Force Sensor Protective Casing System and Design for a Lower Limb Exoskeleton

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Introduction

Measuring ground reaction forces is integral to lower limb exoskeleton functionality as it defines participant gait phase (step or swing). Traditionally, a footplate was used to measure these forces, but the plate's size and bulk made it cumbersome and introduced noise with smaller sized participants, as it is one size fits all.

This project created an adjustable sensor placement design underneath a participant's foot.

Objectives

- Protective Casing
- Secure Sensor (FSR) Fit
- Easy to check quality and make replacements
- Secure shoe attachment

Concept Generation

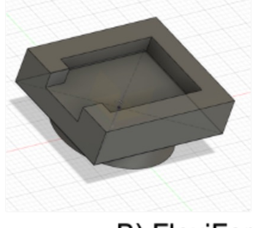
Attachment Options:

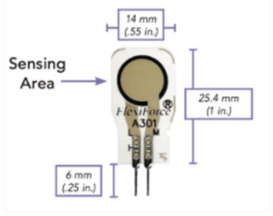
A) Cricket Shoes

B) Screw-In

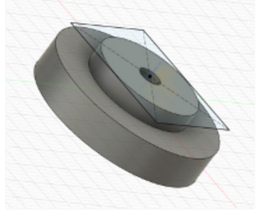
Sensor Options:

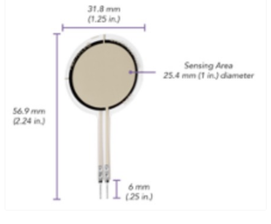
A) FlexiForce A301 Sensor





B) FlexiForce A401 Sensor





Rapid Prototyping & Features

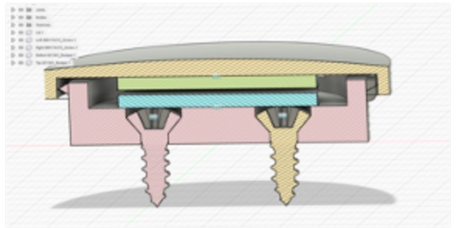
Prototyping and verification testing led to multiple features of improvement developed and added to the design:

Locking Mechanism
Twist-lock cap design included a 4-edge profile with a notched hard stop.

Difficulties:
- Locking securely
- Protecting FSR tail ends

Cover Notch
A small notch added to the cover for part orientation.

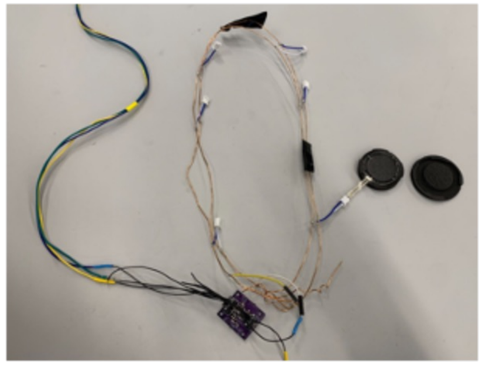
Concentrator Pucks



Difficulties:
- Determining correct height and pressure
- Adjusting design to varying number of pucks

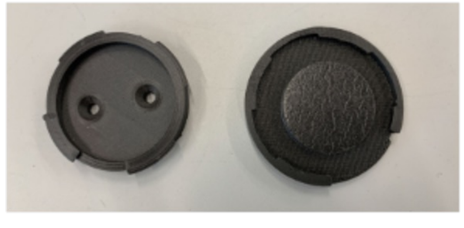
Final Design

Electronic Assembly with FSR in Case:

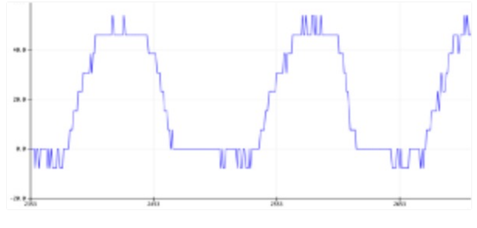


Pucks Attached to Shoes:

Open Puck: Base and Cap



Experimental Validation



Electronic Assembly

FSRs were wired in parallel after soldering connectors to copper wires around the shoe perimeter. Output signals went through an amplifier on a PCB before normalized by Arduino code by participant weight.

