

FEATHERWEIGHT

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Biomechatronic Systems for Humans
4th May 2017



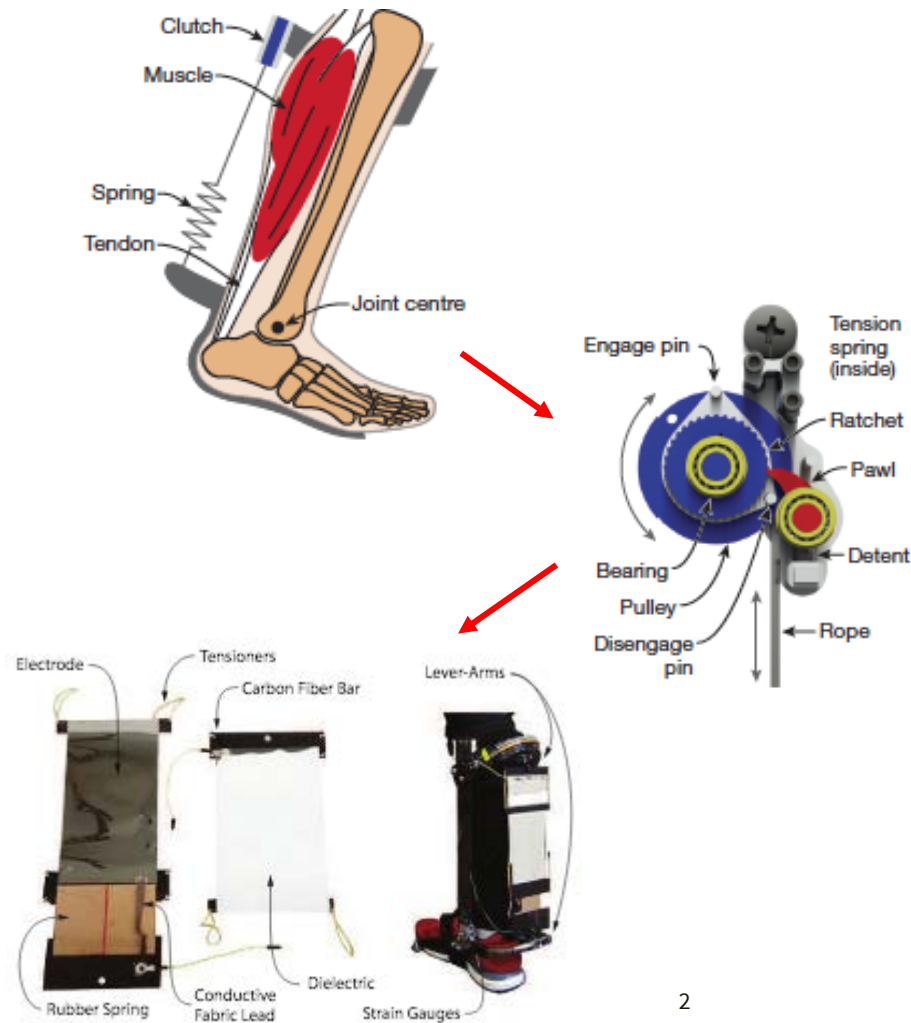
