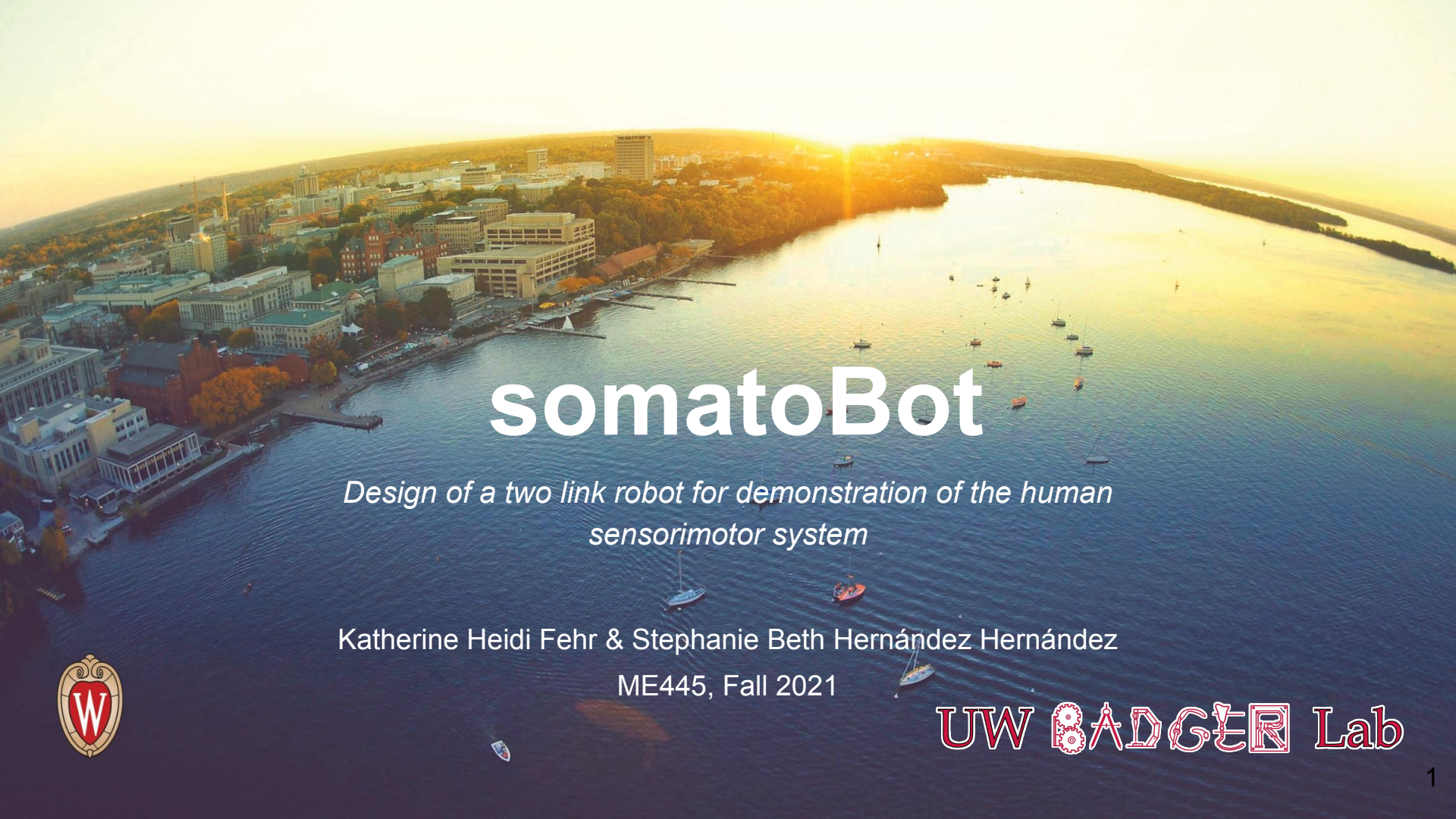


somatoBot

Design of a two link robot for demonstration of the human sensorimotor system

Katherine Heidi Fehr & Stephanie Beth Hernández Hernández

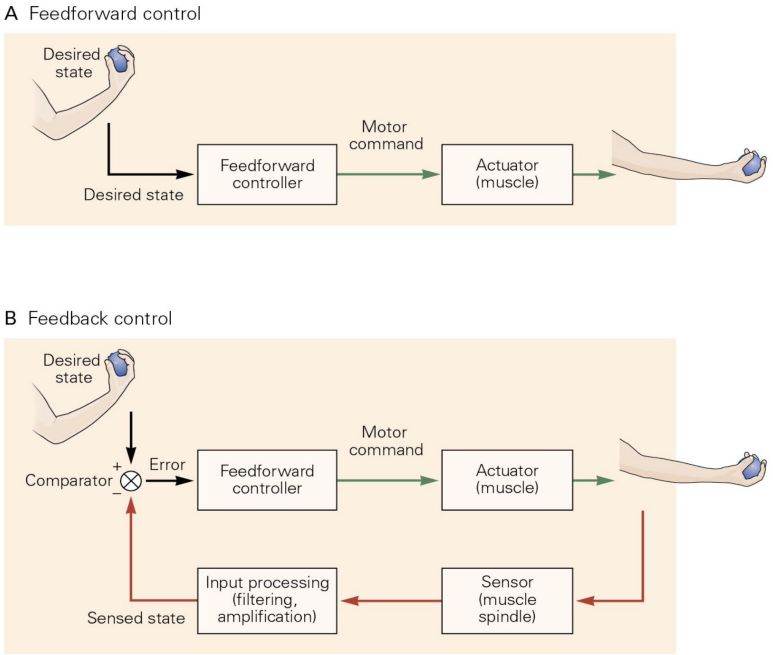
ME445, Fall 2021

UW BADGER Lab

