Robotic Line Follower

AA448 Final Project

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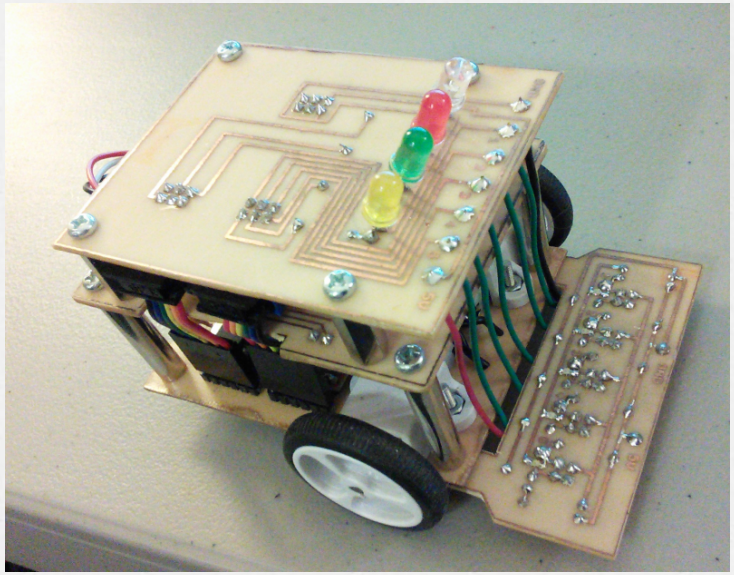
Nat Guy

The Robot

- Arduino Uno board (ATMEGA328 processor)
- Borrowed from RAIN lab
- Programmable in C++



Sensors and Actuators

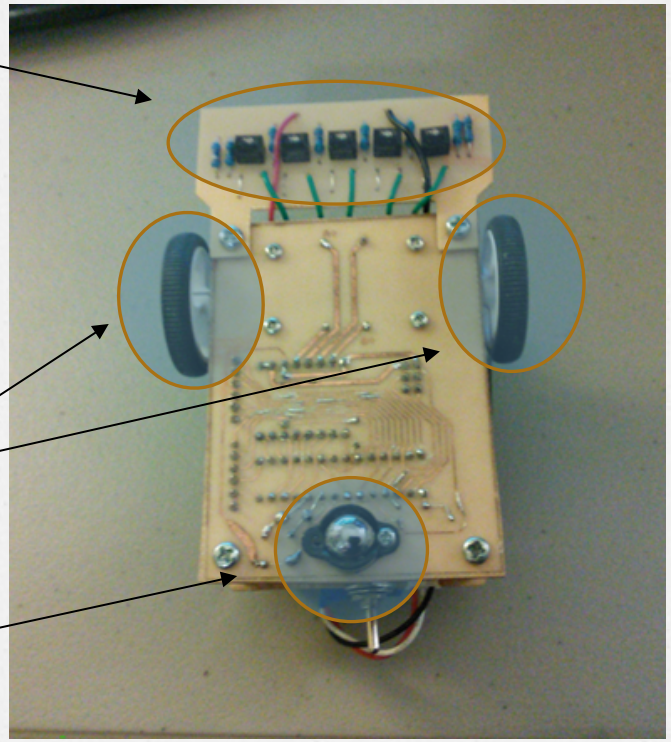
QRD1114 Reflective Object Sensors (5)

- Infrared emitting diodes
- Phototransistors
- Spaced 1cm apart

Differential Drive

- Dual motors
- Speed adjustable with PWM (varying duty cycle)