Outline

■ Outline

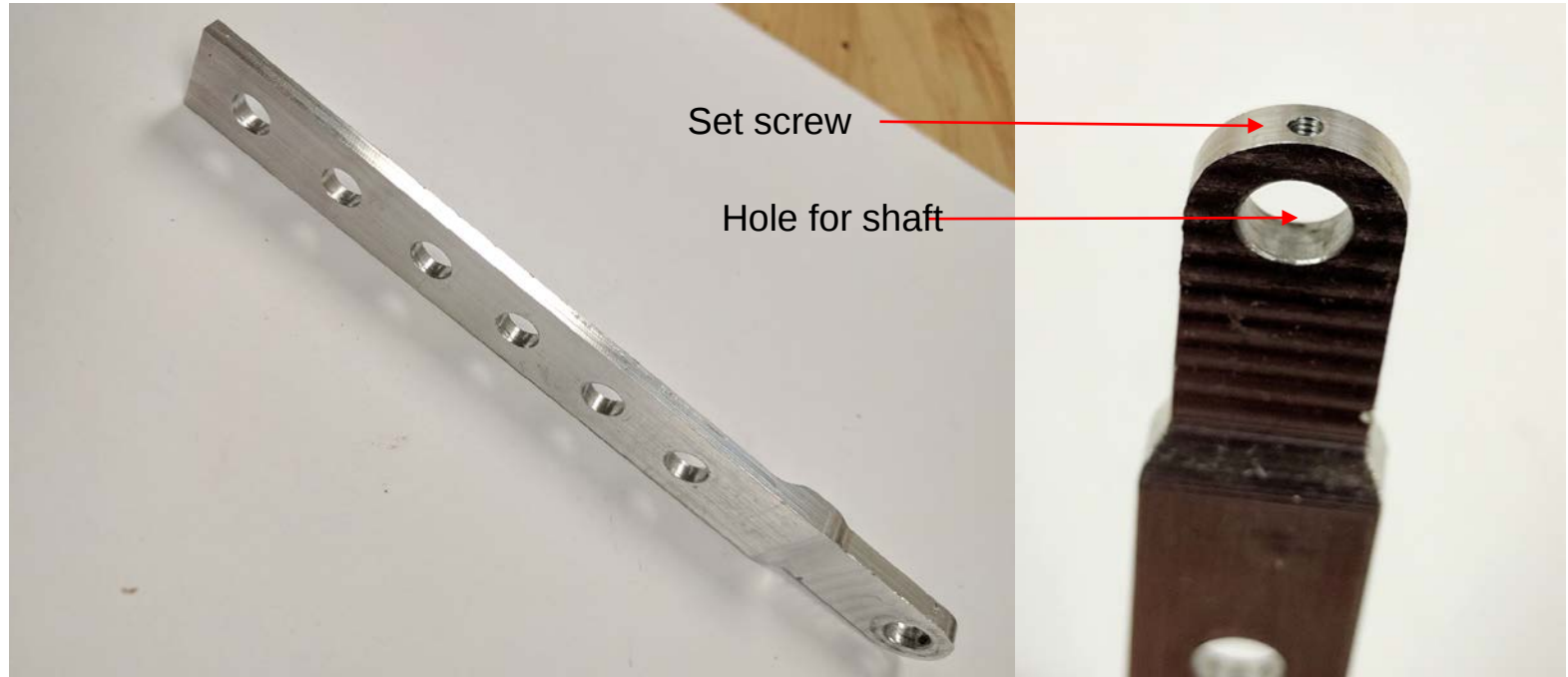
- Recap
- Machined Parts + Assembly
- Strain gauges
- Controller
- Videos + demo