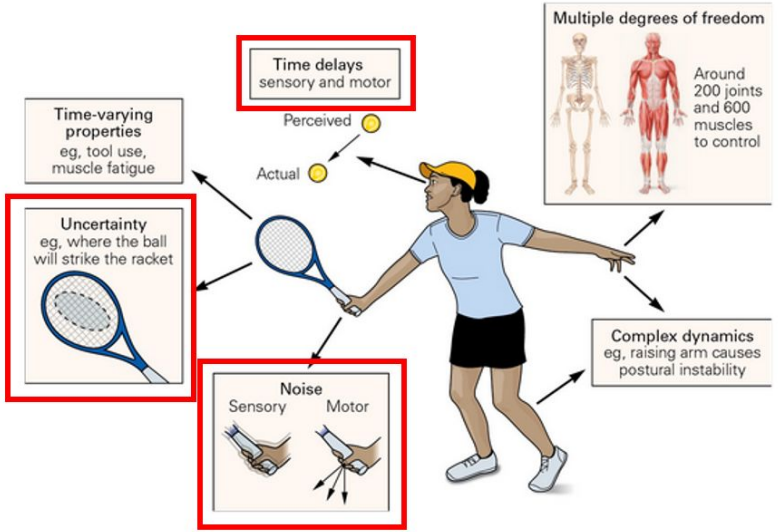
Objective

Using skills and techniques gained in ME445 design and build a small two link planar robot that demonstrates the neural control of the sensorimotor system in humans.

Sensorimotor = Senses & Motor Movement



Challenges:



