ECE 3 Fall 2020 Lab Section 5 Notes – Feedback Control

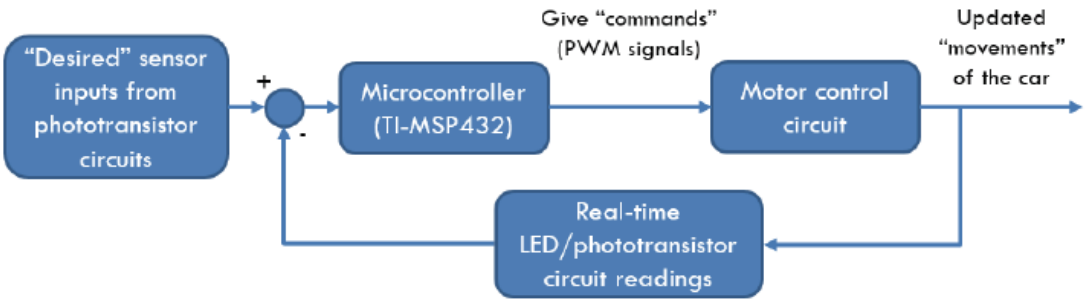


FIGURE 3-1: High level understanding of the ECE3 class project

Sensor Fusion and the Intuition Behind:

Problem of the "guardrail" strategy:

void setup() {

……

}

void loop() {

(1) Read raw sensor data: $[R_0, R_1, \ldots, R_7]$

(2) Pre-process the data (calibration/normalization):

$$\begin{pmatrix} (R_0 + Offset_0) \times Scale_0 = S_0 \\ (R_1 + Offset_1) \times Scale_1 = S_1 \\ \ldots \\ (R_7 + Offset_7) \times Scale_7 = S_7 \end{pmatrix}$$

(3) Change motor speeds based on sensor inputs with fixed thresholds:

…

if (*some sensors "see" black (>some thresholds) and other sensors "see" white (<some thresholds)*)

left_pwm = *some number;*
right_pwm = *some number;*

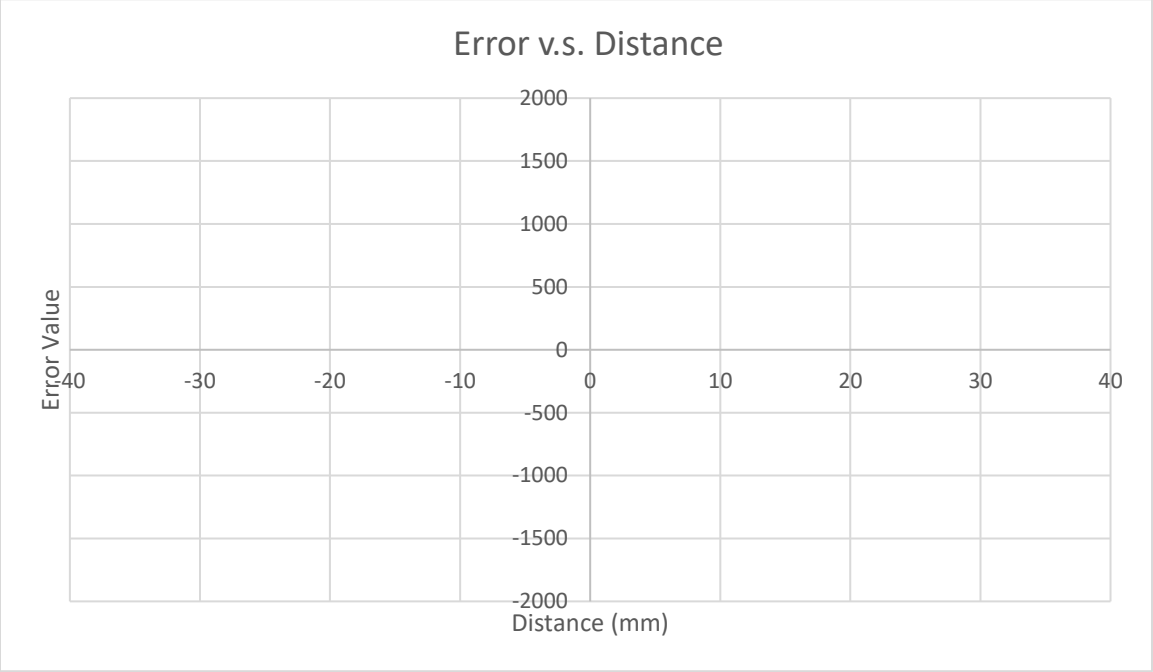
analogWrite (left_pwm_pin, left_pwm);
analogWrite (right_pwm_pin, right_pwm)

else if

…

Intuition of the sensor fusion idea: Can we extract a figure of merit that represents the real time signed distance between the car and the track from the 8 sensor readings? (error value)

