RTV Midterm Presentation

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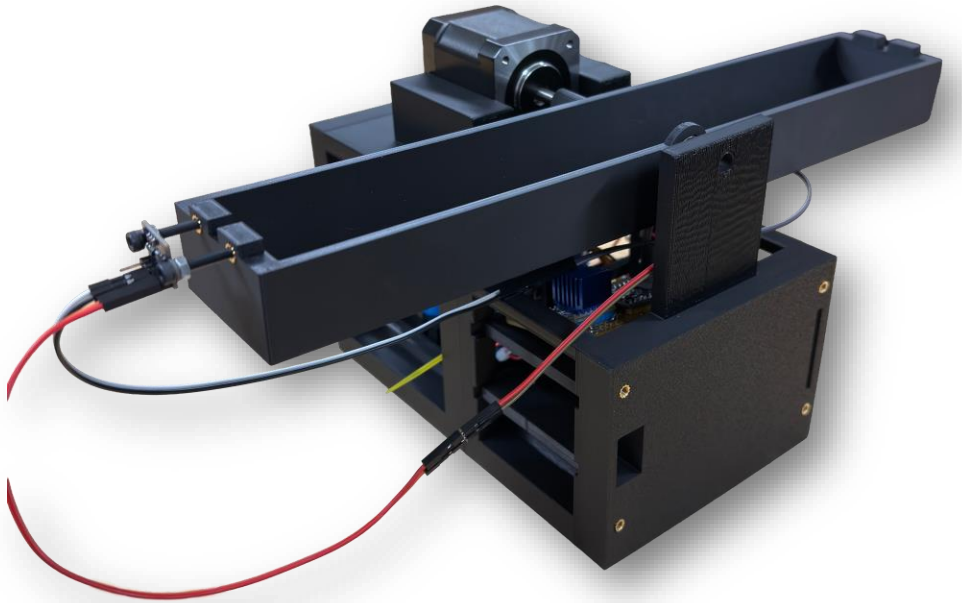
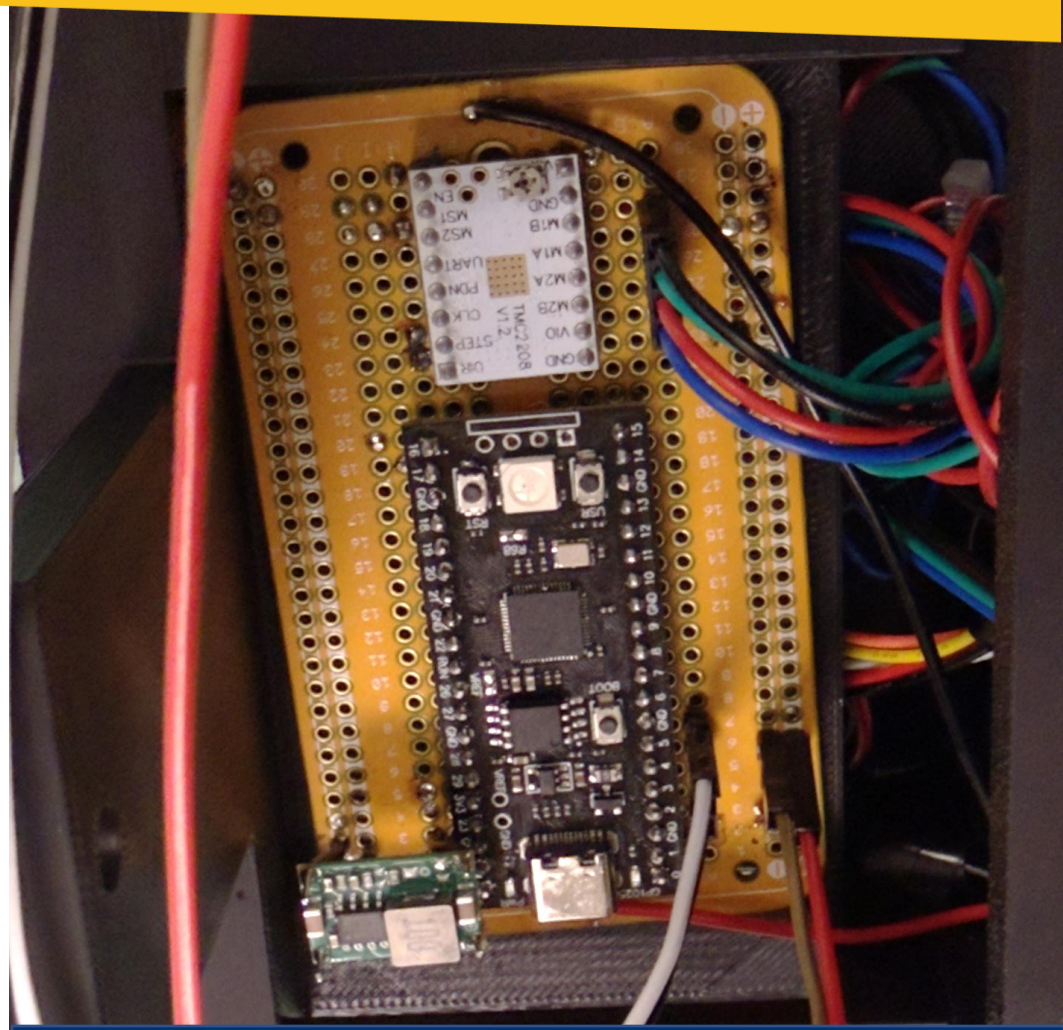
Our Robots

Two physics-based educational robots which show simple physics and robotics for kids.



