BME 200/300

DEPARTMENT OF

Biomedical Engineering

UNIVERSITY OF WISCONSIN–MADISON

Weight Bearing Sensor

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Overview

Topic Order:

1. Client problem
2. Client and sensor background
3. PDS recap
4. Design alternatives
5. Circuit
6. Final design and future steps

Problem Statement

- **Request:** Client wanted an inconspicuous sensor fitting in a patient's shoe to monitor weight distribution

- **Alterations:**
  - Sensor surrounded with padding
  - Sensor would be secured to foot with strap

Introduction

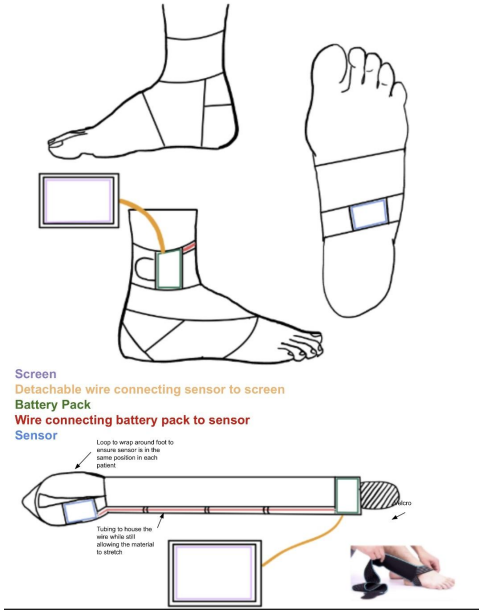
- **Client:** Mr. Daniel Kutschera, PT
- Works with partial weight-bearing patients
  - Given percent weight bearing or pound amount
  - Need help putting this into practice
- **Current Items on the Market:** Beeper Boot, Stappone Rehab Insole [1]
  - Patient size varies greatly

Summary of PDS

- Adjustable to fit variety of sizes
- Comfortable
- As close to wireless as possible
- Accurate within 1-2 lbs/150 lbs
- Under $500