Ideal error value v.s. distance plot:



Benefit:

…
if (*some sensors "see" black (>some thresholds) and other sensors "see" white (<some thresholds)*)

left_pwm = *some number;*
right_pwm = *some number;*

analogWrite (left_pwm_pin, left_pwm);
analogWrite (right_pwm_pin, right_pwm)

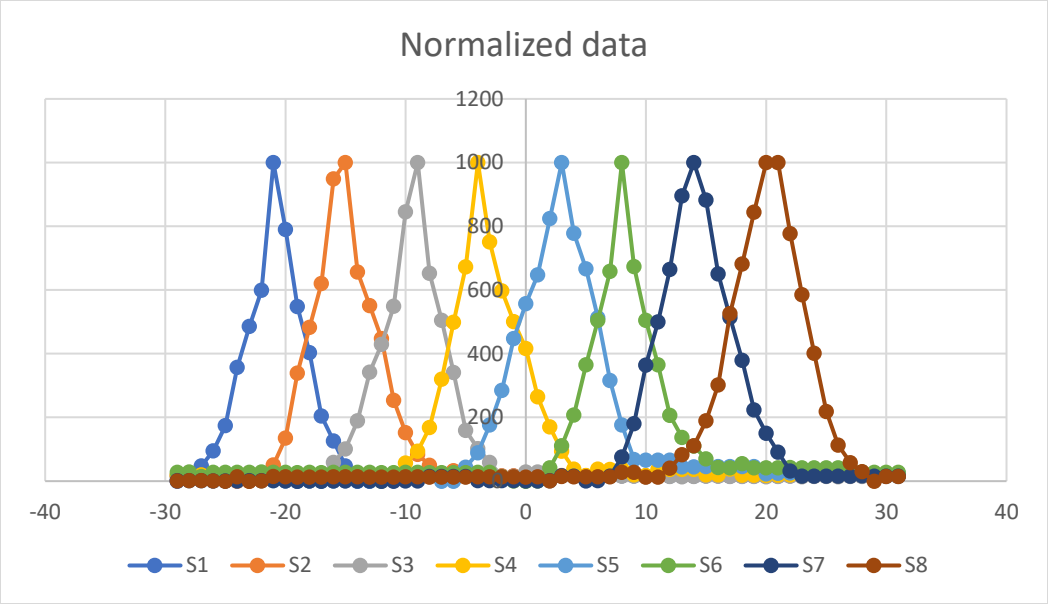
else if
…

…

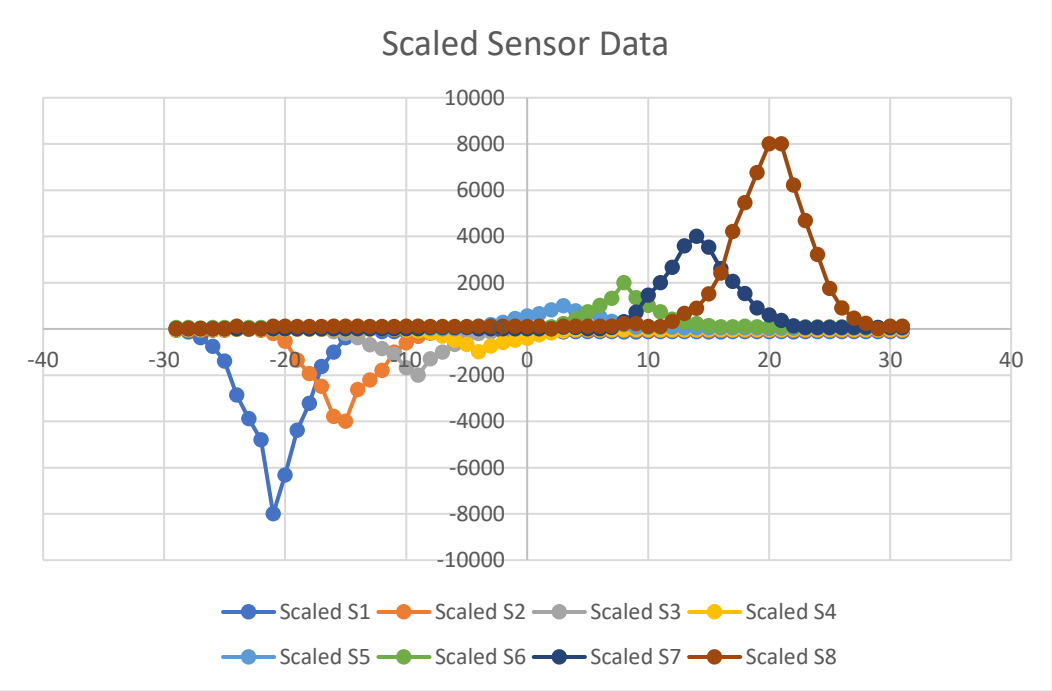
left_pwm = left_base_speed ± k*error
right_pwm = right_base_speed ∓ k*error

analogWrite (left_pwm_pin, left_pwm);
analogWrite (right_pwm_pin, right_pwm)