■ Potential of Electroadhesive

- Light and energy efficient
- Multiple in parallel



Machined Components



Fork plate

Machined Components



Shafts

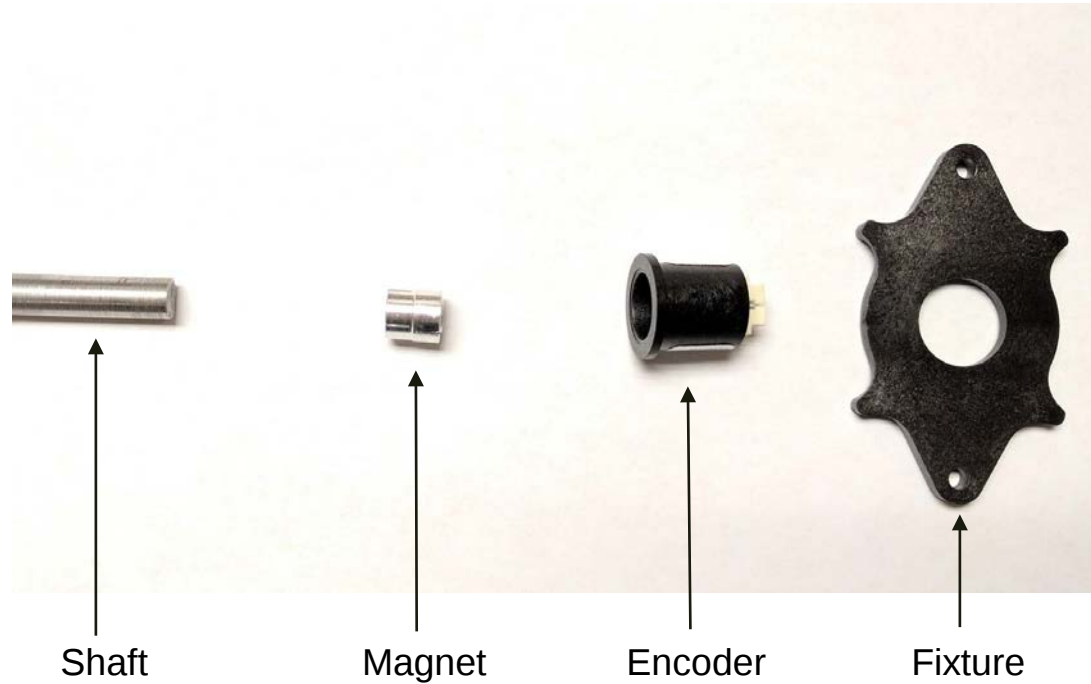


Steel Inserts

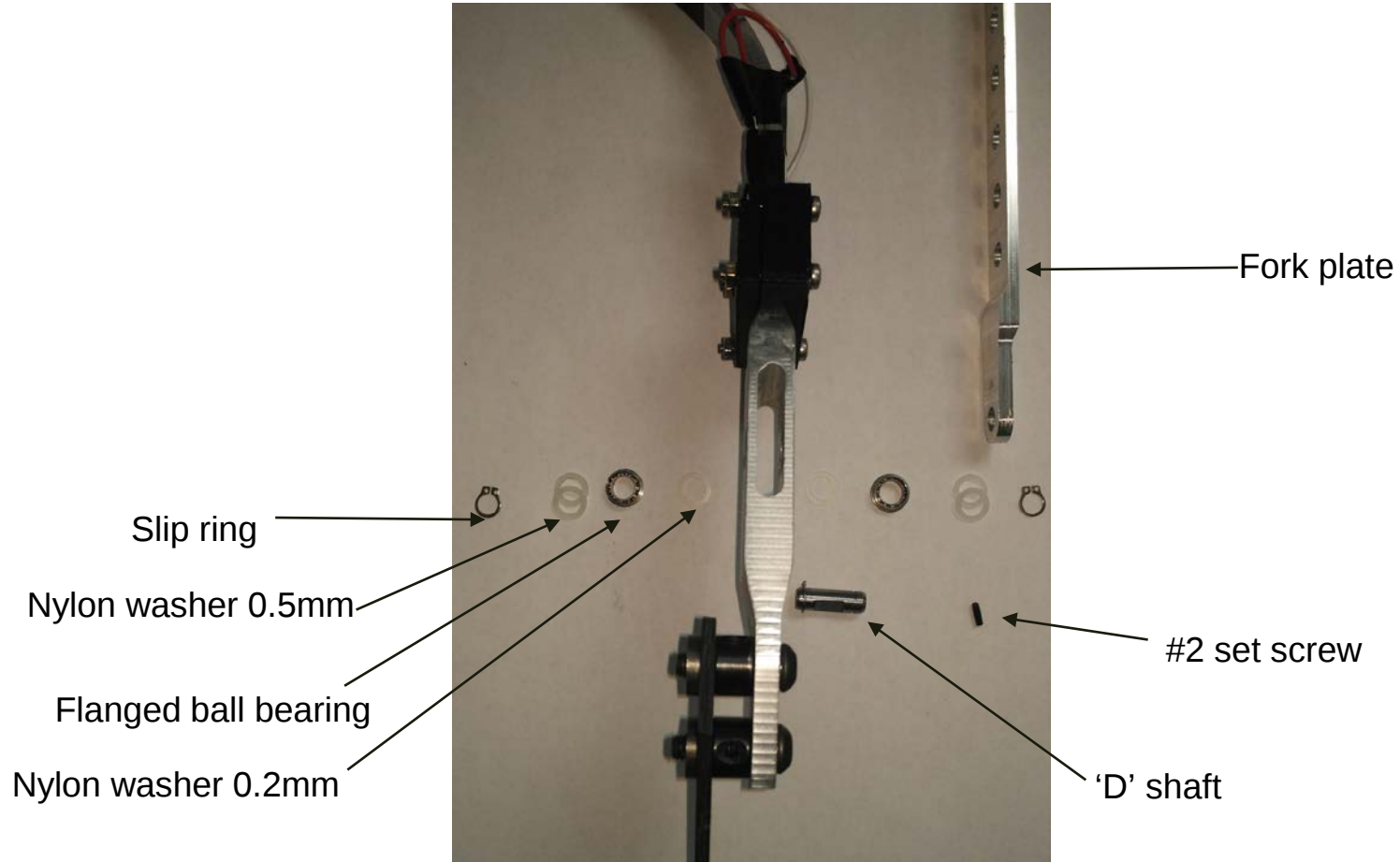


Lower lever arm

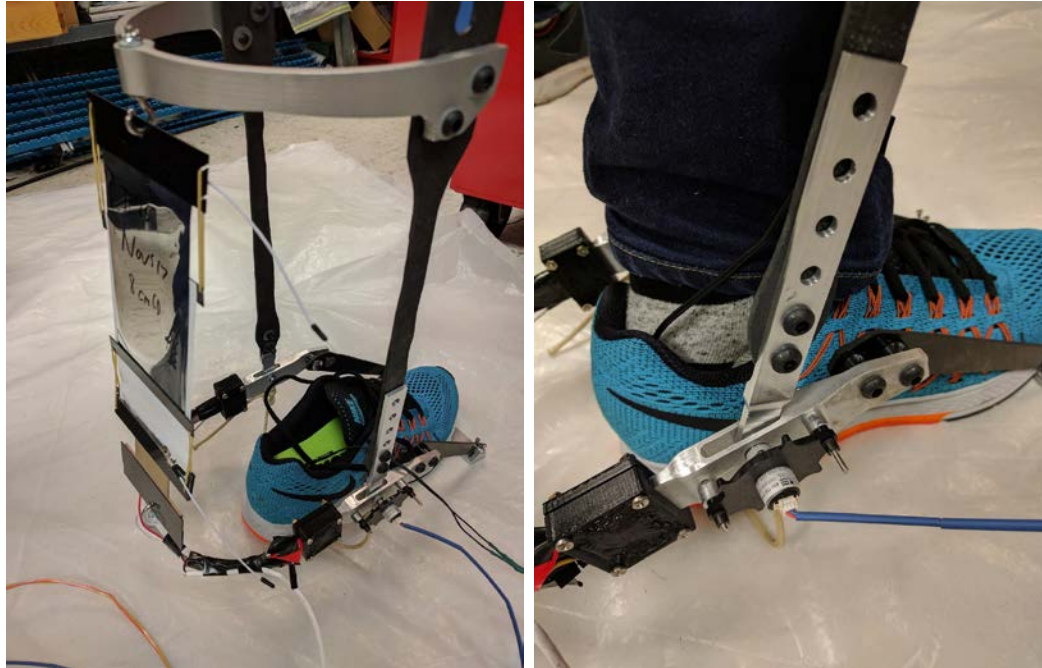
