MECHANICAL ENGINEERING + ROBOTICS

Ezra Kahn

Engineering Portfolio

B.S. Mechanical Engineering, Robotics Minor, Carnegie Mellon University

I design mechanical and robotic systems that turn difficult human needs into testable, manufacturable engineering solutions. My work spans wearable robotics, sensing hardware, embedded control, automation, and rapid fabrication.

SolidWorks | ROS 2 | Python | Embedded Systems | Rapid Prototyping

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SELECTED WORK

Engineering across the full build cycle

Research, design, implementation, and validation presented in a compact recruiter-ready format.

01 PAGES 03-04

Wearable Robotics Research

Electronics packaging and adjustable IMU placement for hip-knee exoskeletons.

02 PAGES 05-06

Hip Exoskeleton Interfaces

A passive thighbar and a rapid motor-stability strap solution.

03 PAGES 07-08

Engineering Internships

Operational software systems at Dogwood Brands and closed-loop gas control at NYSCF.

04 PAGES 09

Personal Robotics

Mechanical design, torque sizing, ROS 2 modeling, and Python launch tooling for a 3-DOF arm.

05 PAGES 10-11

Teams and Fabrication

Academic engineering teams and leading a public two-story build under a one-week schedule.

METAMOBILITY LAB | JUNE 2026-PRESENT

Distributed Electronics Packaging

Compact, serviceable hardware for a distributed exoskeleton communications architecture.

PROBLEM AND CONTRIBUTION

I designed and fabricated enclosures that keep computation close to each IMU, reducing long cable runs across the wearable system.

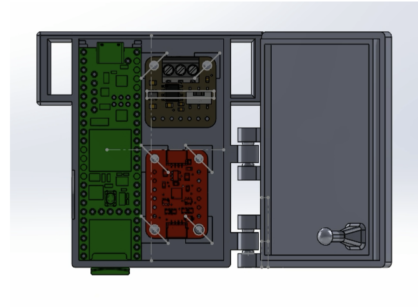
PACKAGING REQUIREMENTS

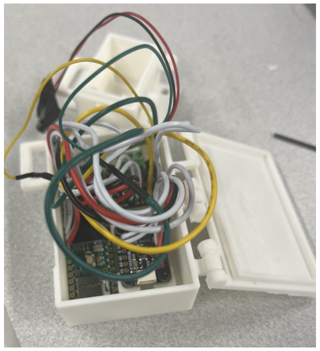
- Lightweight and fast to 3D print.
- Shield status LEDs from infrared motion-capture cameras while preserving debug access.
- Keep connectors accessible, transfer cable loads into the housing, and avoid loading surface-mounted components.

ARCHITECTURE EVOLUTION

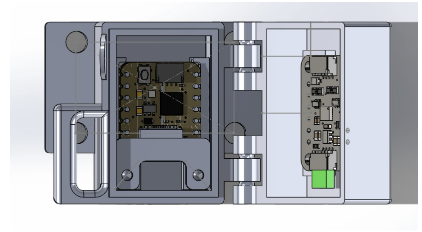
The final QT Py and IMU package reduced enclosure size while preserving connector access, LED shielding, strain relief, and serviceability.

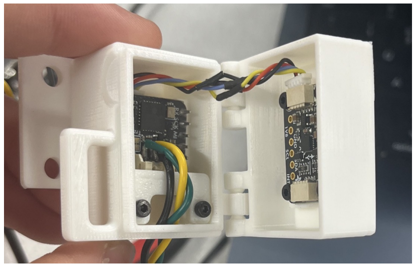
TEENSY + IMU + CAN PAL: CAD AND FABRICATED





QT PY + IMU: CAD AND FABRICATED





SolidWorks | 3D Printing | Sensor Integration | Rapid Prototyping

View the full research repository

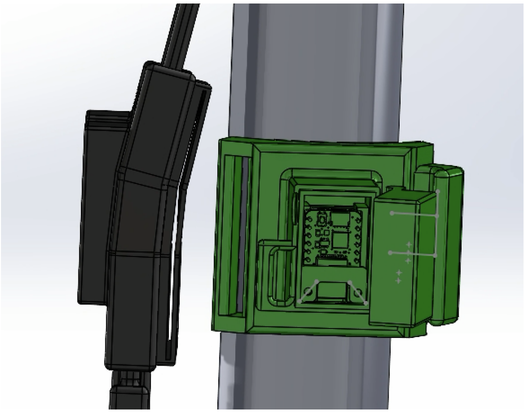
SENSOR PLACEMENT RESEARCH

Adjustable IMU Mounts

Comparable sensor position and orientation across body sizes may reduce setup-driven variation and improve cross-participant model transfer.