Figures adapted from Kandel et al. 2021, Principles of Neuroscience

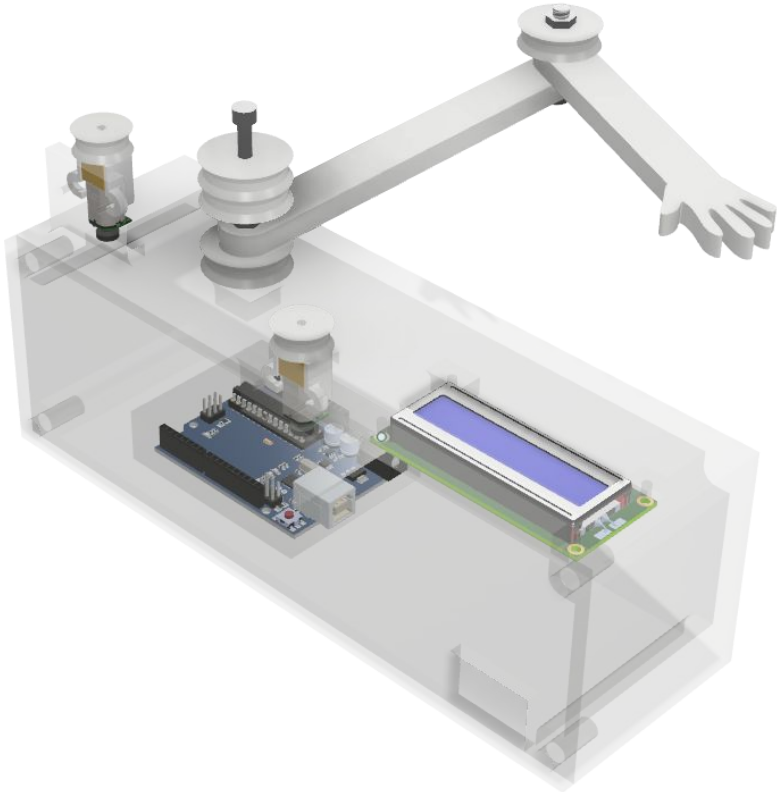
Goals

Develop the platform:
complete physical design of robot and integrate all electrical components.

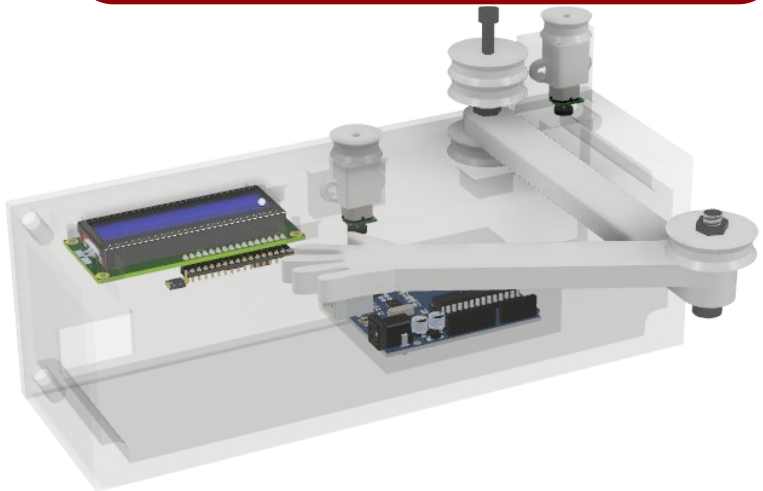
Implement a feedback (closed loop) control algorithm to move our motor arms to a desired position.

Implement a demonstration of a potential challenge to sensorimotor control.