Updated Requirements

- 3D Printed
  - Less aggressive stress testing
- Ball on a Beam instead of a Plate

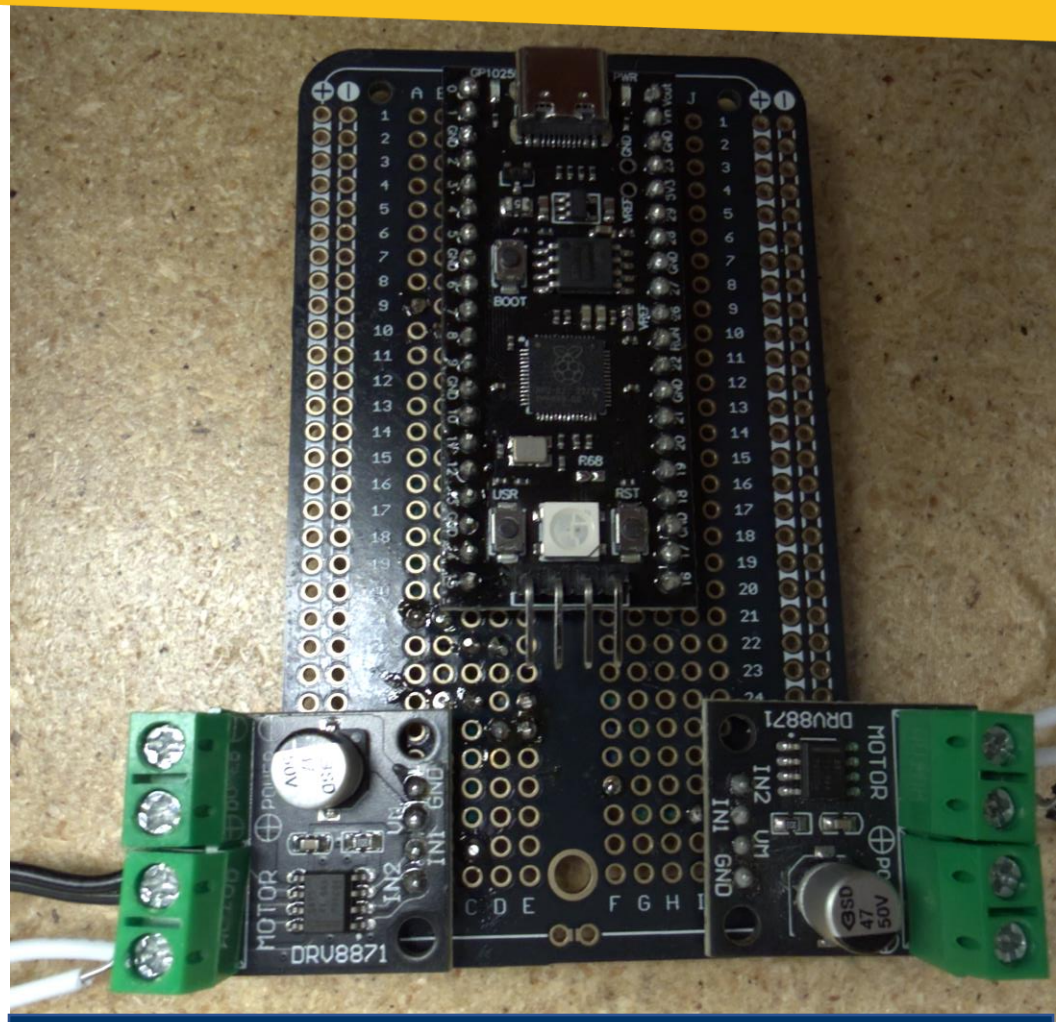


Circuit board for the Ball Beam Balance Robot

Progress Update - Overview

Robot 1:
- Thorough hardware testing
- Modeling the behavior of robot
- Created battery system
- Debugging Issues

Robot 2:
- Thorough hardware testing
  - Investigating intermittent hardware failures
- Testing different sensors
- Debugging Issues



Circuit board for the Inverted Pendulum Robot

Equations of Motion For Simulations

$$\begin{bmatrix} \dot{x} \\ \ddot{x} \\ \dot{\phi} \\ \ddot{\phi} \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & \frac{-(I+ml^2)b}{I(M+m)+Ml^2} & \frac{m^2gl^2}{I(M+m)+Ml^2} & 0 \\ 0 & 0 & 0 & 1 \\ 0 & \frac{-mlb}{I(M+m)+Ml^2} & \frac{mgl(M+m)}{I(M+m)+Ml^2} & 0 \end{bmatrix} \begin{bmatrix} x \\ \dot{x} \\ \phi \\ \dot{\phi} \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{I+ml^2}{I(M+m)+Ml^2} \\ 0 \\ \frac{ml}{I(M+m)+Ml^2} \end{bmatrix} u$$

$$\mathbf{y} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x \\ \dot{x} \\ \phi \\ \dot{\phi} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} u$$