Conclusions

- System experimentally validated to work as expected.
- All objectives met:

Protective Casing	→	3D Printed Plastic
Secure Sensor (FSR) Fit	→	Custom designed base + foam concentrators
Easily replaced and checked for quality	→	Twist Lock Cap
Secure shoe attachment	→	Dual Screws

Future Work

Other adaptations to Ground Force Sensing with FSRs:
- Full foot sensor
- External shoe cover with integrated FSRs

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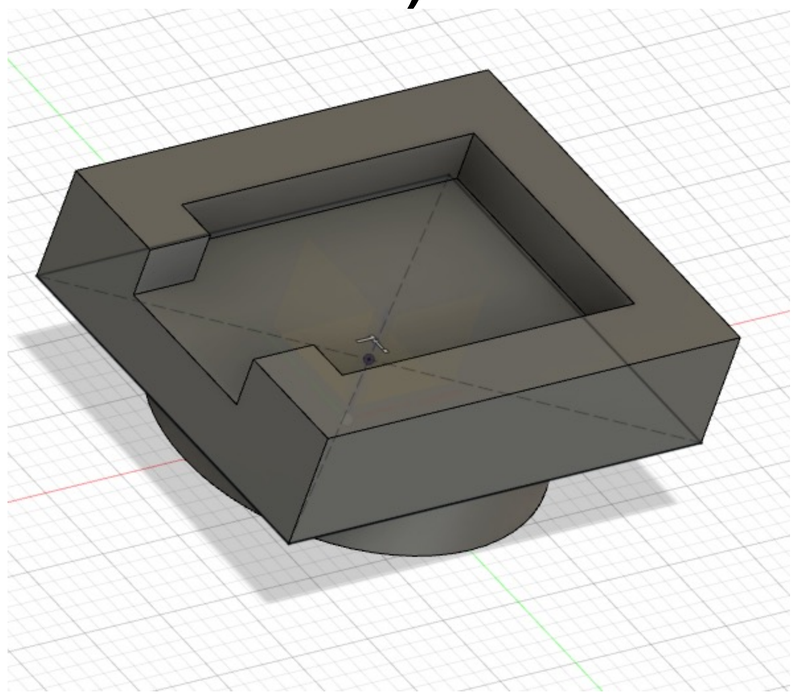