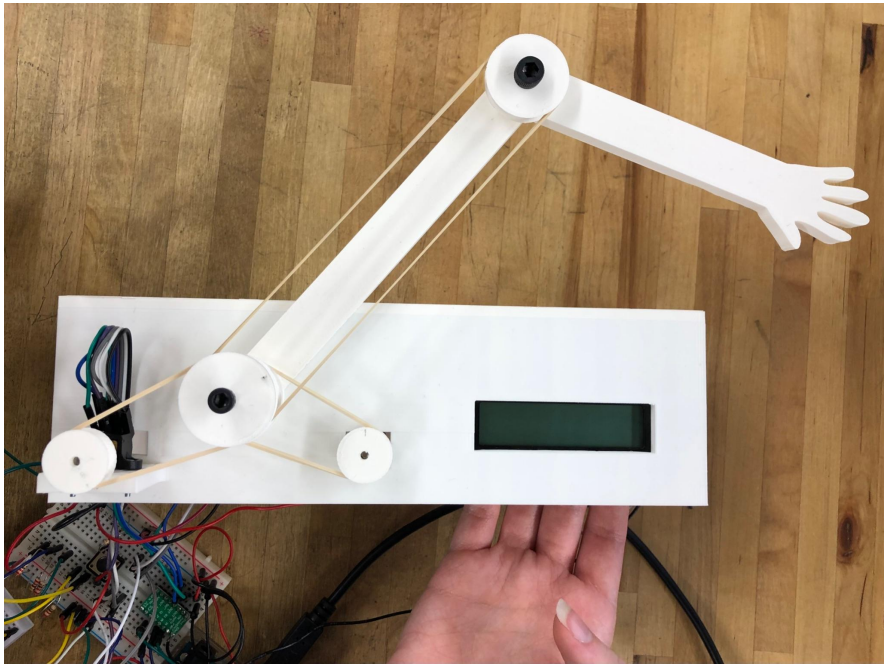
Physical Design

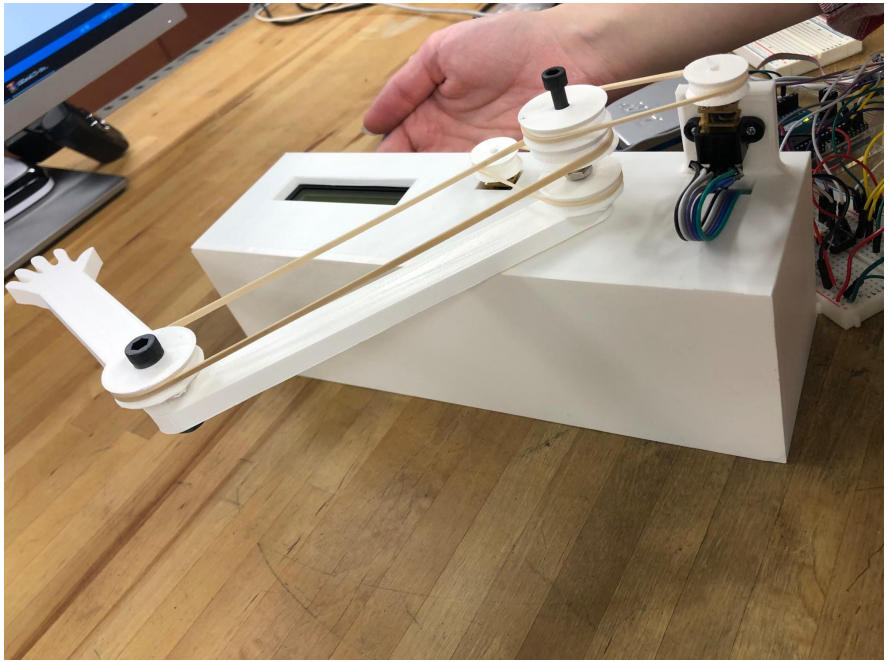


Used design to calculate body dynamics and size motors.