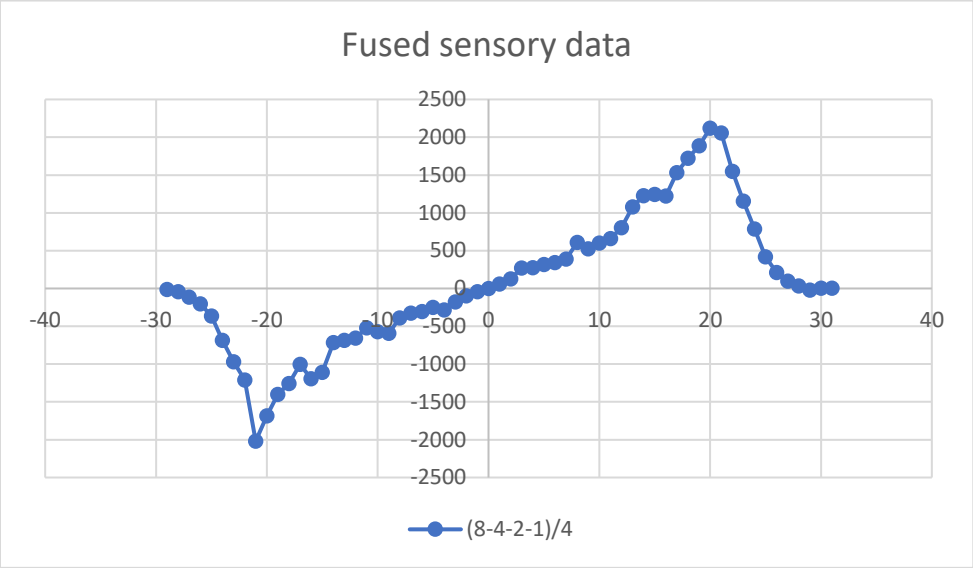
…



Weight factor 8-4-2-1 (-8S1+-4S2+-2S3+-1S4+1S5+2S6+4S7+8S8)



Sensor fusion:

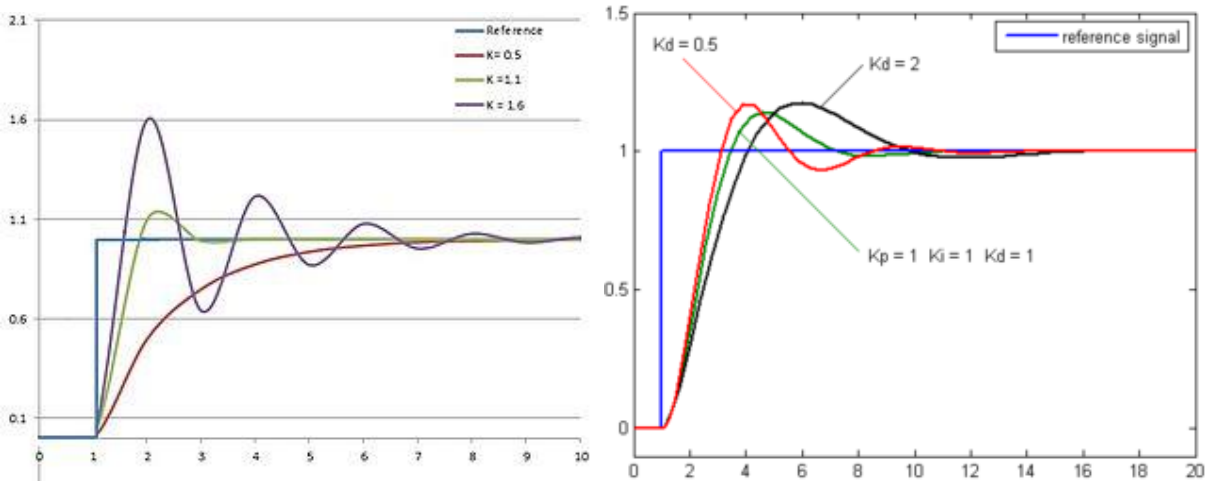


PD controller:

$$Current\ Speed = Reference\ Speed - k_p \times error - k_d \times \frac{derror}{dt}$$

How to implement $\frac{derror}{dt}$?

When to implement the derivative control?



Goal of the project: