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# Exercise 6.1

For controller in part a, the implementation was very similar to go-to-goal controller for omnidirectional robot aside of variable velocity, which is based on the distance to the goal. Variable speed helped a lot with the angular velocity gain, as it could be almost any value.

For controller in part b, the implementation was even more similar to omnidirectional robot with the only difference is the need to transform from “virtual” omnidirectional robot control input to the real control inputs for the unicycle robot. We decided on l = L/2, so the “virtual” omnidirectional robot is halfway out of the robot, this way the robot was able to “cover” the goal, while producing sensible gain for the angular velocity.

Both controllers do not consider the end position orientation. And while controller a was converging to the right orientation, it is just luck. Changing end goal or initial position does show that the target orientation is not considered.

Chart, line chart

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Figure 1. Controller A: Time series of control input.

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Figure 2. Controller A: Time series of wheel speed.

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Figure 3. Controller A: Time series of state trajectory.

Chart

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Figure 4. Controller A: Trajectory plot.

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Figure 5. Controller B: time series of control input.

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Figure 6. Controller B: Time series of wheel speed.

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Figure 7. Controller B: Time series of state trajectory.

Chart, scatter chart

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Figure 8. Controller B: Trajectory plot.

# Exercise 6.2

The first step during implementation was to convert cartesian coordinates to polar coordinate system in order to calculate control inputs while avoiding singularity at origin point. For task A, we’ve tried to randomly pick gain parameters that satisfy the conditions placed by pole placement algorithm and for task B, we calculated the parameters so that the robot does not change direction during its movement. That resulted in much faster convergence to the goal state.

In order to handle final posture of xd = [1 0.5 π/2]T we had to calculate homogeneous transformation matrix by applying which we could shift the robot and goal in such a way, that goal ends up at origin point with proper orientation. It can be achieved by translating [1, 0.5] and then rotating π/2 counterclockwise. The plots and the simulation visualization keep original coordinate system for visualization purposes, but polar coordinates in the plots are in the transformed coordinate system.

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Figure 9. Part A: Timeseries of control input.

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Figure 10. Part A: Time series of state rho, alpha and beta.

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Figure 11. Part A: time series of wheel speed.

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Figure 12. Part A: time series of state trajectory.

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Figure 13. Part B: Time series of control input

Chart, line chart

Description automatically generatedFigure 14. Part B: time series of state rho, alpha, and beta.

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Figure 15. Part B: time series of wheel speed

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Figure 16. Part B: time series of state trajectory.

Chart, line chart

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Figure 17. Part A bonus: time series of control input.

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Description automatically generated

Figure 18. Part A bonus: times series of state rho, alpha, beta.

Chart, line chart

Description automatically generated

Figure 19. Part A bonus: time series of wheel speed.

Chart, line chart

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Figure 20. Part A bonus: time series of state trajectory.

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Figure 21. Part B bonus: time series of control input

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Figure 22. Part B bonus: time series of state rho, alpha, beta.

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Figure 23. Part B bonus: time series of wheel speed.

Chart, line chart

Description automatically generated

Figure 24. Part B bonus: time series of state trajectory.