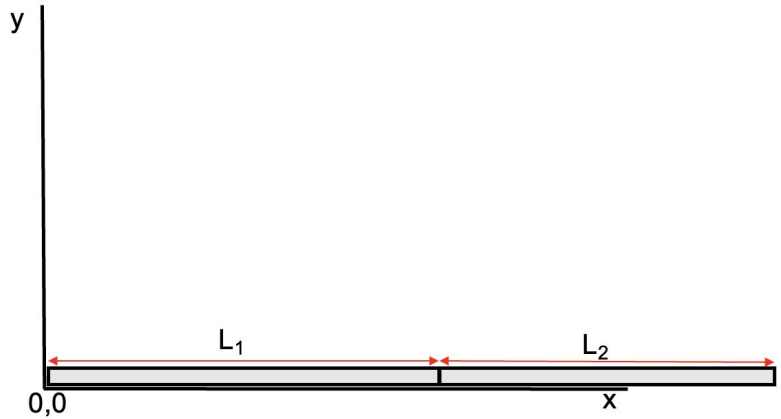


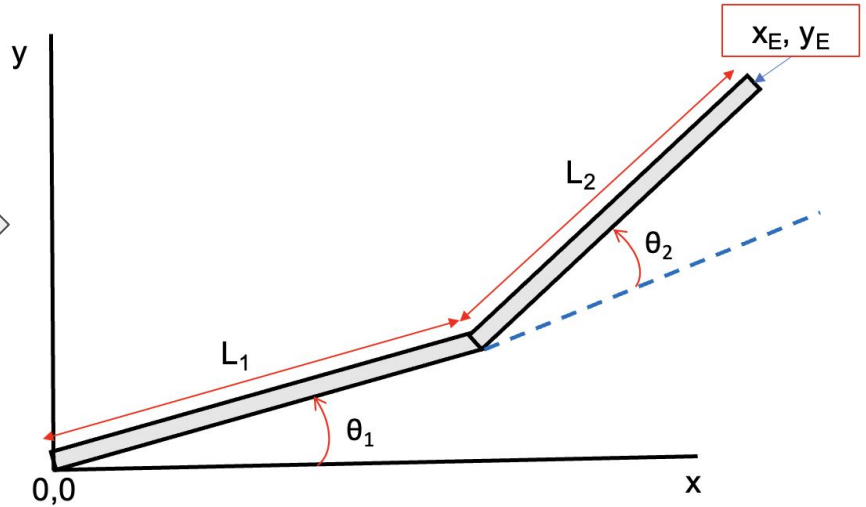
Physical Design





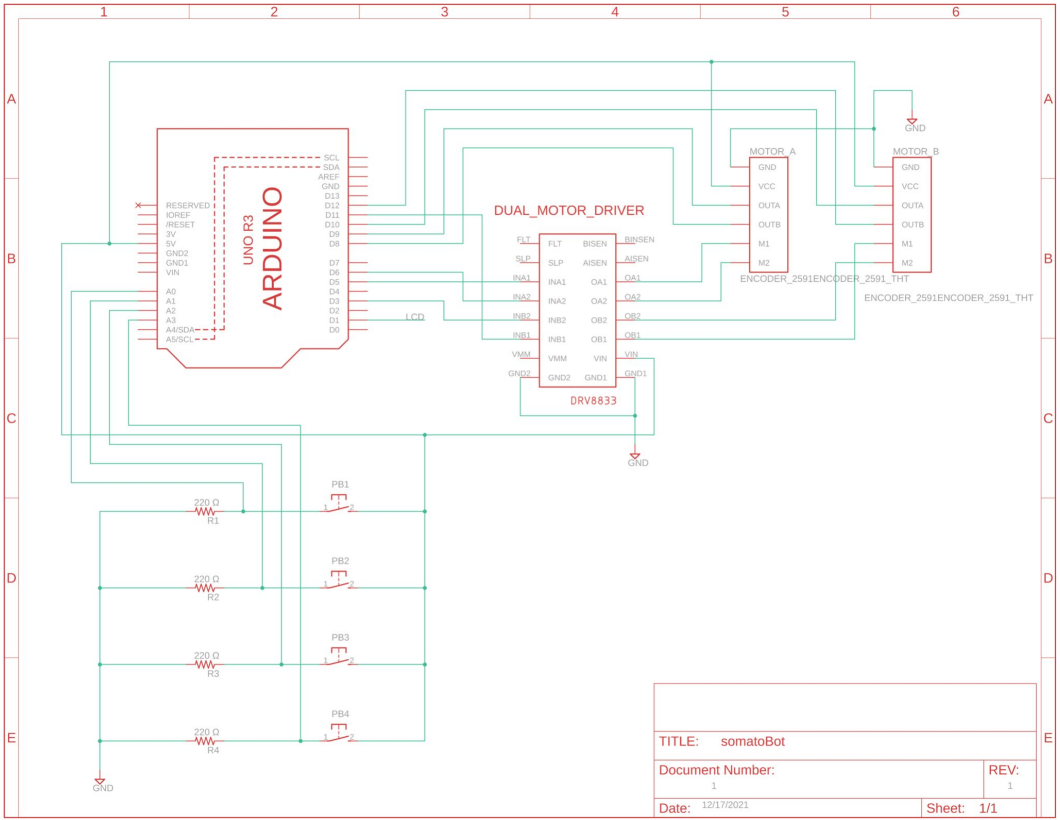
Inverse Kinematics





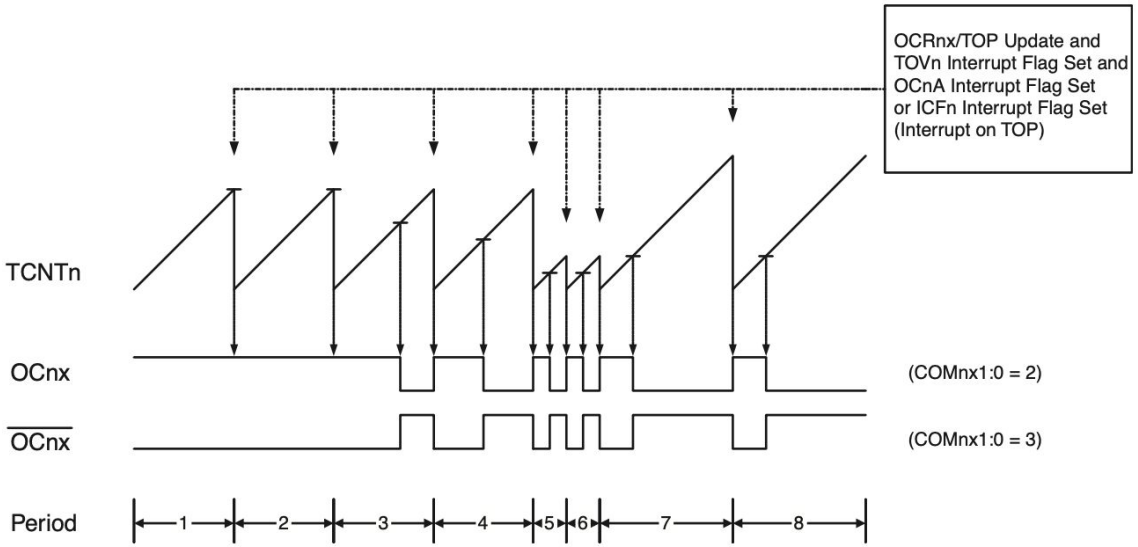