Low-friction ball bearing



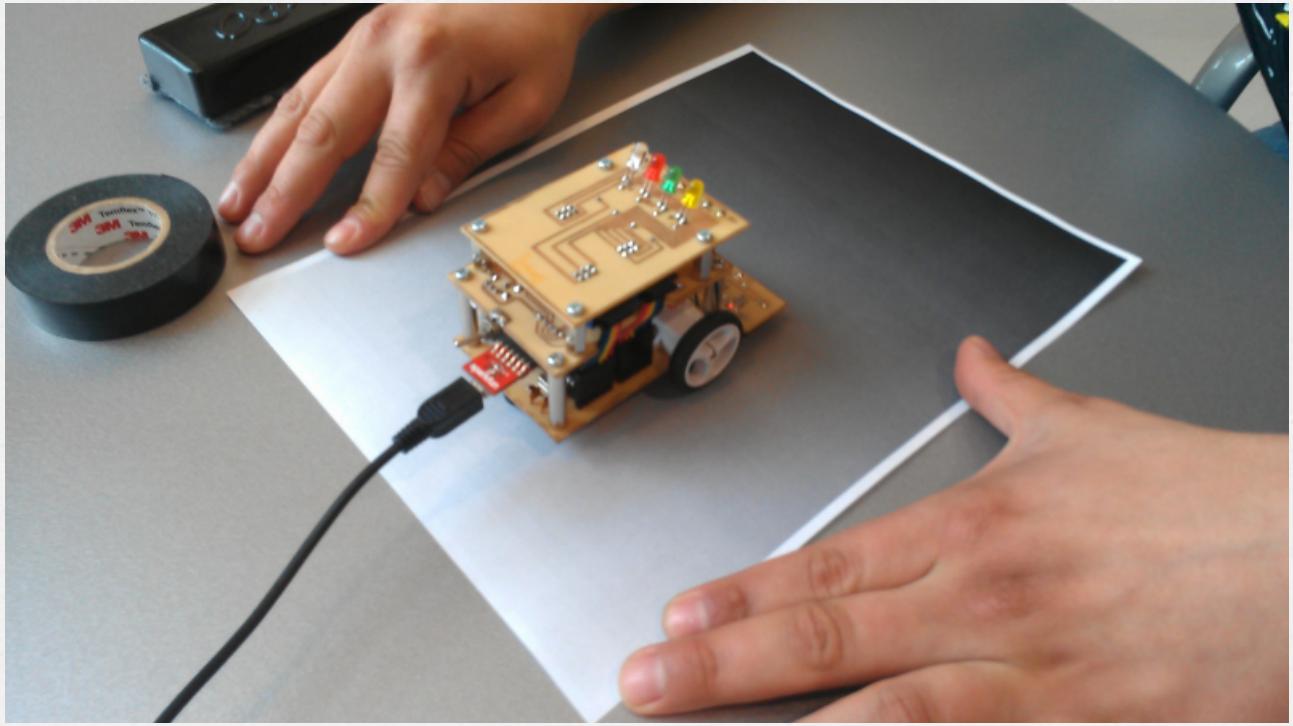
Control Goal

- Want robot to be able to follow black lines
- Black line will be directly in the center of the sensors
- Center as setpoint, differential drive as actuators

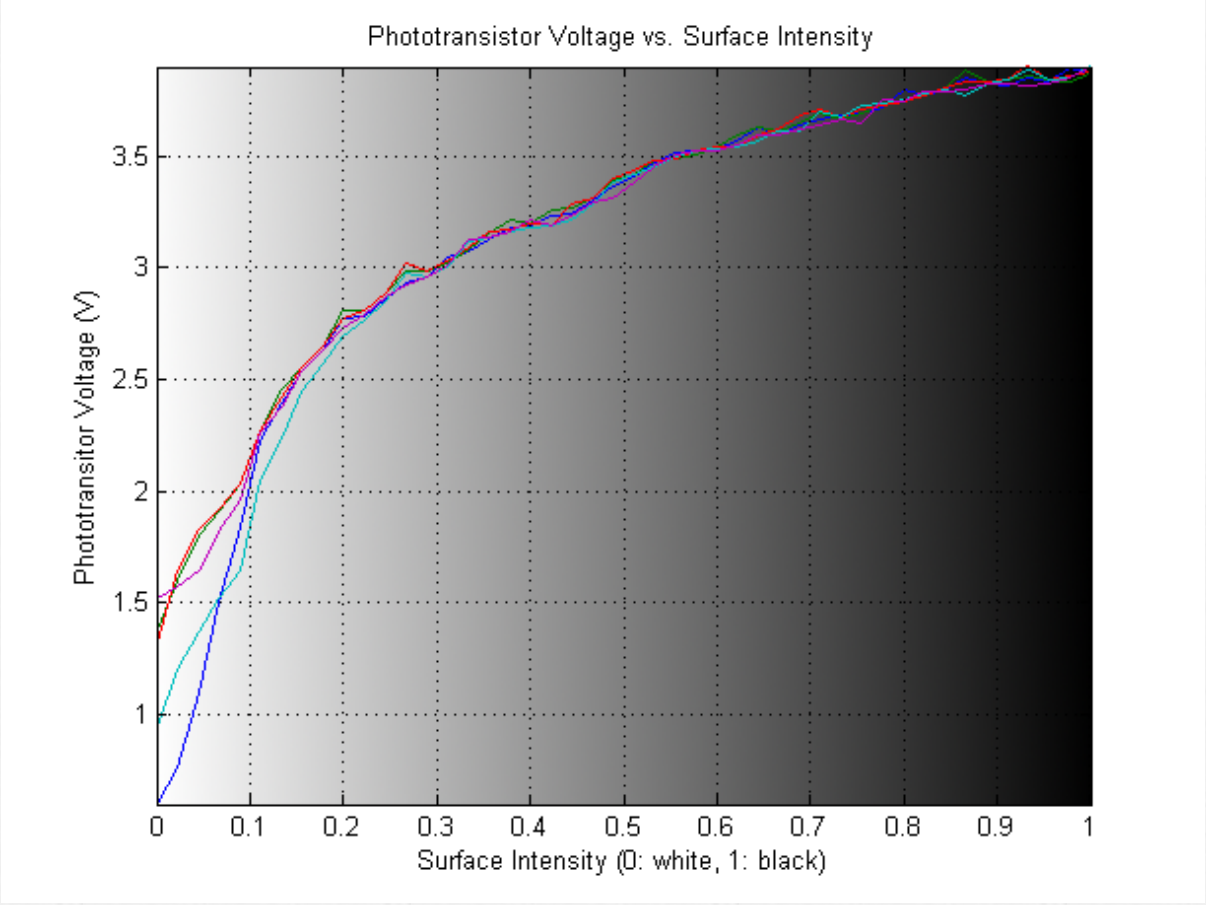
Characterizing Sensors (1)

- Necessary to find output-voltage-to-intensity function for IR sensors
- Find IR sensor voltages as robot advances along black-white gradient

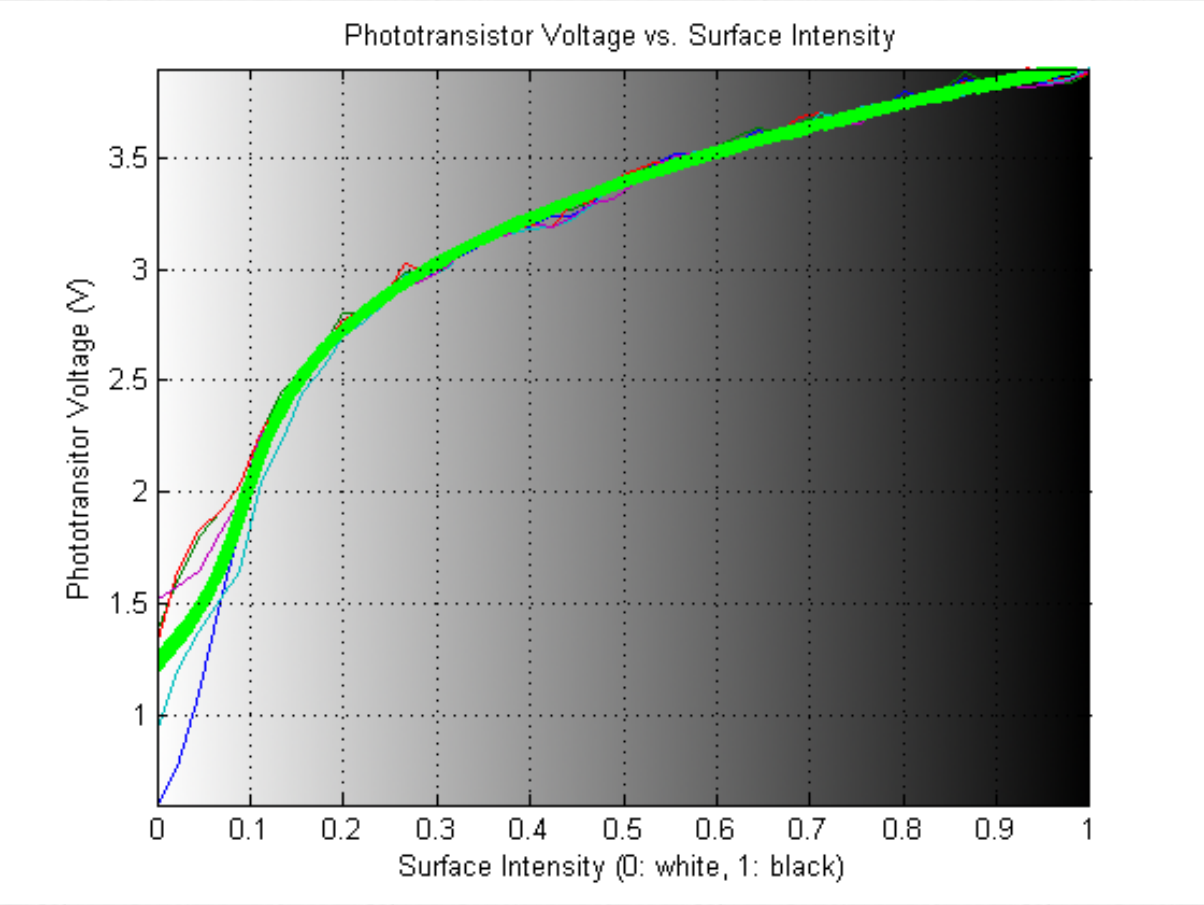
Characterizing Sensors (2)



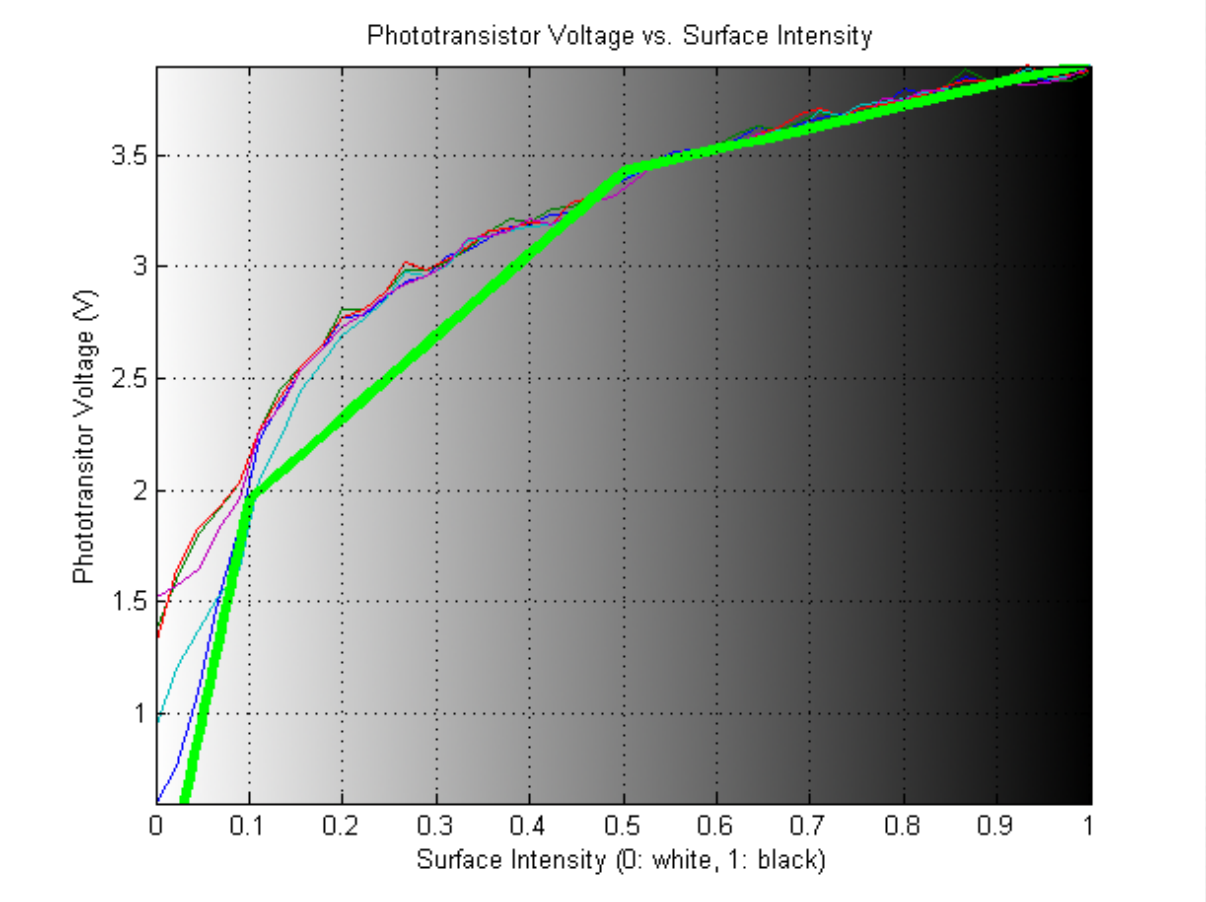
Characterizing Sensors (3)



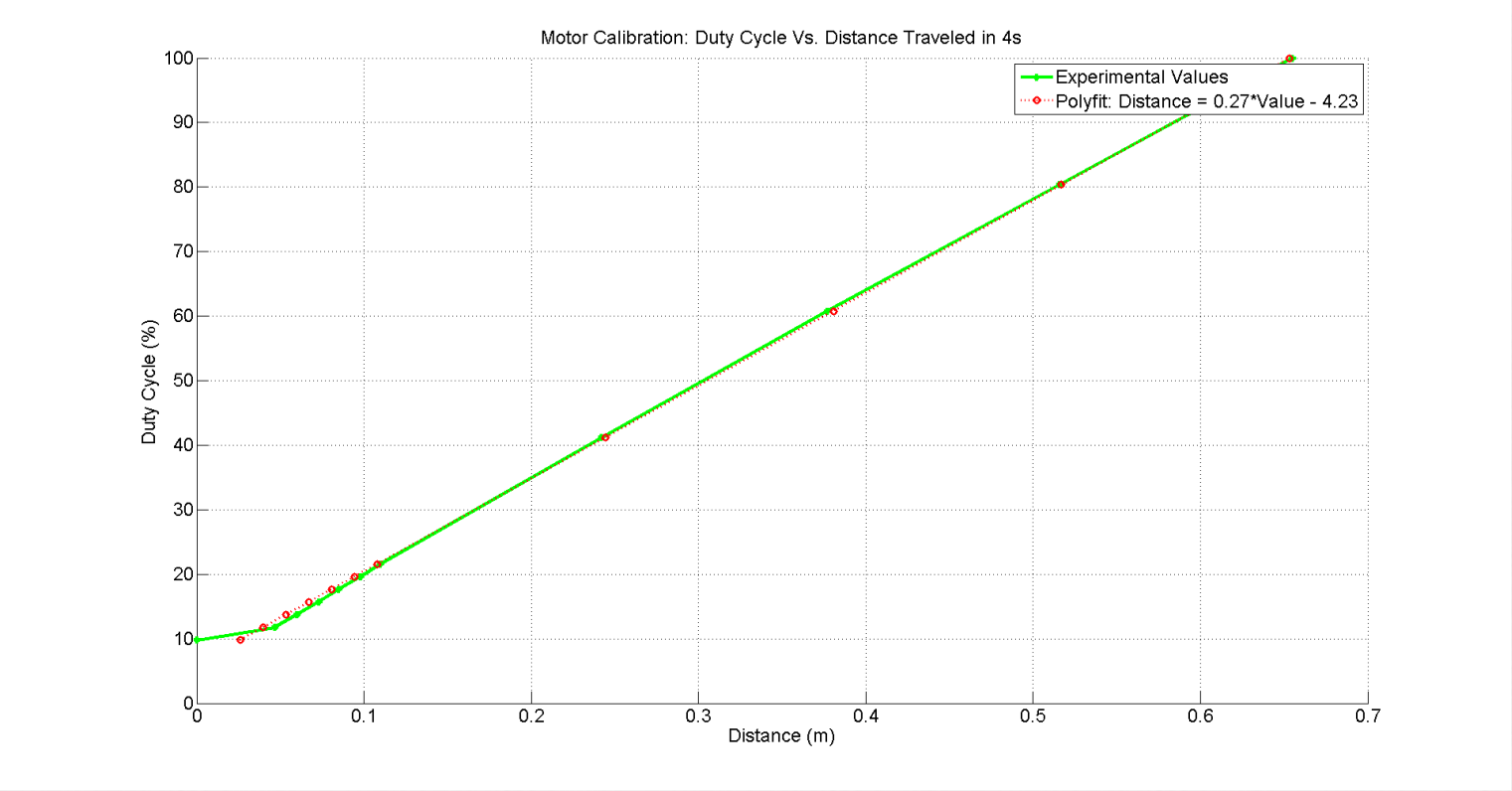
Characterizing Sensors (4)



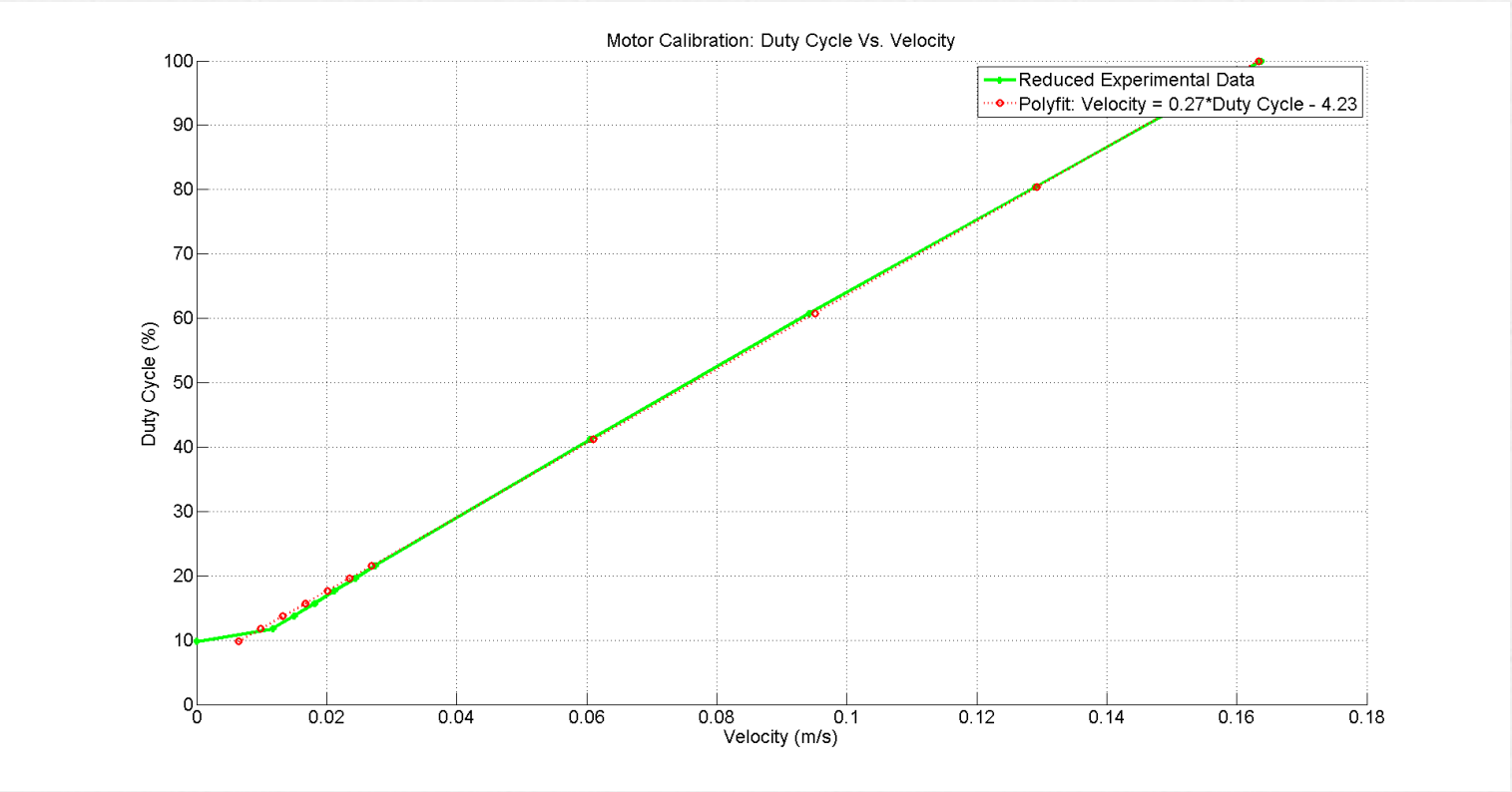
Characterizing Sensors (5)



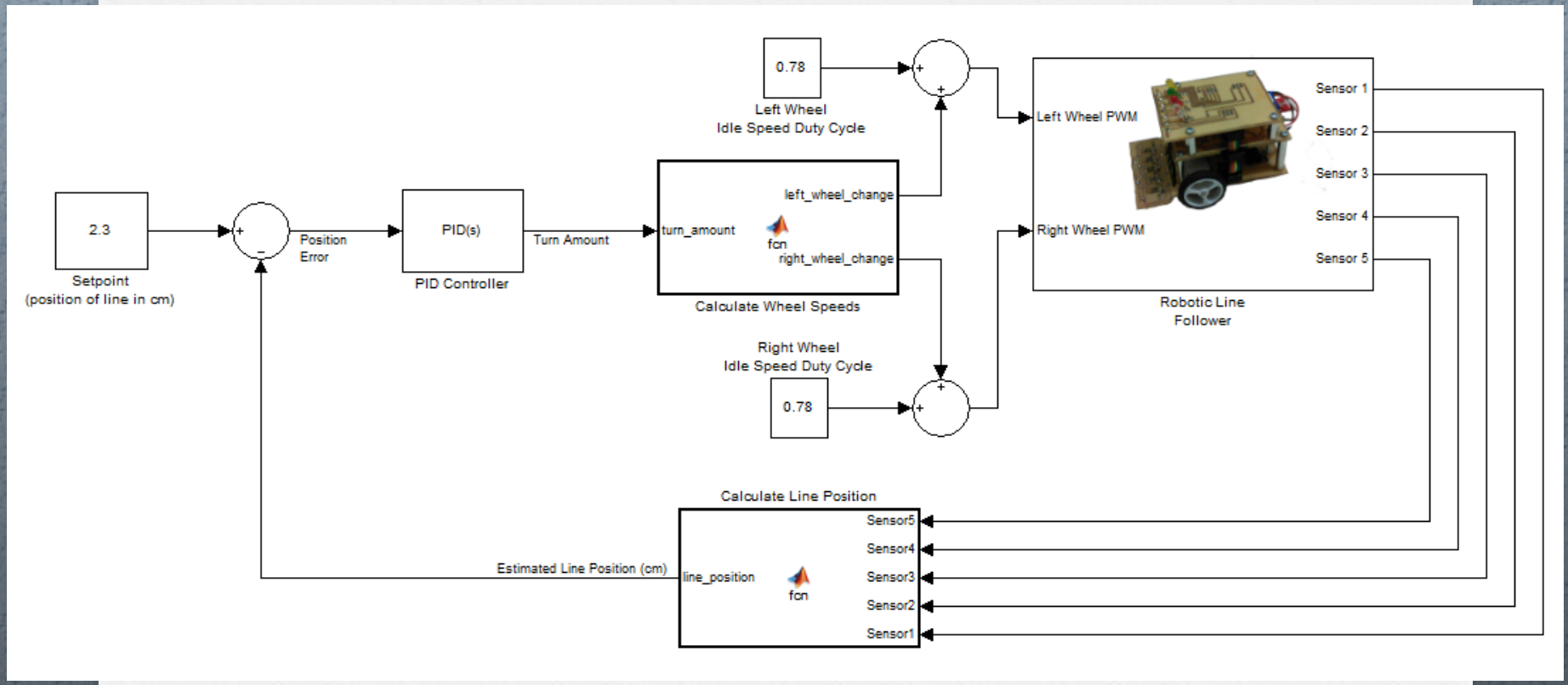
Characterizing Actuators (1)



Characterizing Actuators (2)



System Diagram



Determining Gains

- Used Ziegler-Nichols
  - Turned up Kp until robot oscillated periodically
  - Called that Kp value “Ku” and period “Tu”
  - Kp = 0.6*Ku
  - Ki = 2Kp/Tu
  - Kd = Kp*Tu/8
- Hand-tweaked afterwards

Implementation

- Programmed in C++
- About 300 lines of code
- Control loop runs about 60 times per second
- Only used last 60 integral values (to avoid windup)
- Average of 4 derivative values (to smooth noise)
- Kp = 130, Ki = 60, Kd = 2

Demonstration