# Question 3

*Line-tracking Performance [10]:* Develop a PD line tracking controller to enable the robot to take-off from a starting location, go to a fixed height of 1.0 m, and return to the ground. Many approaches could be used (select your preferred approach). The most naive solution would follow a method similar to the approach detailed in (2) but reduce the magnitude of the incremental change in the waypoint by a smaller value (e.g., 1 cm) and assign a desired velocity to each waypoint following a velocity profile (consider a ramp profile due to a constant positive, zero, then negative acceleration). Plot the error between the desired pose (position and orientation) and the actual pose. Examine the convergence of the robot to each waypoint. Does the system oscillate about the waypoints? What happens when modifying the gains associated with the position control (outer loop)? Plot the response for multiple gains and discuss qualitatively the change in performance.

## Line-tracking Performance

3.1 Below are the figures showing the actual/desired position, as well as the position error (**using the normal gains**):

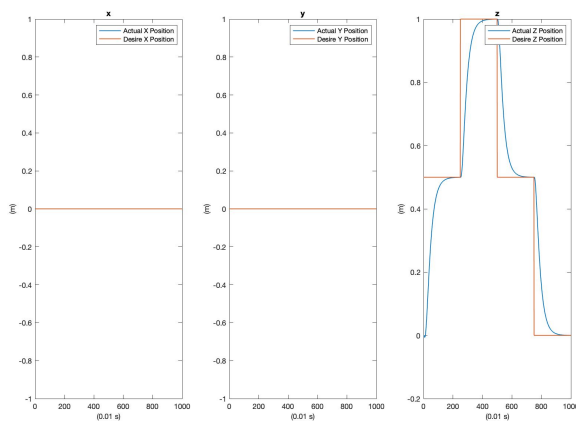| Kp | 17 | 17 | 20 |
|---|---|---|---|
| Kv | 6.6 | 6.6 | 9 |
| Kr | 190 | 198 | 80 |
| Kw | 30 | 30 | 17.88 |



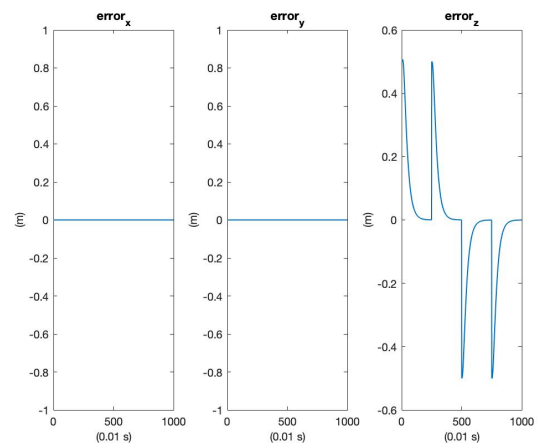Figure 1. actual position vs desired position          Figure 2. Position Errors

