EBS 221 Agricultural Robotics
Spring quarter 2025

Assignment 3 (100 points)

A. Consider a rectangular field with N=10 rows of length RL=20 m each; its south-west corner is at coordinates (0,0). An autonomous robot must cover and spray the field in parallel rows. The sprayer's implement width is W=2.5 m, and it defines the width of the row. The robot's wheelbase is L=3m, and the maximum steering angle of its bicycle model is ±60°. The robot's initial position is at coordinates (–3W, RL/2), and its orientation is 0°. Its final position is the same as the initial one, and its final orientation is free.

B. Generate the field node coordinates, populate the node-to-node transition cost matrix, and compute an optimal field-coverage node sequence using the genetic algorithm optimizer. Print the node sequence, then check the solution. Does it make sense? Do you observe any issues with the computed sequence? Is it always the same if you run the optimizer multiple times?

C. Generate waypoints for the entire path, from initial to final positions. Plot the path's waypoints.

D. Follow the path with your pure-pursuit controller and plot the robot's path (the origin of its reference frame) on top of the desired path. Select robot speed and tune the look-ahead distance. Find a way to avoid computing a look-ahead in another row. Report the RMS cross-track error on straight line segments inside the field, as well as the corresponding error when turning at headlands.

E. Repeat step D for the same path, with maximum steering angle of ±30°. What do you observe during turns?

F. Re-solve steps B, C, and D with a maximum steering angle of ±30°.

EXTRA CREDIT. If you feel 'adventurous' and have time, include Fish-tail turns in steps B, C, D! (extra 30 points over 100).