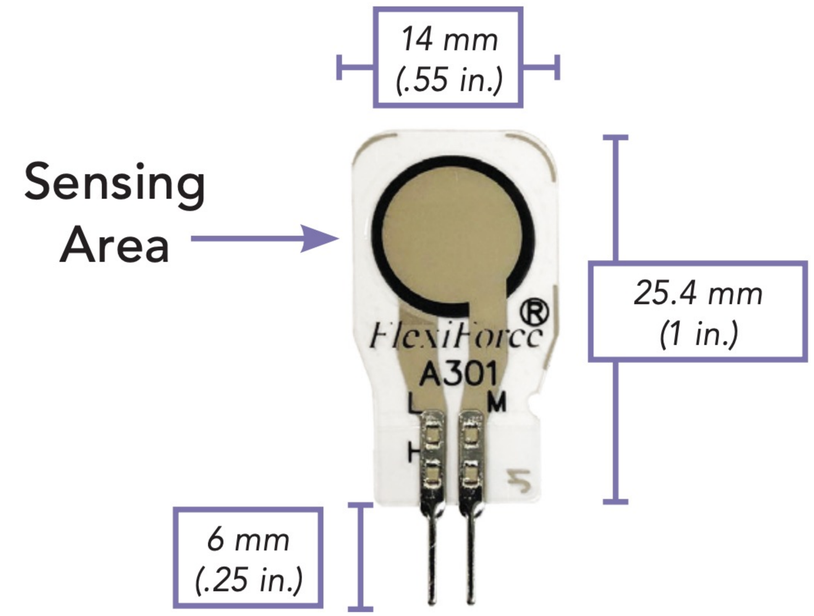

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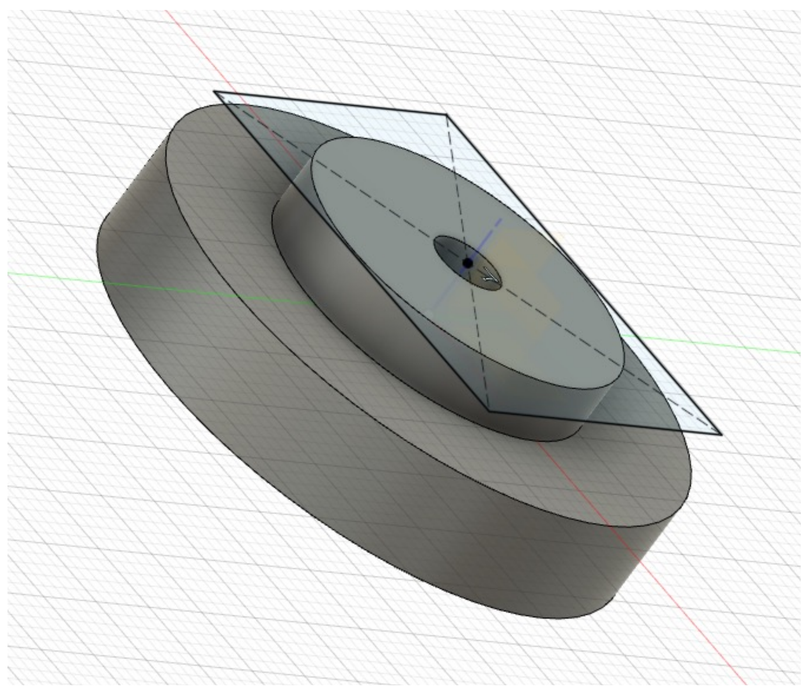

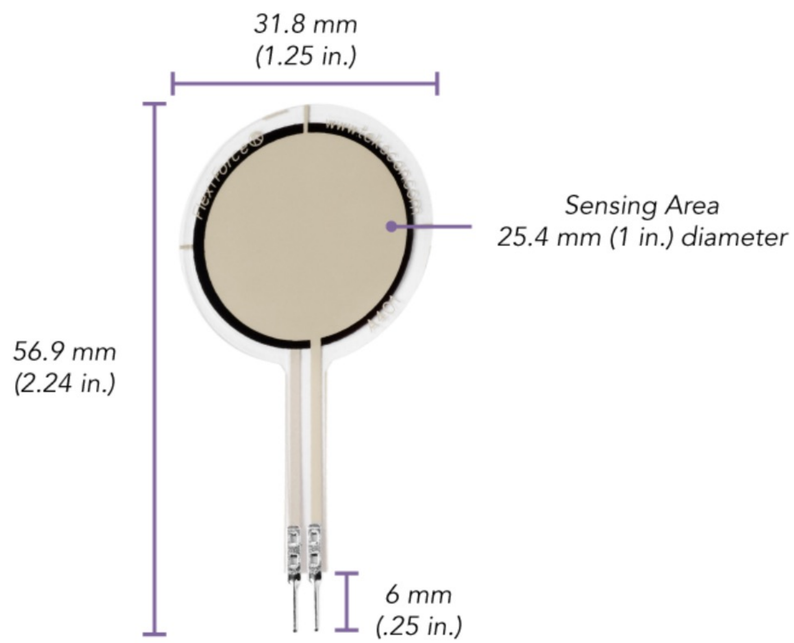

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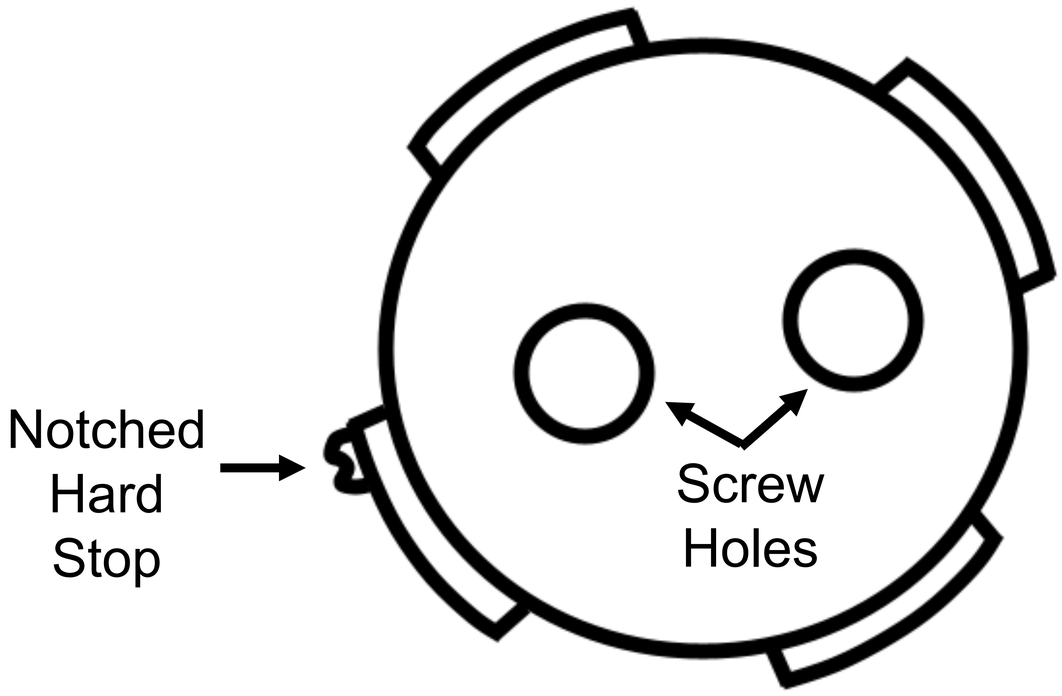

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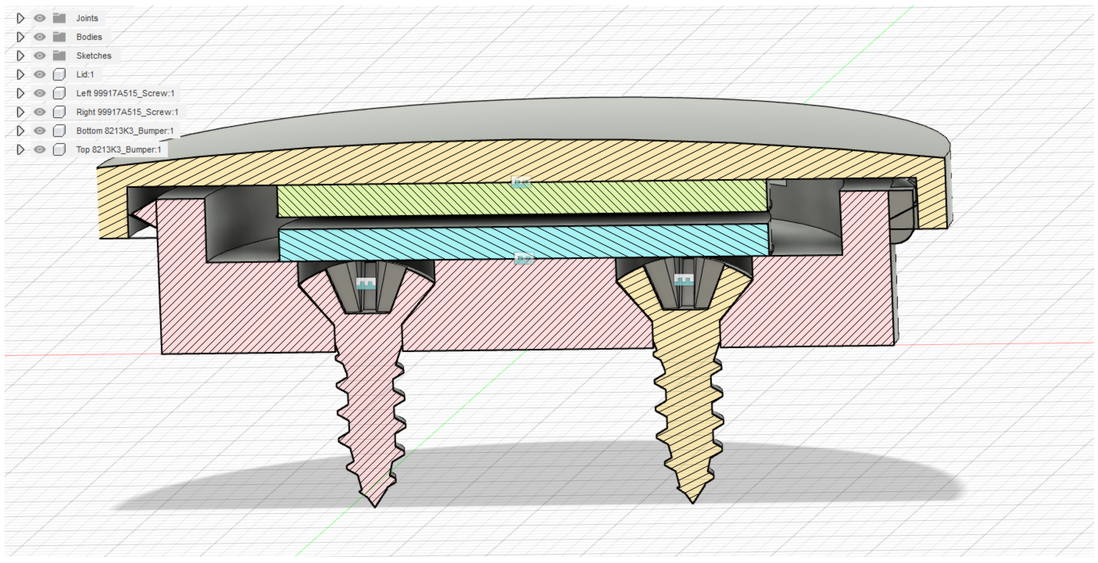