Robot Trajectory

Schematic



Resource management!

PWM Motor Control



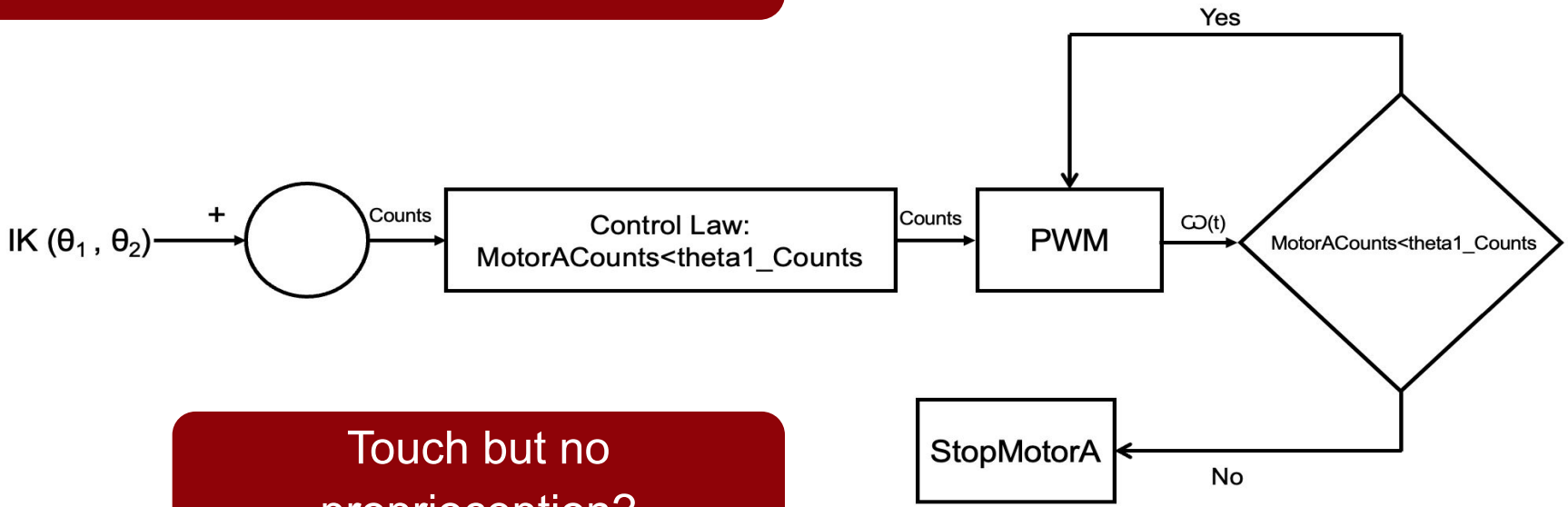
TOP value was adjusted by controller to increase or decrease velocity of the two motors.