**(We set 4 waypoints: (0,0,0.5m), (0,0,1m),(0,0,0.5m), (0,0,0))**

3.2 Below are the figures showing the actual/desired position, as well as the position error (**using bigger Kp**):

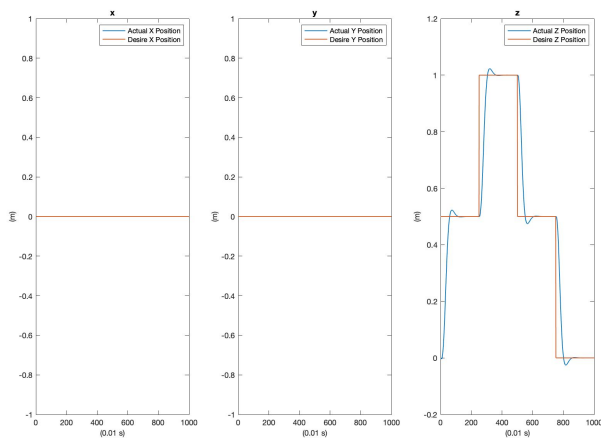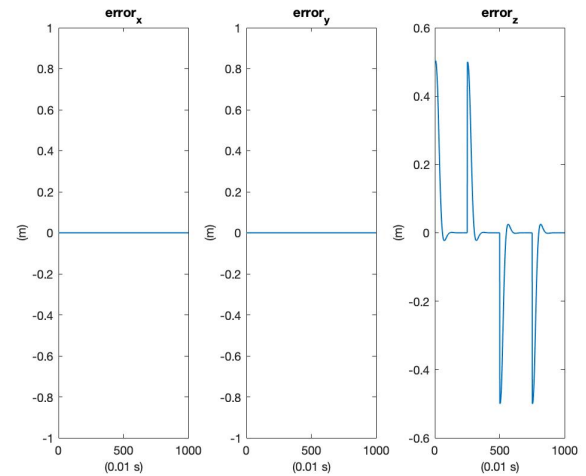| Kp | 17 | 17 | **40** |
|---|---|---|---|
| Kv | 6.6 | 6.6 | 9 |
| Kr | 190 | 198 | 80 |
| Kw | 30 | 30 | 17.88 |



Figure 3. actual position vs desired position

Figure 4. Position Errors

3.3 Below are the figures showing the actual/desired position, as well as the position error (**using bigger Kv**):

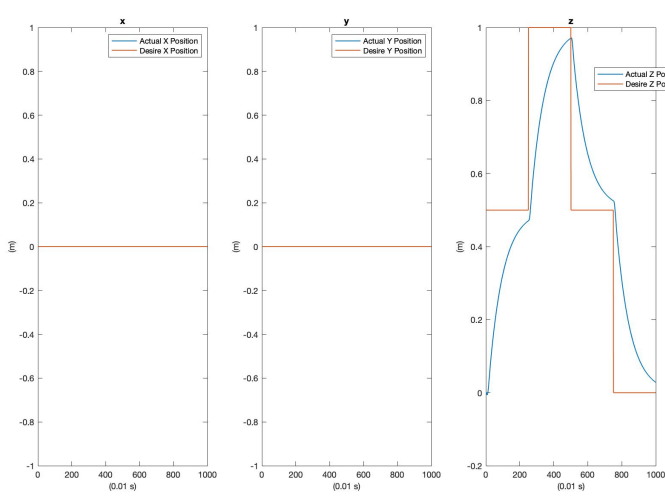| Kp | 17 | 17 | 20 |
|---|---|---|---|
| Kv | 6.6 | 6.6 | **18** |
| Kr | 190 | 198 | 80 |
| Kw | 30 | 30 | 17.88 |

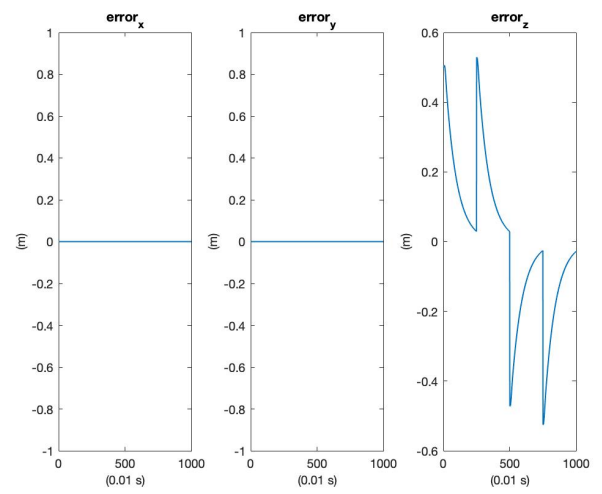Figure 5. actual position vs desired position



Figure 6. Position Errors

# Comment

**Indicate when new waypoints are sent to the system.**

The waypoint is sent to the system at t=0.

**Examine the convergence of the robot to each waypoint.**

Robot is able to converge to the waypoint under all gain conditions.

We noticed that our system is able to converge to the waypoints