EBS 221 Agricultural Robotics
Spring quarter 2025

Assignment 2

A. (45 pts)

Write a Matlab function that implements a pure-pursuit controller. The function should be called in your main program every DT, and return the steering angle and cross-track error:
[steer_angle, cross_track_error] = purePursuitController(q, L, Ld, path);

Use the following parameters: tractor with wheelbase = 2.5 m; $\gamma_{max} = 45^o$; $\gamma_{min} = -\gamma_{max}$; v = v_{max}= 1 m/s; $\tau_\gamma = 0.0$ s, $\tau_v = 0.0$ s; dt=1 ms; DT=10 ms.
Initial pose [15 5 π/2]. T = 60.0 s; % maximum simulation time.

B. (20 pts)

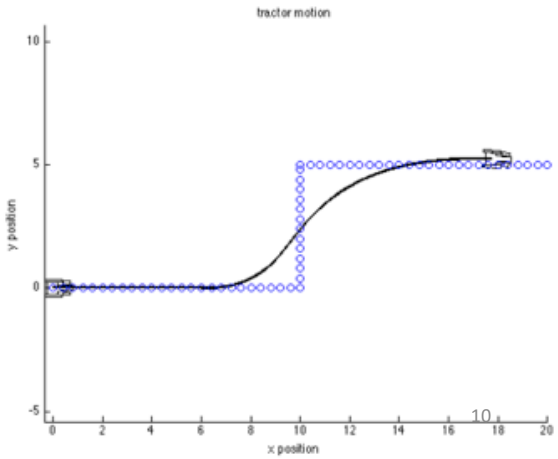
1. Generate points on a circle of radius 5m, centered at (9,7), using this code:

```
a = 0: 0.1 : 2*pi;  % angle step for points on circular path
x = 9 + 5*sin(a); y = 7-5*cos(a);
```

2. Write a script that performs closed-loop path tracking to follow the circular path using a look-ahead l_d= 2 m. Use your robot_bike_dyn.m.
3. Plot the cross-track error and the robot's trace (the trace of the point on the robot's frame origin).
4. Why is the cross-track error nonzero, whereas the robot path looks good? How can you improve the cross-track error calculation?

C. (20 pts)

1. Execute a 'lane-change' path scenario, like the one shown below:



The robot starts at (0,0). The first path segment starts at (0,0). The lengths of the path segments are 10 m (horizontal), 5 m (up), and 10 m (horizontal).
2. Plot the histogram and find the mean, max, 95th percentile and RMS values of the absolute value of the cross-track error.
3. Explore different values of l_d at a fixed speed and comment on path tracking smoothness, stability, and corner-cutting.
4. Double the speed. Should l_d change?

D. (15 pts)

1. Introduce: $\tau_\gamma = 0.15$ s, $\tau_v = 0.5$ s. Select a look-ahead distance, l_d, and compare the resulting path with the robot path with instantaneous dynamics ($\tau_\gamma = 0.0$ s, $\tau_v = 0.0$ s) and the same l_d.
2. Double the steering time lag and observe and report the effects.
3. Tighten the steering angle constraint (e.g., $\gamma_{max} = 35^o$) and discuss effects.

Hint: "Discussing errors" can be qualitative, but must also involve quantifying the behavior with error statistics (mean, max, 95%, RMS).