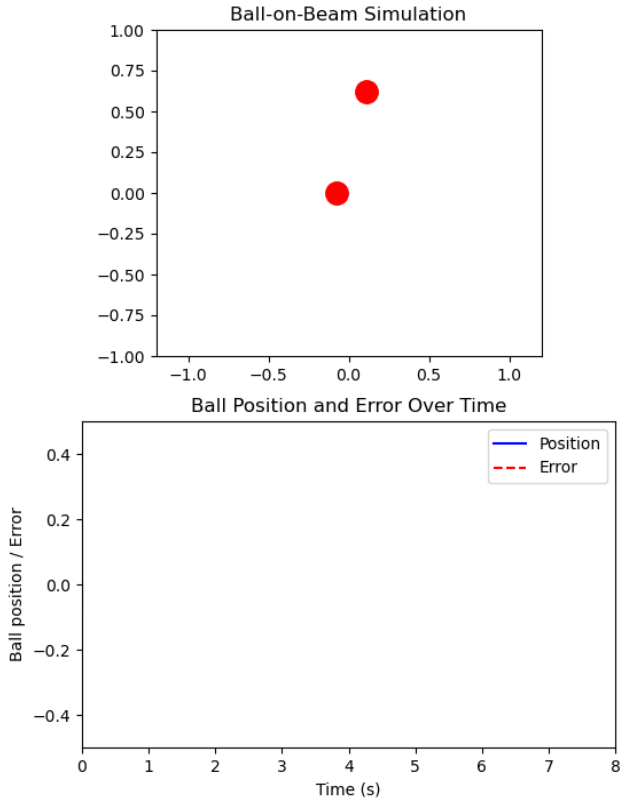
Robot 1: Inverted Pendulum Equations

$$\begin{bmatrix} \dot{r} \\ \ddot{r} \\ \dot{\alpha} \\ \ddot{\alpha} \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & \frac{-mg}{\left(\frac{J}{R^2}+m\right)} & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} r \\ \dot{r} \\ \alpha \\ \dot{\alpha} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix} u$$

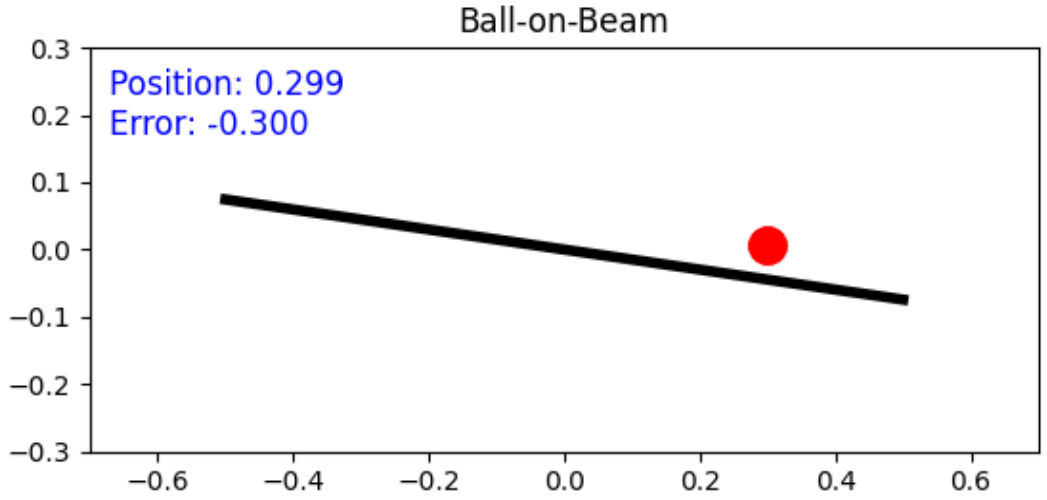
$$y = \begin{bmatrix} 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} r \\ \dot{r} \\ \alpha \\ \dot{\alpha} \end{bmatrix}$$

Robot 2 Ball and Beam balance system

Progress Update - Sims



Inverted Pendulum Robot Sim



Ball Beam Balance Robot Sim

Issues Encountered

Robot 1:

- Potentiometer was not accurate enough
- Loses power under heavy loads
- Wires somehow crossed (According to MEs)

Robot 2:

- Battery sparked
- Consistently fried Picos
- Parts not working out of box
- Motor driver was not good

Updated Parts List

Robot 1:

- Potentiometer -> Magnetic Encoder
- Bulk Capacitors
- Lots of electrical tape

Robot 2:

- Ultrasonic sensor -> ToF
- TMC2208 -> TMC2209 motor driver
- Schottky Diode/P-type MOSFET

Timeline

- Finish first two prototypes by Thursday, March 26th
- Meet with sponsor to get final approval on design
- Prep for Undergrad Symposium April 24th
- Mass produce 5 of each for the end of the semester

Thank You!

Any Questions?