Rowing biomechanics for lower extremities

Date: 3/14/2023

Client: Jill Thein-Nissenbaum, Tricia DeSouza
Advisor: Dr. John Puccinelli
Team:

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Problem statement

Many college rowing athletes, particularly women, are susceptible to lifelong lower back or hip injuries due to disparate weight distributions on each leg while rowing. This issue can be addressed through gathering real-time data on athlete biomechanics, but this data is often difficult to obtain. Collection and analysis of biomechanical data will enable athletes to adapt their technique towards better performance, and will assist coaches and trainers in preventing injury. The client, Dr. Jill Thein-Nissenbaum, has tasked the team with creating a force plate system that can collect biomechanical data from rowers' lower extremities. The team's goal is to create a wireless sensor system in the rowboat that will capture load distribution during time of use and will assess lower extremity asymmetry to establish risk stratification. Additionally, the team aims to translate the force plate system into a user-friendly interface that will enable coaches and athletes to understand essential biofeedback information, thereby improving both performance and safeguarding against potential injuries.

Brief status update

This week, the team met with Dr. Gruben and Dr. Bell to discuss the feasibility of our current load cell design. Dr. Gruben informed us that even with our new budget of $1000, we would not be able to procure the quantity and quality of load cells necessary to give accurate force

readings. The load cells within our budget are highly sensitive to off-axis loads, so if the net force from the rower's foot does not align perfectly with the intended axis of the load cell, it will throw very large errors. To account for this, Dr. Gruben suggested we alter our design to utilize two plates that can rotate over a frictionless pivot and an angular encoder to measure the angle of rotation, which would be proportional to the difference in normal foot force. The team has workshopped a few modifications to this design, and we would like to discuss these ideas with the clients and Dr. Gruben before moving forward.

Difficulties / advice requests

The knowledge we gained this week about the feasibility of using load cells is incredibly valuable to the outcome of this project, however, it does change a lot of our design. We will need to think carefully about how to move forward with our project and our clients' wishes are the top priority.

Current design
Proposed footplate design
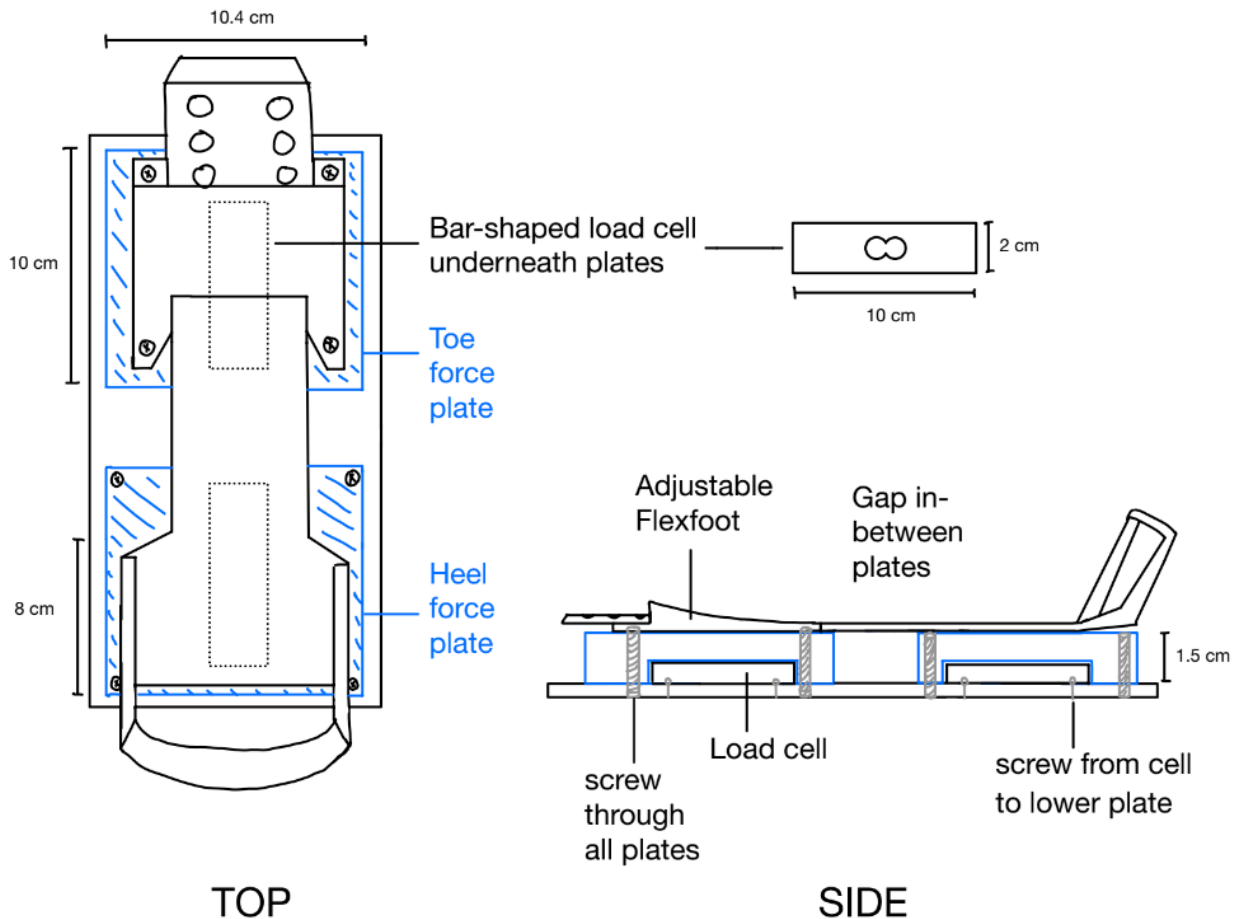
Display design matrix winner: Raspberry Pi + 7" LCD
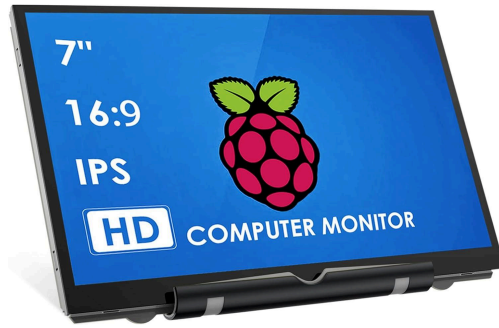
Materials and expenses