Magnetic Encoder



Lower lever-arm assembly



Full assembly

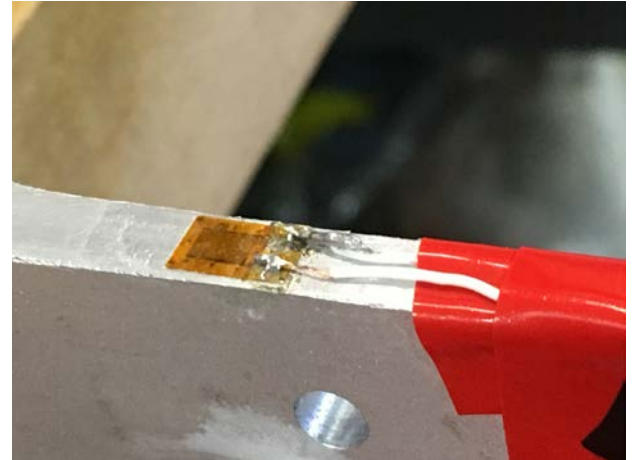
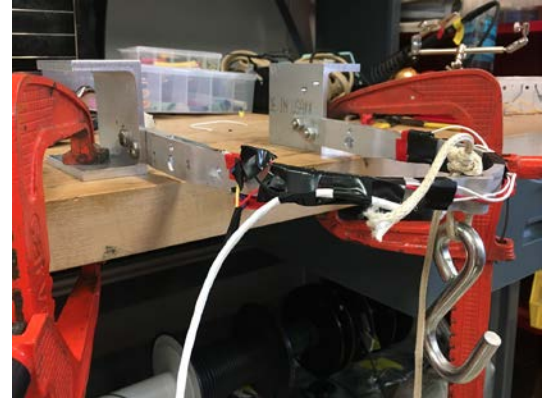


Total weight - 670 grams

1.47 lbs

Strain Gauges

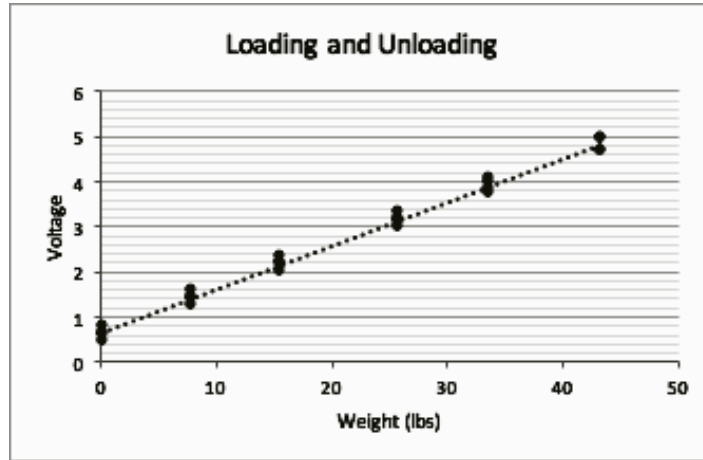
- Goal
 - Provide feedback of ankle torques
- Process
 - Go through hell
- Results
 - Calibration of strain gauges
 - Arduino readings from amplifier



Test Rig



Strain Gauge Results



$$y = .0968x + 0.626$$

$$R^2 = 0.99235$$

$$\text{Torque}_{\text{fixture}} = \text{Moment Arm}_{\text{fixture}} * \text{Force}$$

$$\text{Torque}_{\text{ankle}} = \text{Moment Arm}_{\text{ankle}} * \text{Force}$$

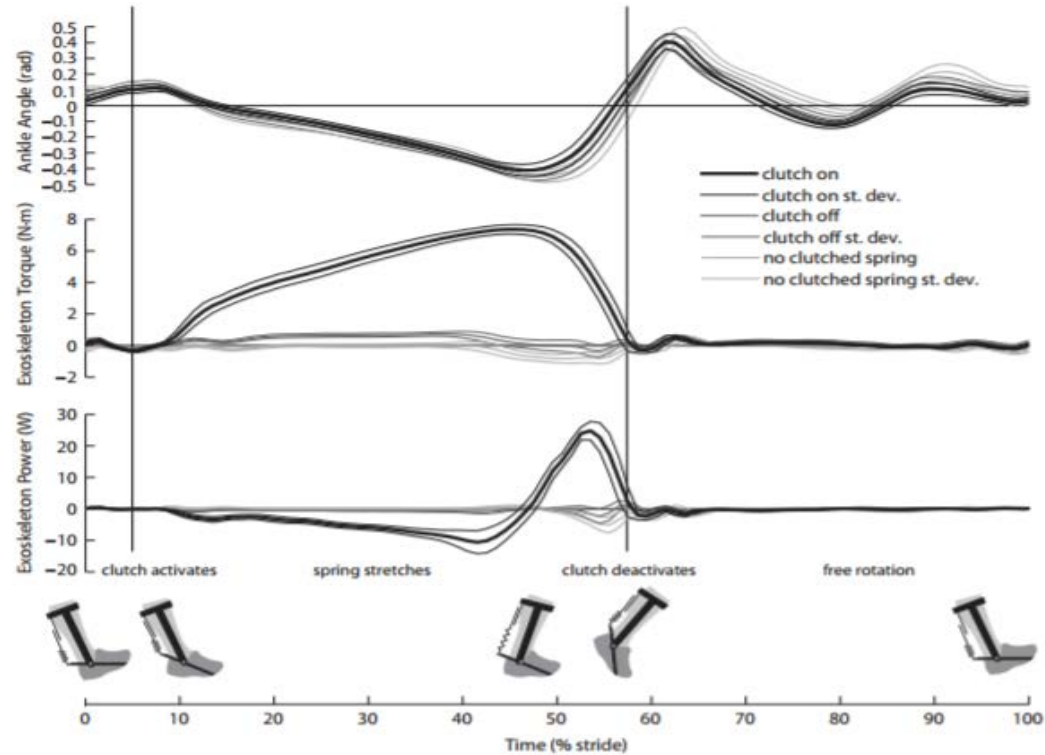
$$\text{Voltage} = \text{Slope} * \text{Force} + \text{Y-Int}$$

$$\text{Torque}_{\text{ankle}} = (\text{Voltage} - \text{Y-Int}) / \text{Slope} * \text{Moment Arm}_{\text{ankle}}$$

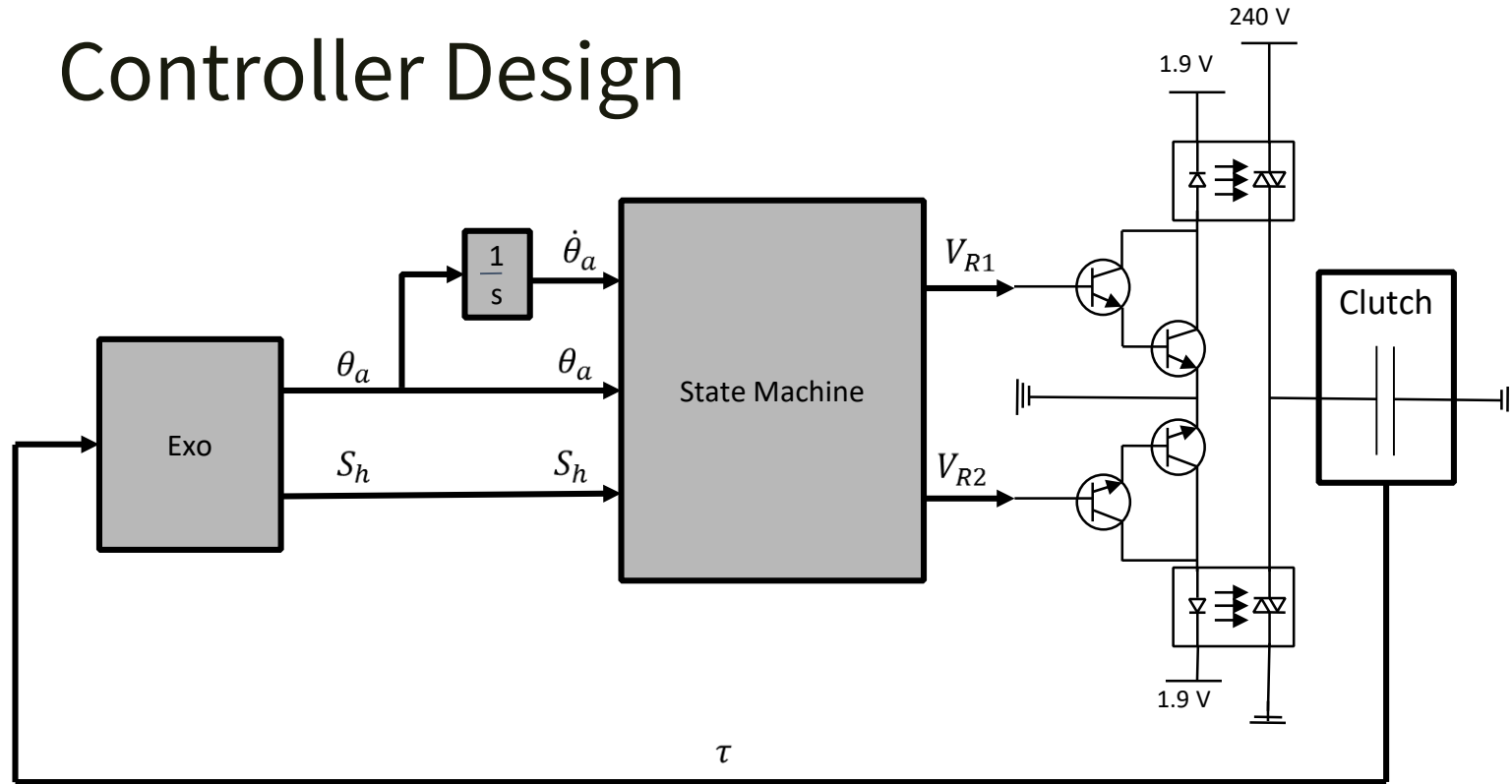
Using Protection



Controller Design



Controller Design



State Machine: if $\dot{\theta}_a < 0$ and $S_h = \text{on}$, clutch on
 when $\theta_a > \theta_{at \text{ clutch activation}}$, clutch off

Controller Design

Input: S_h , θ_a , R_c

Loop:{

switch(FSM_state):

{

case: clutch_off

if($d\theta_a < 0$ && $S_h == 1$){

FSM_state = clutch_on;

θ_a activation = θ_a ; $R_c = 1$

Break;}

case: clutch_on

if($\theta_a == \theta_a$ activation){

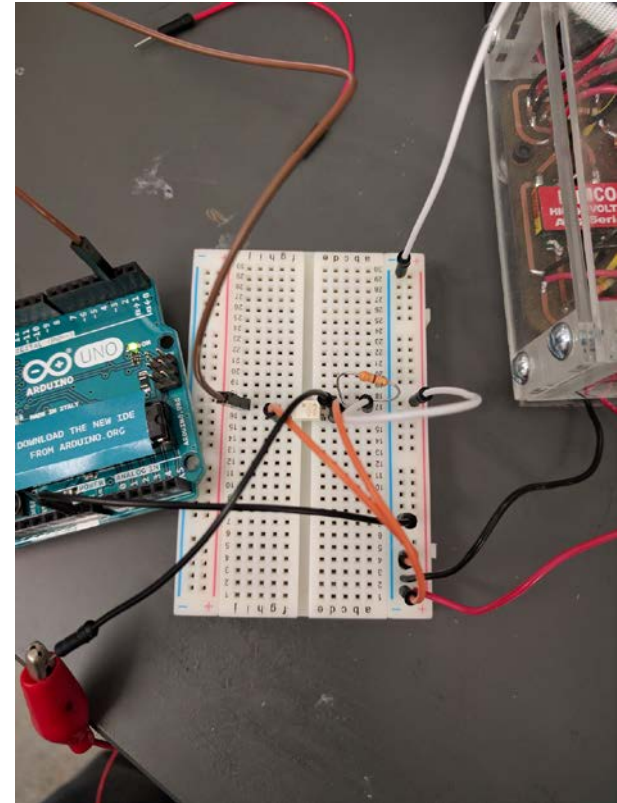
Fsm_state = clutch_off;