Fast PWM Mode, Timing Diagram

(image from ATMEL ATmega328p data sheet)

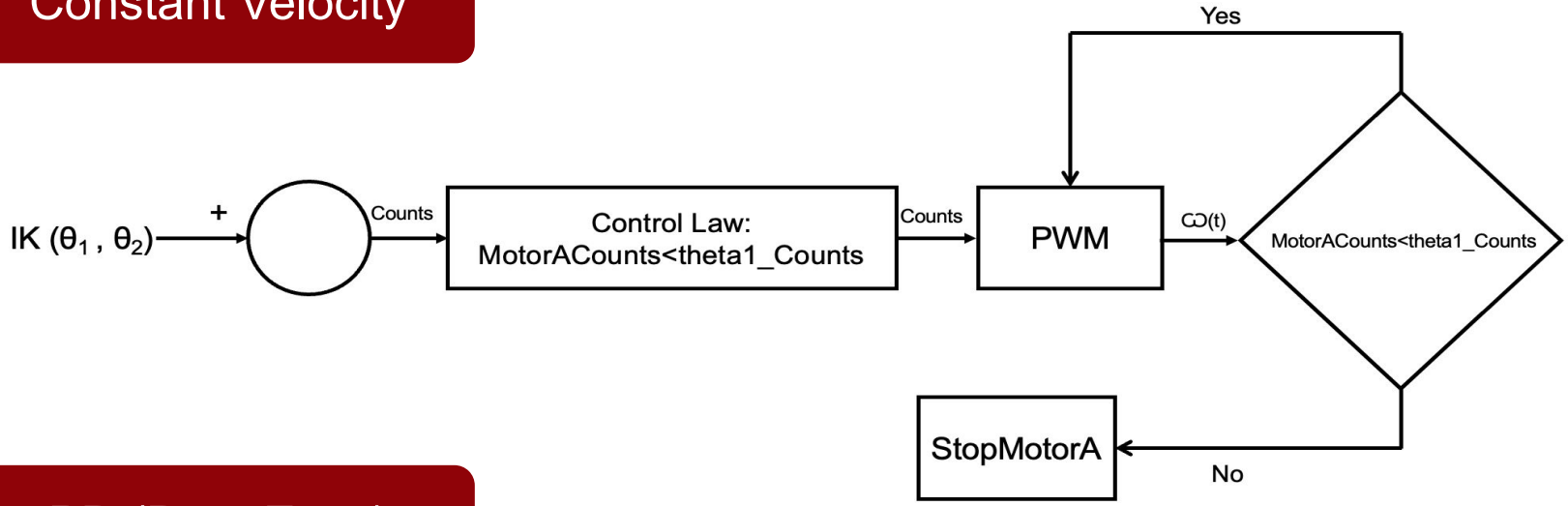
Control Laws

Constant Velocity (Normal Mode)

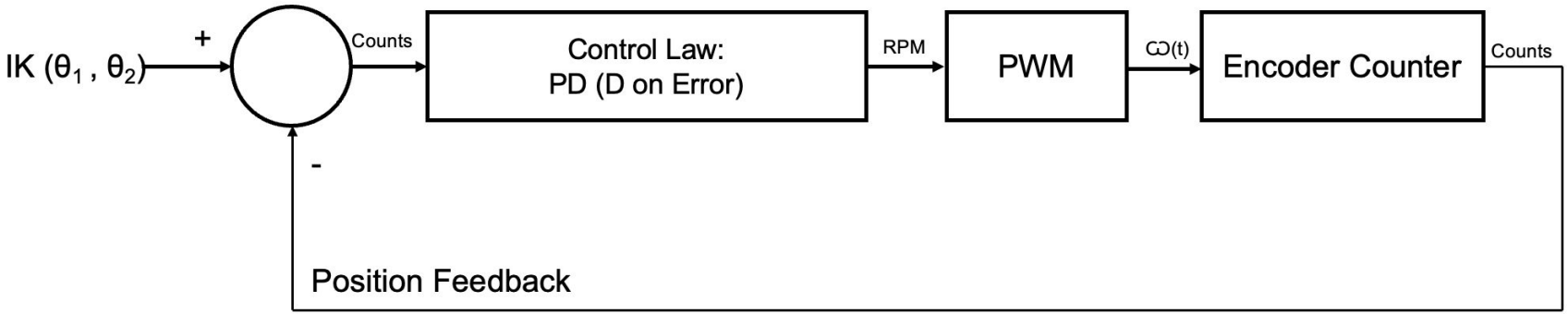


Touch but no proprioception?