Item	Description	Manufac-turer	Mft Pt#	Vendor	Vendor Cat#	Date	#	Cost Each	Total	Link
Electronics										
Raspberry Pi	Microcontroller	Raspberry Pi		Sparkfun	DEV-15446	2/15	1	$45	$60.43	Link
Raspberry Pi	7" Display Screen	Raspberry Pi		Amazon		2/23	1	$33.99	$33.99	
Raspberry Pi	20W 5V 4A Power Supply	Raspberry Pi		Amazon		2/23	1`	$11.99	$11.99	
MicroSD Card	32GB 3D NAND High Speed MicroSD Card with Adapter	Silicon Power USA		Amazon		2/23	1	$8.99	$8.99	
HDMI Cable	4K Micro HDMI to HDMI Cable 1 FT Adapter 2.0	Szsea US		Amazon		2/23	1	$8.99	$8.99	
Raw Materials										
									$0.00	
									$0.00	
								TOTAL:	**$124.39**	

Major team goals for the next week

1. Finalize our footplate design with Dr. Gruben's advice and our clients' input.
2. Write a detailed fabrication plan for the footplate.
3. Order necessary materials for the footplate.

Next week's individual goals

- Neha
  - Decide on final sensing components
  - Create fabrication plan
- Simmi
  - Decide on ways to embed IMU sensors
  - Research FSRs, IMUs and formulas to get force from angles
- Allicia
  - Work with the team on choosing the best design idea moving forward.
  - Research data storage solutions (my current idea is a USB hard drive).
  - Work on an executable file for raw data processing.
- Emily
  - Research FSRs, IMUs, or angular encoder to buy/test
  - Prototype with the four load cells
- Colin
  - Start fabrication
  - Design new SolidWorks model based on design we move forward with

Timeline

Task	Jan 26	Feb 2	Feb 9	Feb 16	Feb 23	Feb 29	March 1	March 8	March 15	March 22	March 29	April 5	April 12	April 19	April 26	May 3	May 10
Project R&D																	
Empathize	X	X	X														
Background	X	X	X	x													
Prototyping				x	x	X	x	x	x								
Testings																	
Deliverables																	
Progress Reports		x	x	x	x	X		x	x								
Prelim presentation							x										
Final Poster																	
Meetings																	
Client		x		X					x								
Advisor		x	x	X	X	x		x	x								
Website																	
Update		x	x	x	X	X		x									

Filled boxes = projected timeline
X = task was worked on or completed

Previous week's goals and accomplishments

- Neha:
    - Met with Dr. Gruben
    - Brainstormed new designs
    - Researched ADCs compatible with Raspberry Pi
- Allicia:
    - Worked out the lag issue with the Raspberry Pi display.
    - Brainstormed ideas with the group after our meeting.
    - Researched alternatives to the HX711 for load cell signal amplification.
- Emily:
    - Brainstormed with group after meeting with Dr. Gruben
    - Removed footplates off provided ergometer, created elementary footplate design
- Colin:
    - Researched materials for load cell housing
- Simmi:
    - Researched rotary encoders for angle measurement asymmetry
    - Brainstormed designs with the team
- Team previous goal:
    - Order load cells
    - Fabricate footplate

Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Neha Kulkarni	3/13	Brainstorming, research	5	5	28
Simmi Kaur	3/13	Brainstorming, research	5	5	28
Emily Wadzinski	3/13	Brainstorming with group	3	3	25
Emily Wadzinski	3/14	Research	1	4	26
Colin Fessenden	3/12	Met with Dr. Gruben	1	1	22
Allicia Moeller	3/12	Remade the demo GUI	3	3	37
Allicia Moeller	3/13	Research design idea	4	7	41