Design Alternatives Considered

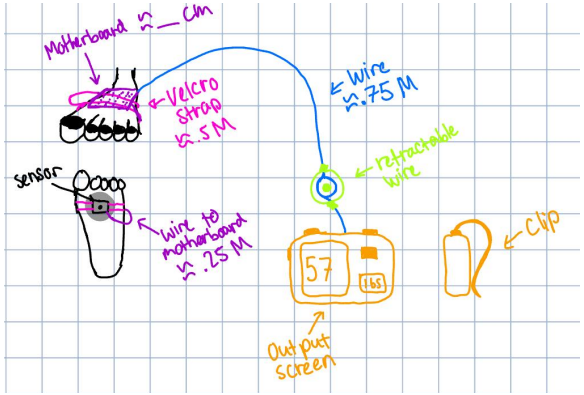
Design 1: The Built in Strap



Pros: Very versatile

Cons: Velcro can wear

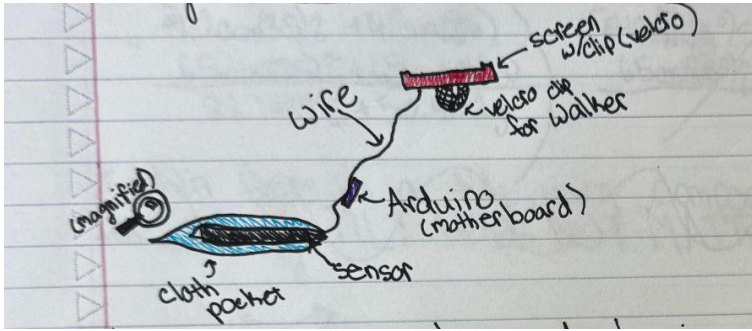
Design 2: The Wrap-Around



Pros: Can be placed at any area of foot

Cons: Could restrict patients range of motion

Design 3: The Cloth Pocket



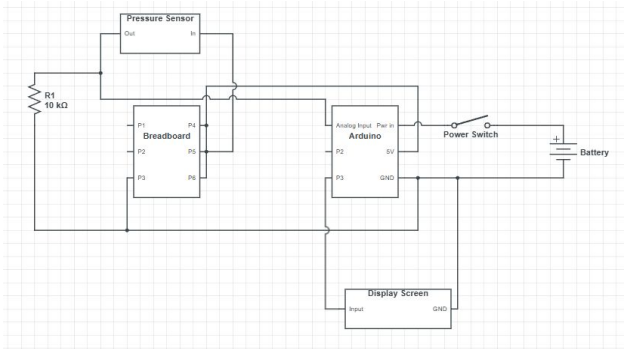
Pros: Can be placed comfortably in shoe

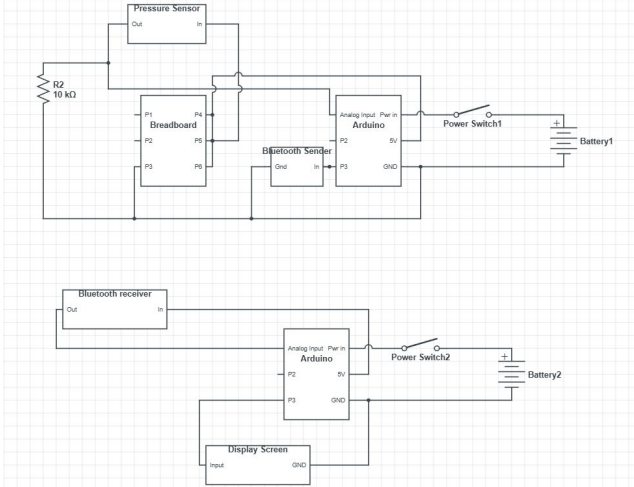
Cons: Arduino might be heavy for the wire

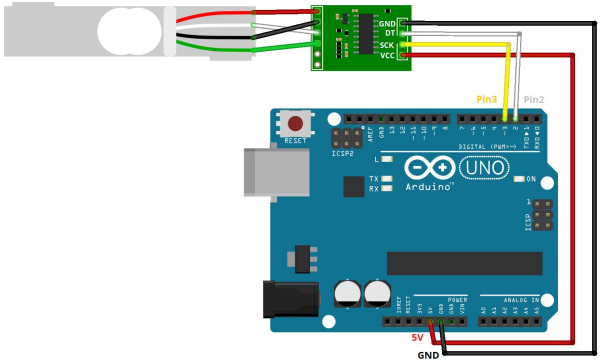
Design Matrix

			Design 1		Design 2		Design 3
Criteria	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Safety	35	4.5	31.5	4	28	4	28
Ergonomics	25	5	25	4	20	4	20
Versatility	20	4	16	5	20	5	20
Ease of use	15	4	12	3	12	4	12
Cost	5	3	3	4	4	4.5	4.5
Total	100	**Sum**	**87.5**	**Sum**	**84**	**Sum**	**84.5**

Circuit Design Alternatives Considered







Base circuit:
Pros: very simple, cheap, and easy to assemble
Cons: not compact, medium accuracy

Base circuit with bluetooth:
Pros: most compact
Cons: medium accuracy, higher cost

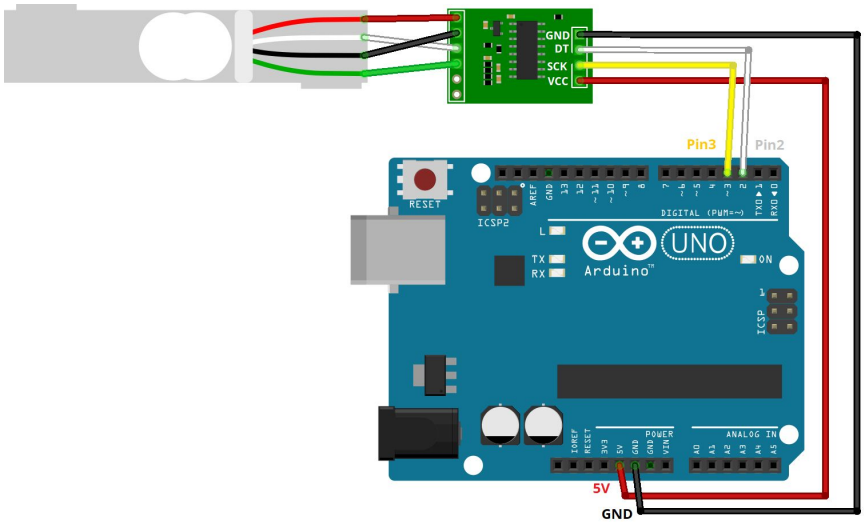
Circuit with amplifier:
Pros: simple, high accuracy, easy to assemble
Cons: not compact
[2]