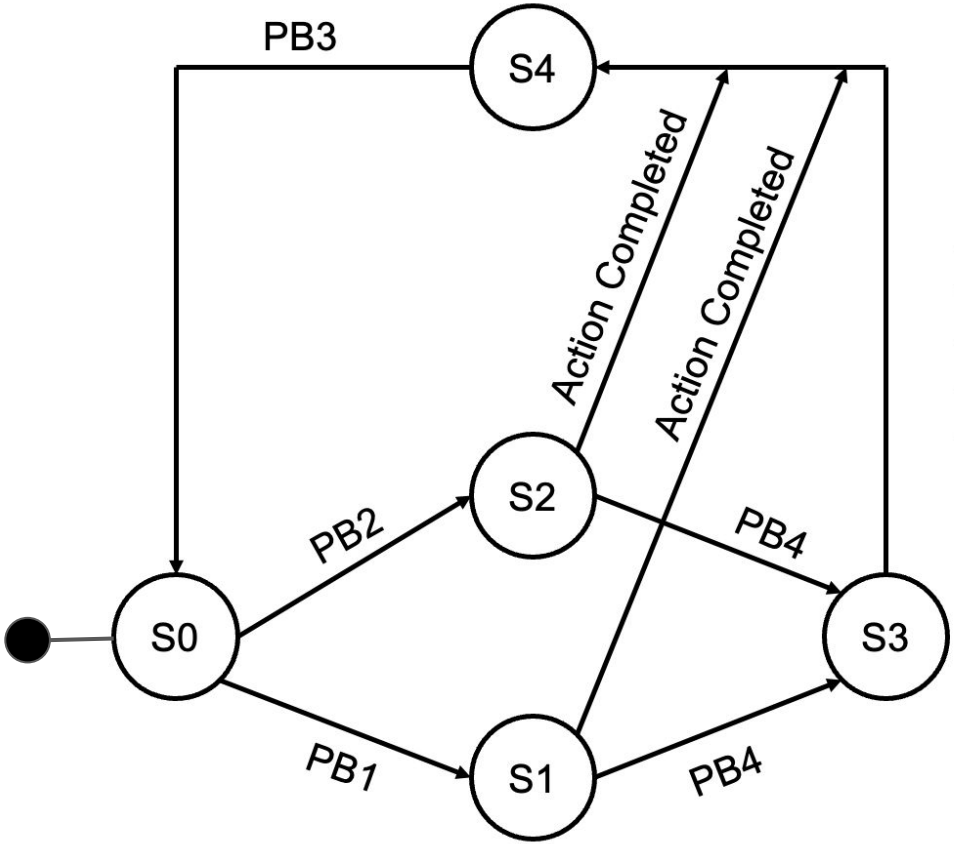
Constant Velocity



PD (D on Error)



State Machine



S0: Ready…
S1: Normal Mode
S2: Noise Mode
S3: E-Stop
S4: Restart

Challenges Overcome

- Debugging on Arduino & setting up with Atmel Studio (not arduino IDE)
- PWM
- Communicating to new LCD via serial (without premade library)
- How to perform an inverse kinematic analysis for a two link robot

How to set up an entire system from scratch!

Future Work

- Refine mechanical design and pulley system
- Replace/Repair LCD
- Resolve conflict between encoder counter and state machine
  - Dedicated encoder counter
- Add additional modes with corresponding control laws

ME445 Tools/Topics Covered:

- Circuit design
- Data sheet reading
- C programming & debugging with CodeVision AVR and Atmel Studio
- Digital I/O & Digital logic
- Interrupts & timers
- State transition diagrams
- Use of an LCD
- Encoder counting
- PD Control
- Fixed point math
- PWM & H-Bridge