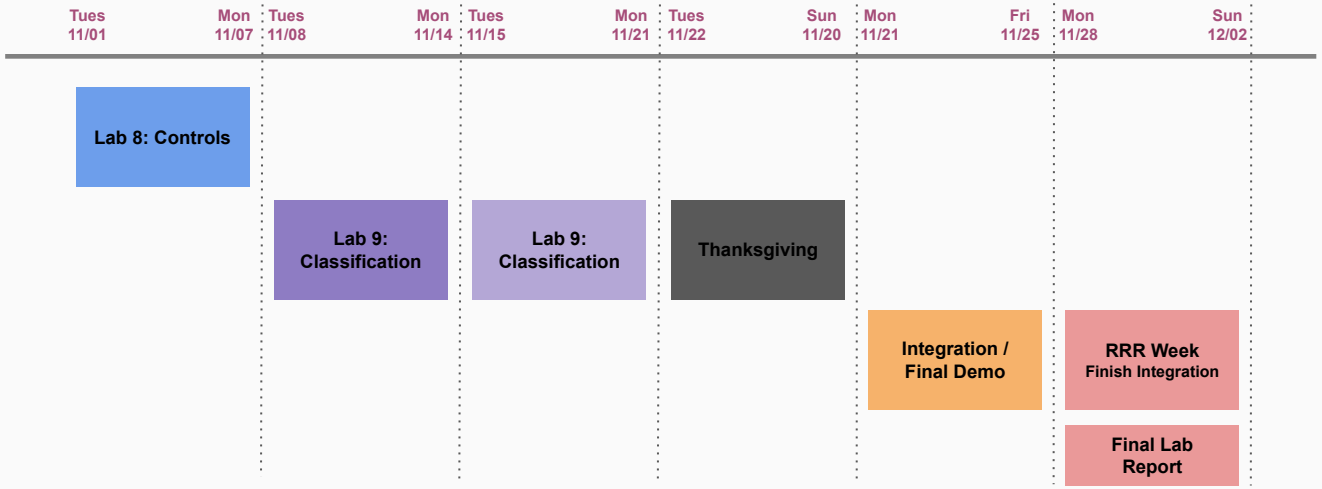
Lab 8: Controls Part 2

EECS 16B Fall 2022

https://links.eecs16b.org/lab8-slides

Lab Schedule



Today’s Lab

- More Controls!
  - Last week: Implemented a controller to make S1XT33N drive straight
  - This week: extend controller to turning
    - Derive equation
    - Implement turning in Arduino code
- Ensure mic board is still working in preparation for Classification next week

Review: Closed-Loop Control

Open-Loop Equations

$$u_L^{OL} = \frac{v^* + \beta_L}{\theta_L}$$

$$u_R^{OL} = \frac{v^* + \beta_R}{\theta_R}$$

Closed-Loop Equations

$$u_L[i] = u_L^{OL} - \frac{f_L}{\theta_L}\delta[i]$$

$$u_R[i] = u_R^{OL} + \frac{f_R}{\theta_R}\delta[i]$$

$$\delta[i] = d_L[i] - d_R[i]$$

Part 1: Exploiting Delta to Turn our Car

- Turning:
  - One wheel moves faster than the other
  - + delta → dL > dR → turning right
  - - delta → dL < dR → turning left
- How can we make one wheel travel farther with our control scheme?
  - Add an offset value to δ[i] in the code
  - Car “corrects” it by driving δ → 0
  - Naive idea: add a constant offset?

Closed-Loop Equations

$$u_L[i] = u_L^{OL} - \frac{f_L}{\theta_L}\delta[i]$$

$$u_R[i] = u_R^{OL} + \frac{f_R}{\theta_R}\delta[i]$$

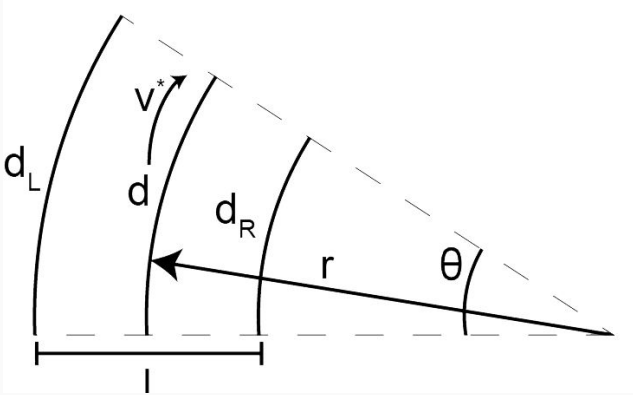
$$\delta[i] = d_L[i] - d_R[i]$$

Part 1: Controlled Turning

- Issues with adding constant offset:
  - Car tries to turn very suddenly
  - if offset is too big, wheels leave the controllable range
  - Isn't really "aesthetic": car will turn and then drive straight rather than sweeping an angle

Part 1: Controlled Turning (continued)

- We want a gradual, circular turn.
  - Add offset as a variable dependent on time
- In the case of a circular turn, what should δ[i] be at time i?
  - Use arc length formula!
  - Relate distance to velocity and time steps!
  - Check with us when you derive $\delta_{ref}[i] = f(r, v^*, l, i)$



Parts 2 - 3: turning.ino File

- Code the function for δ[i] you found in Part 1
  - Control loop and the data collection have different periods
  - Account for different sampling rates of data collection and controller
- (Optionally) apply a straight correction for any lingering turning due to mechanical errors

Part 4: Mic Board Verification

- We will be using the mic board next week for the SVD/PCA lab!
- Verify that your biasing circuits and front-end circuitry still work as expected.

Tips and Common Errors

- Make sure to have one delta_reference positive (left) and the other negative (right)
- You can manipulate the turn radius and run times (in ms!) of the turning sequence
- Ensure you've replaced v* with v* / m ONLY in delta_reference function

Forms & Information

- Help request form: https://eecs16b.org/lab-help
- Checkoff request form: https://eecs16b.org/lab-checkoff
- Extension Requests: https://eecs16b.org/extensions
- Makeup Lab: https://makeup.eecs16b.org
- Slides: https://links.eecs16b.org/lab8-slides
- Anon Feedback: https://eecs16b.org/lab-anon-feedback
- Lab Grades error: https://links.eecs16b.org/lab-checkoff-error