IN DEVELOPMENT

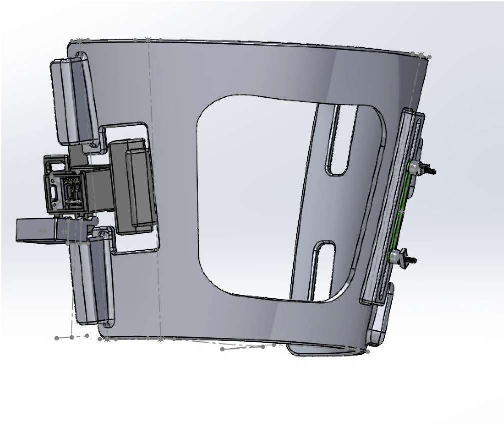
Shin



Adjusts along the leg and around the cuff. A strap and foam interface limit slip while preserving fit adjustment.

VERSION 2 CAD

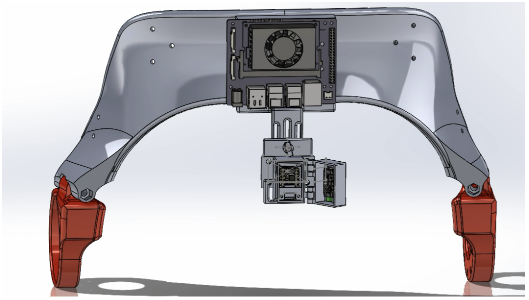
Thigh



A captured strap guide moves vertically and laterally. Retention hardware bounds travel and holds the selected position.

COMPLETED CAD

Pelvis



A slider positions the IMU along the back plate and locks it relative to the exoskeleton. A static version remains the comparison baseline.

RESEARCH QUESTION

Can adjustable sensor mounts produce more repeatable placement across participants and, in turn, more transferable gait-sensing algorithms? The mechanical systems are designed; comparative testing will quantify the benefit.

Hip Exoskeleton Thighbar

A lightweight thigh interface with one passive translational degree of freedom for gait-driven misalignment compensation.

WHAT I DESIGNED

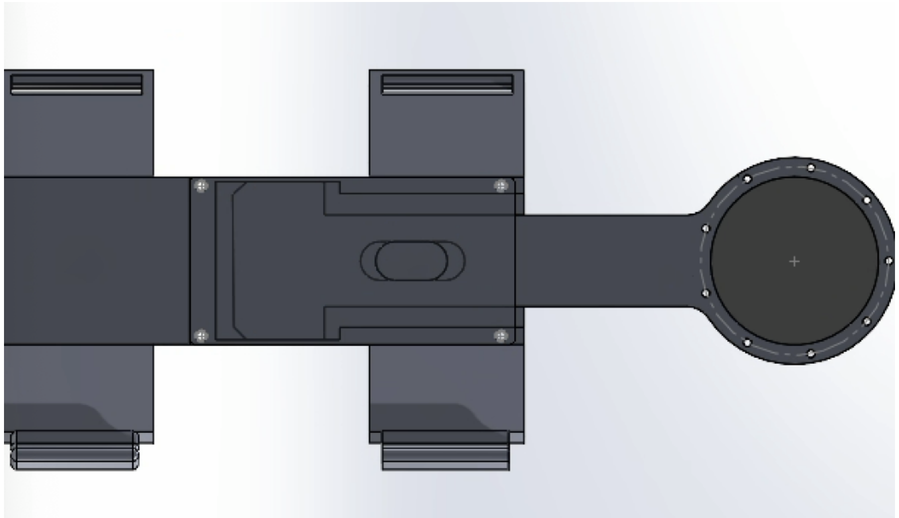
I designed a wraparound thighbar that connects the hip exoskeleton to the wearer. A guided prismatic rail lets the interface move vertically during gait, absorbing relative motion instead of forcing it into the leg.

DESIGN REQUIREMENTS

- Wrap securely and comfortably around the thigh.
- Allow controlled vertical travel without binding.
- Add misalignment compensation without another actuator or substantial added mass.

OUTCOME

The final assembly combines the thigh wrap, slider, and exoskeleton connection in a compact serviceable mechanism that passively follows the wearer through gait.



SolidWorks | Wearable Interface Design | Research Synthesis

View the full thighbar project

FEBRUARY-MARCH 2026 | TEMPORARY SOLUTION

Motor-Stability Strap Attachments

A rapid, reversible support created while the hip-exoskeleton pelvis was being repaired.

NEED

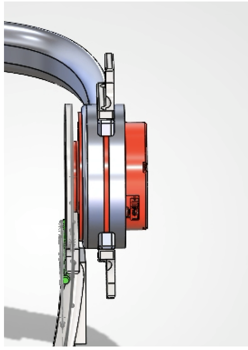
A pelvis issue allowed the motor assembly to separate from its support. I created a strap interface to stabilize it until the pelvis repair was complete.

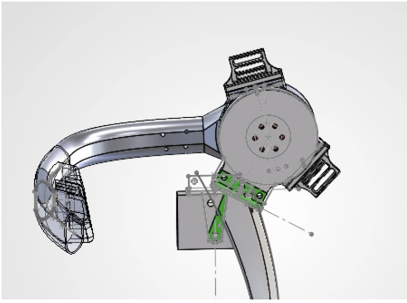
TEST METHOD

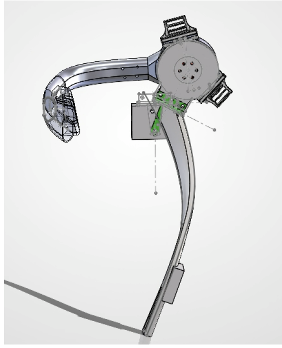
A repositionable fixture compared strap locations. I then checked the selected layout in the full exoskeleton for fit, access, visible motion, and component interference.

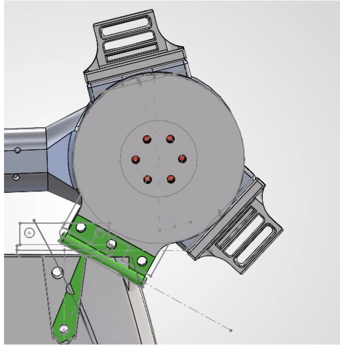
OUTCOME

Testing identified and documented the preferred strap location in final CAD. The temporary support was ultimately unnecessary because the pelvis issue was resolved a few days after testing.









SolidWorks | Design Testing | Rapid Problem Solving

View the motor-stability project

DOGWOOD BRANDS | MAY 2025-JAN 2026

Software Engineering Intern

Internal automation and data systems for a boutique private equity firm operating consumer and franchise businesses.

KPI reporting

Automated daily performance reporting for more than 60 Supercuts locations using Python and advanced Excel workflows.

Vendor web scraper

Built a traceable Python pipeline for PDF, Excel, and CSV inputs that enriches vendor data from public websites and returns source URLs, confidence ratings, and review notes.

AI-powered HR chatbot

Led implementation work with teammates in Pakistan and India, coordinating responsibilities across time zones and connecting technical decisions to recruiting needs.

THE DOGWOOD BRANDS TEAM

What the role developed

- Ownership of ambiguous, business-facing technical work.
- Team leadership and stakeholder alignment.
- Python, advanced Excel, web scraping, and data analytics.

Python | Advanced Excel | Data Analytics | Team Leadership

View public scraper   Visit Dogwood Brands

NEW YORK STEM CELL FOUNDATION | JUN-AUG 2023

Digital Gas-Pressure Control

A prototype architecture for replacing manual adjustment with continuous sensing and closed-loop control on the NYSCF Array.

SYSTEM ARCHITECTURE

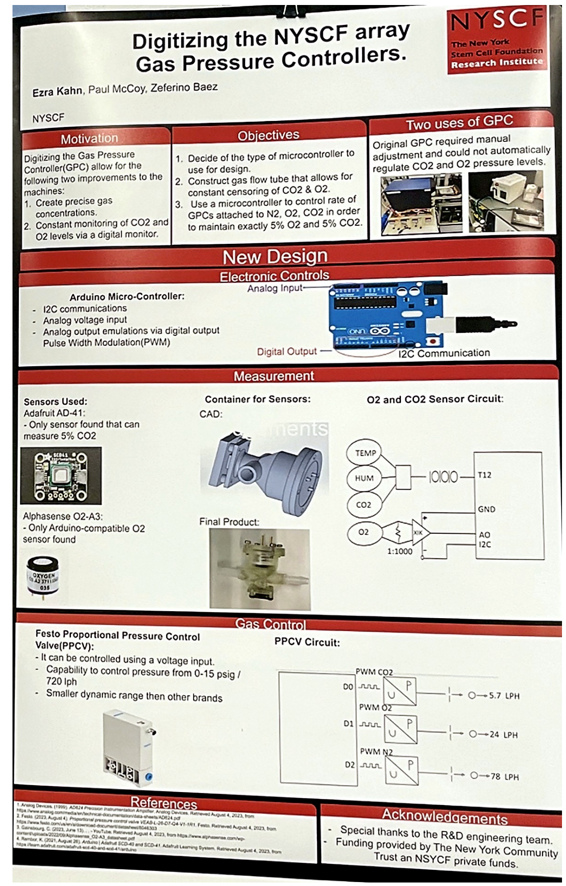
- Integrated pressure, CO2, and O2 sensing through analog inputs and I2C communication.
- Mapped outputs to proportional valves for CO2, O2, and N2 flow.
- Designed a compact CAD housing for the gas-sensing hardware.

CONTROL APPROACH

The prototype firmware runs a PID pressure loop with separate PI corrections for CO2 and O2. Remaining demand is assigned to nitrogen. Safety logic closes every valve if sensor data fails, becomes stale, or pressure exceeds the limit.

CONFIDENTIALITY

The public repository contains the prototype control algorithm and safeguards. All other implementation files remain confidential.



Embedded C++ | PID/PI Control | Sensor Integration | SolidWorks

[View the public control algorithm]

JUNE 2026-PRESENT | IN DEVELOPMENT

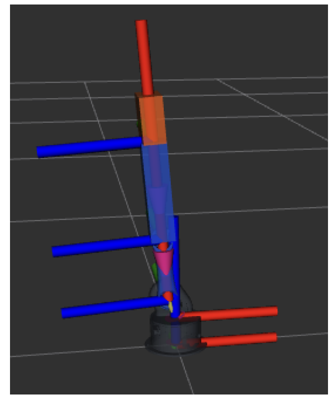
3-DOF Robotic Arm

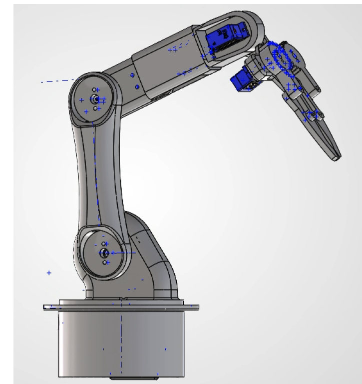
Mechanical design, torque sizing, ROS 2 modeling, and Python launch tooling for a lightweight pick-and-place arm.

MECHANICAL DESIGN

The SolidWorks assembly separates the base, waist, structural links, servo models, and geared gripper. PLA mass properties and center-of-mass locations feed the joint-load calculations.

With a 10 g payload and 2.0 safety factor, the required torque is 7.65 kgf-cm at the shoulder and 3.88 kgf-cm at the elbow.



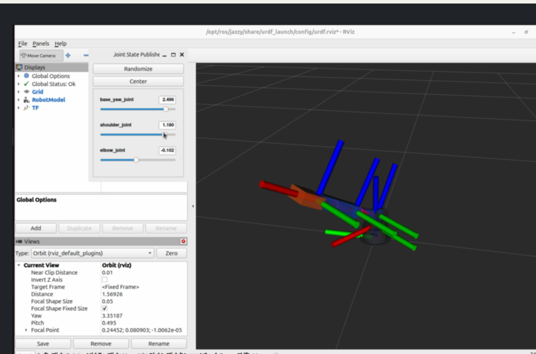


ROS 2 MODEL

A five-link URDF/Xacro chain defines three revolute joints, axes, limits, origins, and transforms using the SolidWorks meshes. A Python launch file starts the state publishers and RViz together; the model is verified through RViz and the TF tree.

NEXT VALIDATION

The planned build uses an ESP32, PCA9685 PWM driver, separate fused 6 V servo rail, joint calibration, coordinated motion, and repeated pick-and-place testing.



SolidWorks | ROS 2 | Python | URDF/Xacro | Torque Analysis

View the project repository

Watch the motion demonstration

CARNEGIE MELLON AND FIRST ROBOTICS

Team-Based Engineering

Mechanical design and leadership in multidisciplinary competition environments.

CURRENT

Carnegie Mellon Racing

Structures and Electrical Integration

- Model battery-enclosure components in SolidWorks while satisfying structural, packaging, and electrical-integration requirements.
- Coordinate enclosure geometry, component placement, and system interfaces across structures and electrical teams.

Teamwork | Mechanical Design | Iterative Testing

2021-2024

Avenues Robotics

Mechanical Subteam Lead

- Led mechanical design, fabrication, and iterative testing for competition robots.
- Helped develop systems that qualified for the World Championships, reached by approximately the top 2.5% of teams.

Teamwork | Mechanical Design | Iterative Testing

CMU SPRING CARNIVAL | 2025 AND 2026

Booth Manufacturing and Building Lead

Led the construction of two public, multi-story wooden structures that placed 2nd and 3rd in the fraternity division.

ONE-WEEK PUBLIC BUILD

Everything moved onto Midway the Friday before Carnival and had to open the next Thursday. I ran the build through framing plans, cut lists, wall layout, assembly, second-story construction, and final facade work.

LEADERSHIP UNDER CONSTRAINTS

I kept a rotating volunteer crew productive and safe while coordinating the sequence of dependent work. Walls had to be squared and sheathed before the deck, the deck before the second story, and painting after the structure stopped moving.

RESULTS

The 2025 and 2026 builds placed 2nd and 3rd in the fraternity division, respectively.

Fabrication | Shop Drawings | Assembly Sequencing | Team Leadership

View the full build story