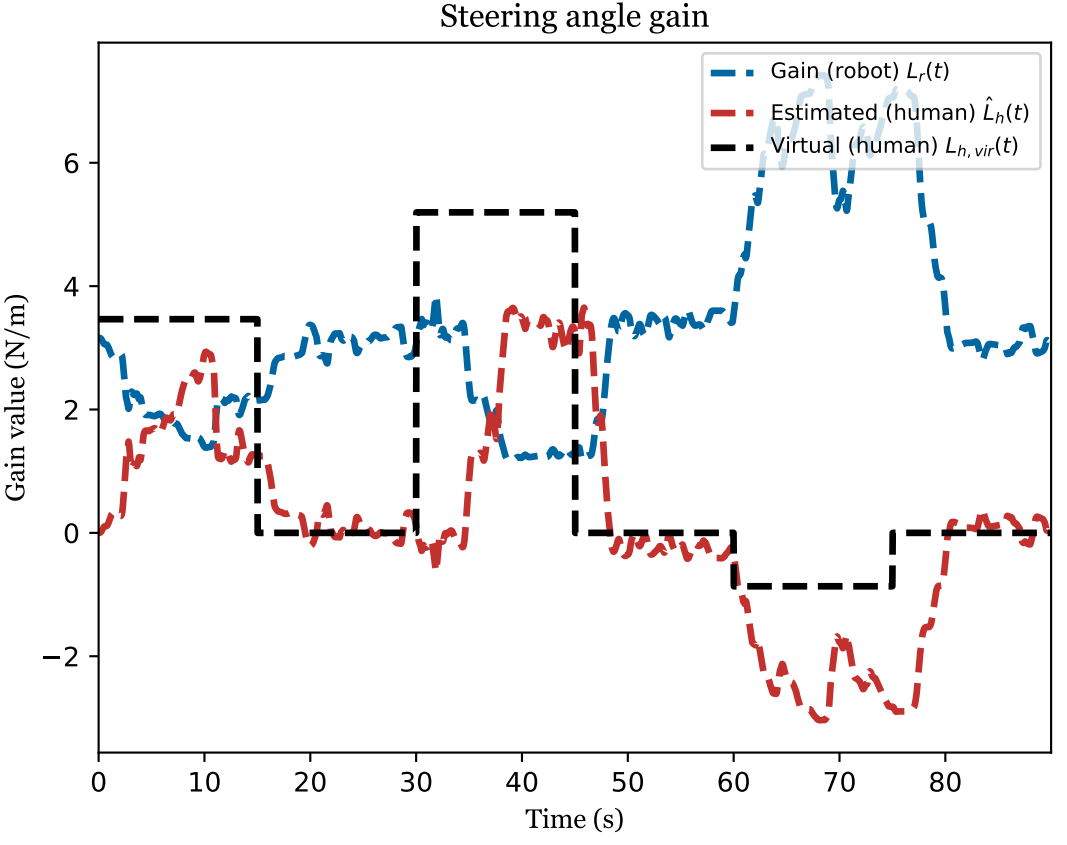

Forcing function in time domain
Amplitude (-)
Time (s)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
2
4
6
8
10