Circuit Design Matrix

		Basic Circuit		Basic Circuit with bluetooth		Circuit with amplifier	
Criteria	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Safety	30	4.5	27	5	30	4.5	27
Accuracy	25	4	20	4	20	5	25
Compactness	20	4	16	4.5	18	4	16
Simplicity	10	5	10	3	6	4.5	9
Cost	5	4.5	4.5	3.5	3.5	4	4
Total	100	**Sum**	**77.5**	**Sum**	**77.5**	**Sum**	**81**

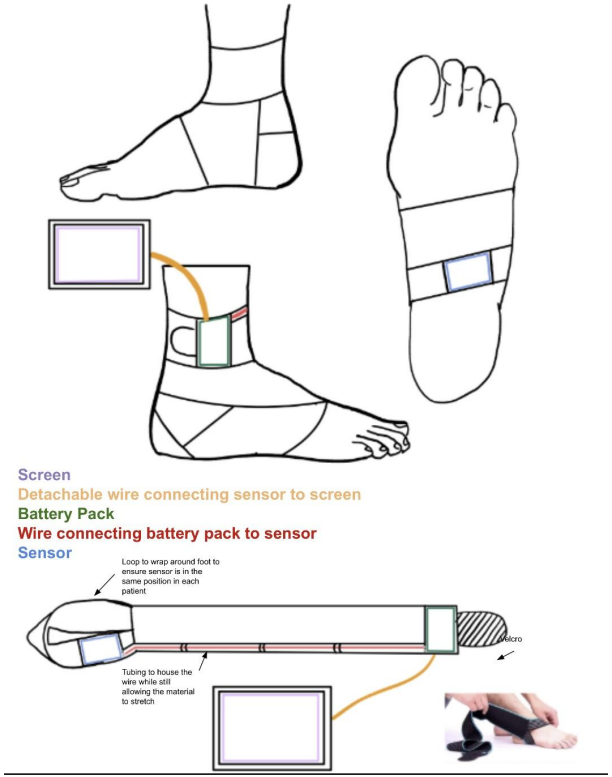
Final Circuit Design

- Highly accurate
- Simple
- Easy to fabricate
- Medium price point
- Avoids allergenic and dangerous materials [3]



Final Design

- Adjustable strap
- Battery pack
- Wired
- Sensor located on bottom of foot
- External screen



Design 1: Built in Strap

Testing and results

- No current testing results
- Future testing
  - Durability tests
  - Accuracy tests

Future Work

- Fine tune design to client needs
- Fabrication
- Testing
- Potential additions
  - Application software
  - Bluetooth

References

[1] “STAPPONE Rehab,” *stappone*, May 10, 2023. https://www.stappone.com/en/products/partial-weight-bearing-management/stappone-rehab/

[2] S. Santos, “Arduino with Load Cell and HX711 Amplifier (Digital Scale) | Random Nerd Tutorials,” Apr. 27, 2022. Available: https://randomnerdtutorials.com/arduino-load-cell-hx711/.

[3] K. Pachenko and J. Thyssen *Contact dermatitis from biomedical devices, implants, and metals-trouble from within* The journal of allergy and clinical immunology. In practice, https://pubmed.ncbi.nlm.nih.gov/39067854/.

Acknowledgements

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