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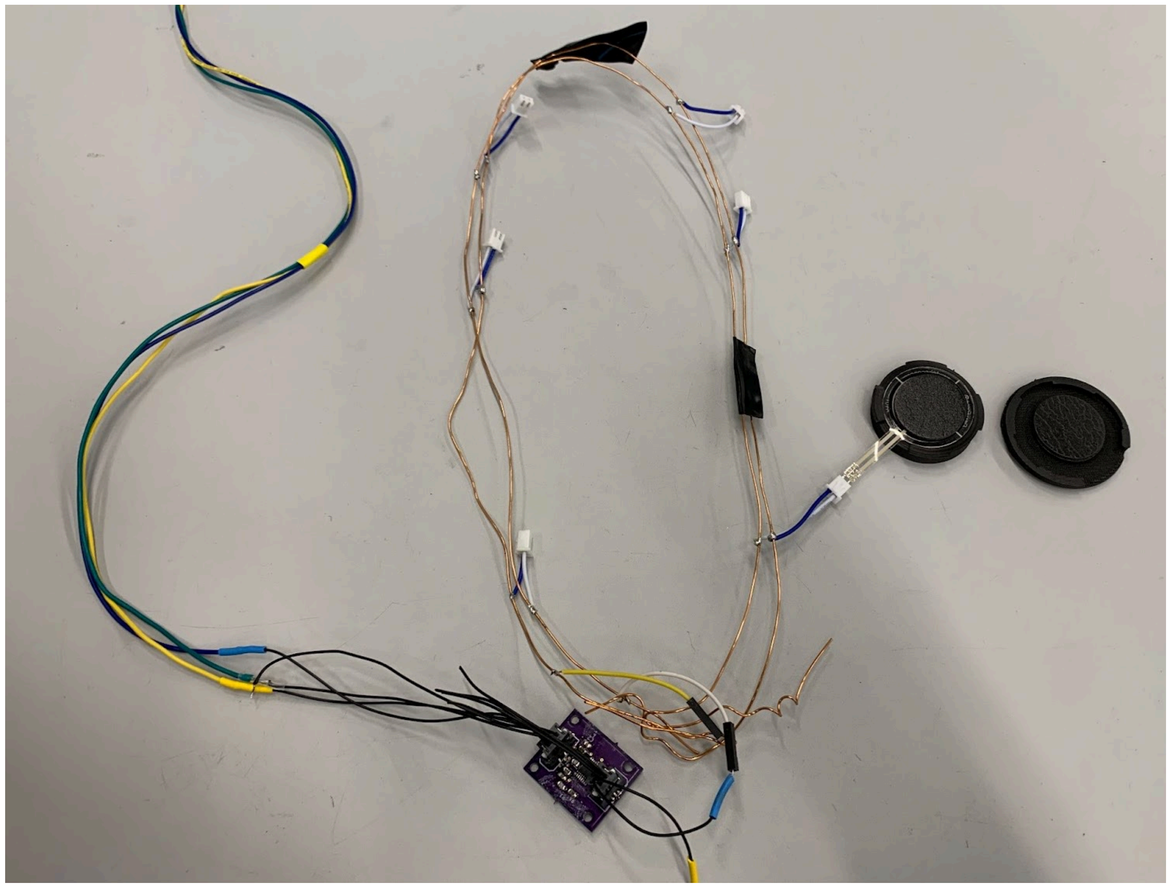

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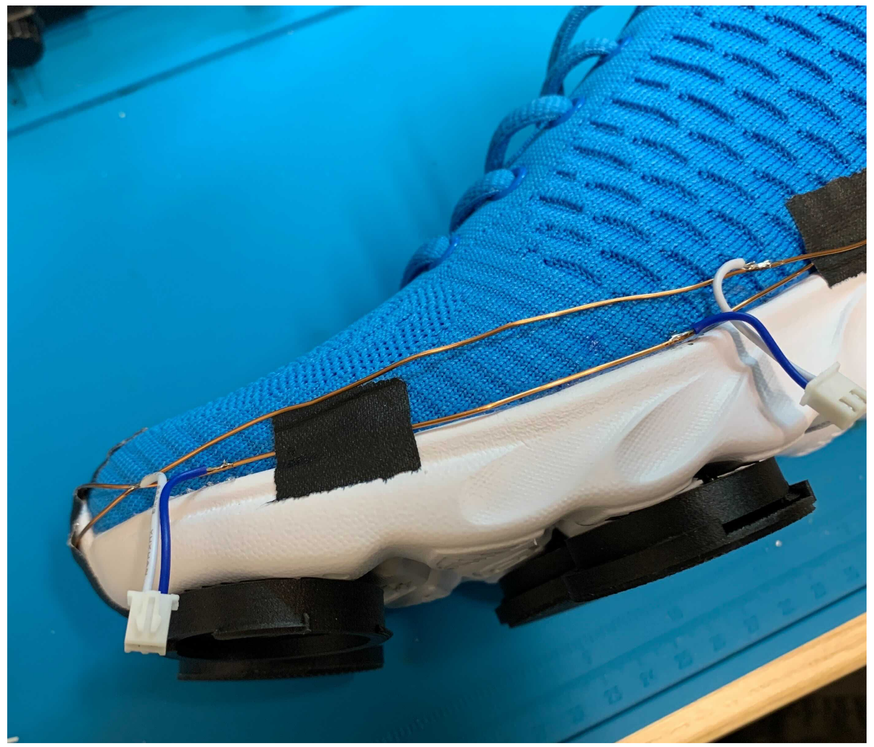