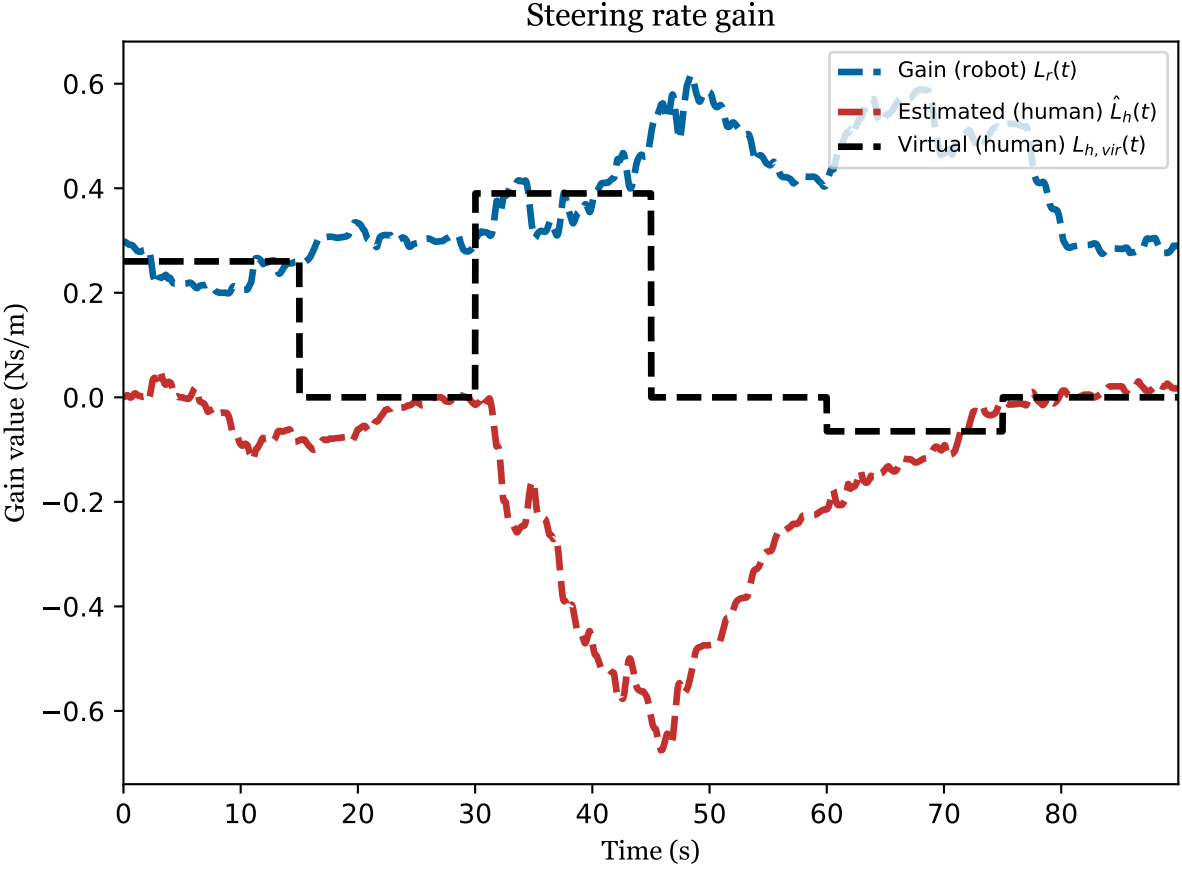

Measured and estimated steering angle
Reference $\phi_r(t)$
Steering angle $\phi(t)$
Estimated $\hat{\phi}(t)$
Steering angle (rad)
Time (s)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
2
4
6
8
10


Measured and estimated steering rate
Reference $\dot{\phi}_r(t)$
Steering rate $\dot{\phi}(t)$
Estimated $\hat{\dot{\phi}}(t)$
Steering rate (rad)
Time (s)
2
1
0
−1
−2
0
2
4
6
8
10


Input torque
Input torque (robot) $u_r(t)$
Estimated (human) $\hat{u}_h(t)$
Virtual (human) $u_{h,vir}(t)$
Torque (Nm)
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
2
4
6
8
10
Time (s)


Input torque
Torque (Nm)
Time (s)
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10


Steering angle gain
Gain (robot) $L_r(t)$
Estimated (human) $\hat{L}_h(t)$
Virtual (human) $L_{h,vir}(t)$
Gain value (N/m)
6
4
2
0
−2
0
10
20
30
40
50
60
70
80
Time (s)


Steering rate gain
Gain (robot) $L_r(t)$
Estimated (human) $\hat{L}_h(t)$
Virtual (human) $L_{h,vir}(t)$
Gain value (Ns/m)
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
0
10
20
30
40
50
60
70
80
Time (s)