$R_c = 0$;

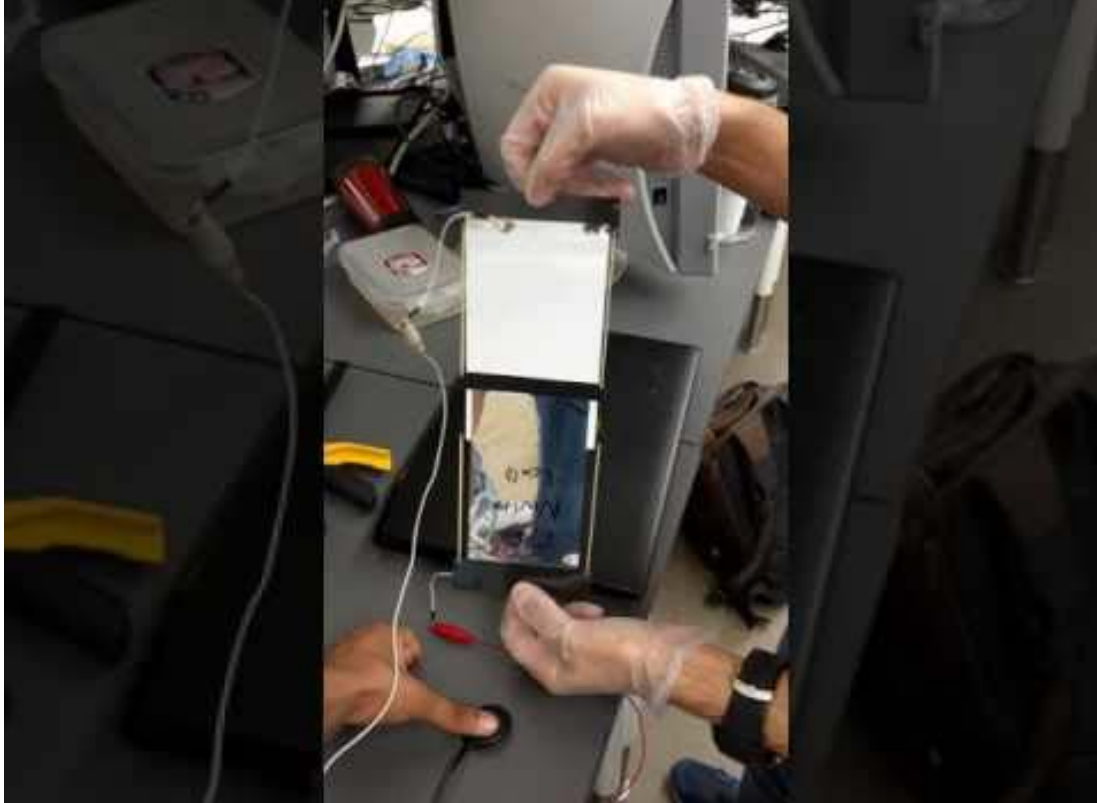
Break; }

}

}



Controller Implementation



Controller Implementation



A decorative vertical plaid pattern on the left side of the slide, featuring a mix of dark blue, red, green, and yellow lines.

Questions?

A decorative vertical plaid pattern on the left side of the slide, featuring a mix of dark blue, red, green, and yellow lines.

Extra Slides

A vertical decorative border on the left side of the slide featuring a complex plaid pattern with intersecting lines of red, green, blue, and yellow.

Weights

Inserts:- 2g each

Fork plate: 17g each

Side strut: 34g each

Bolts: 4g each

Lower lever arm: 242g with wires and stuff. ~ 210 without

Upper lever arm: 151g

Toe plate: 64g

Side toe: 8gm each

Bearing: 1g

Shaft; 8 g, 6g