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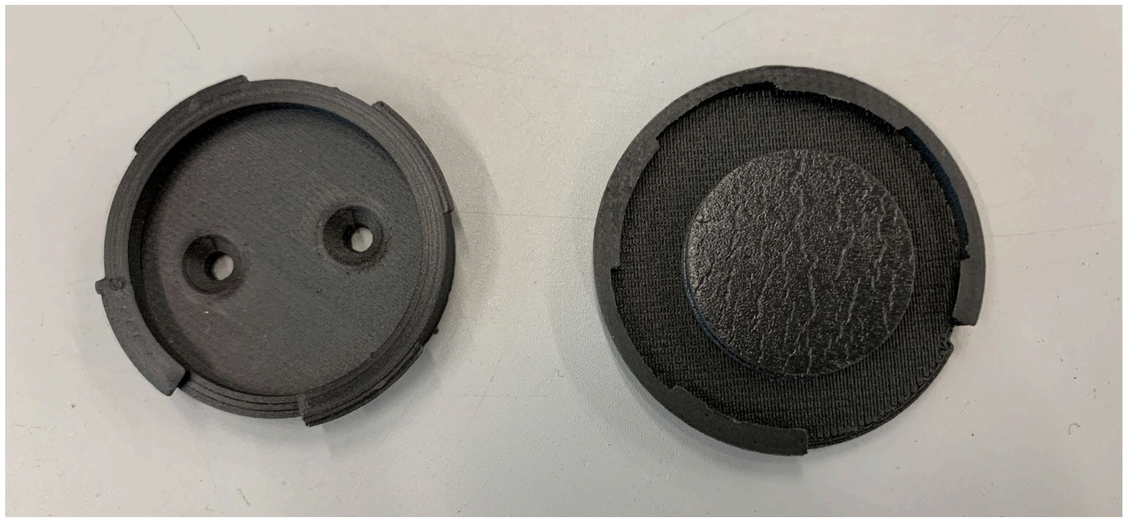

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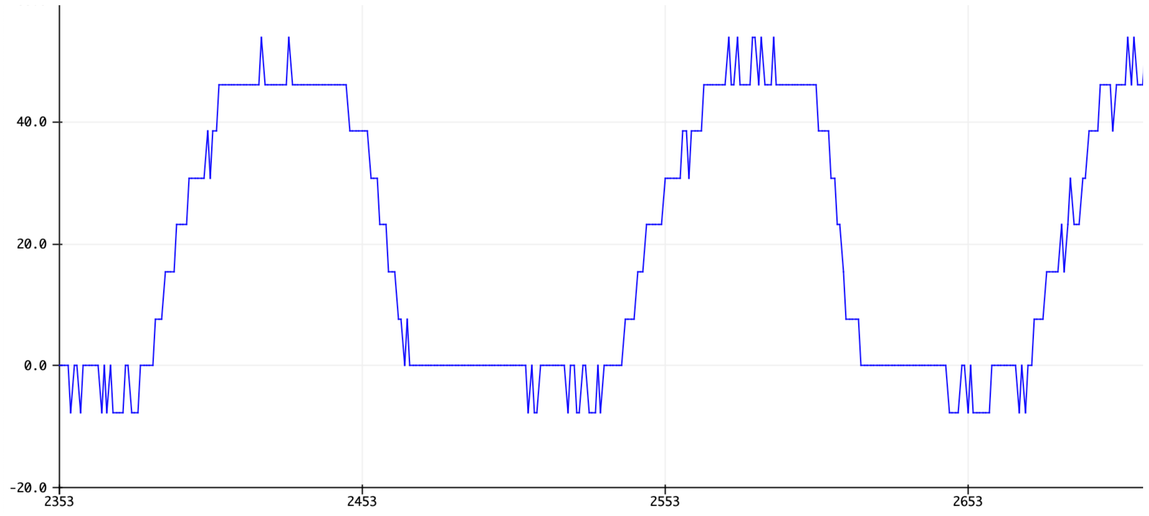

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