Engineering Portfolio

Northeastern University | Mechanical Engineering
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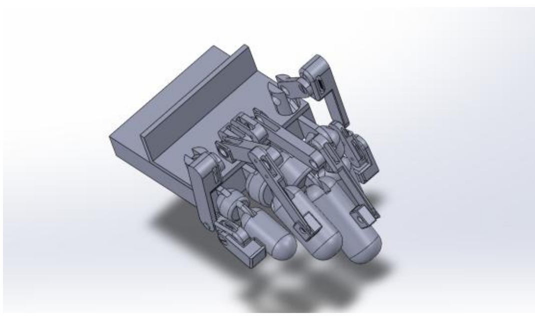
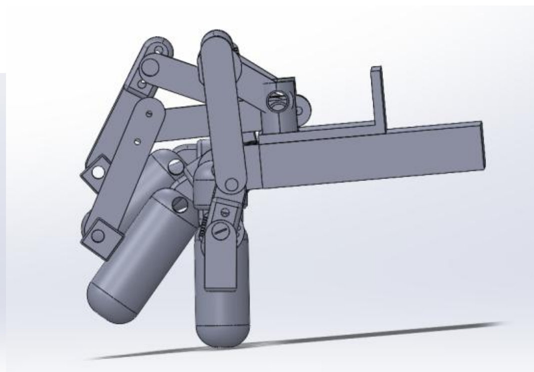
Robotic Arm Control Glove – Overview

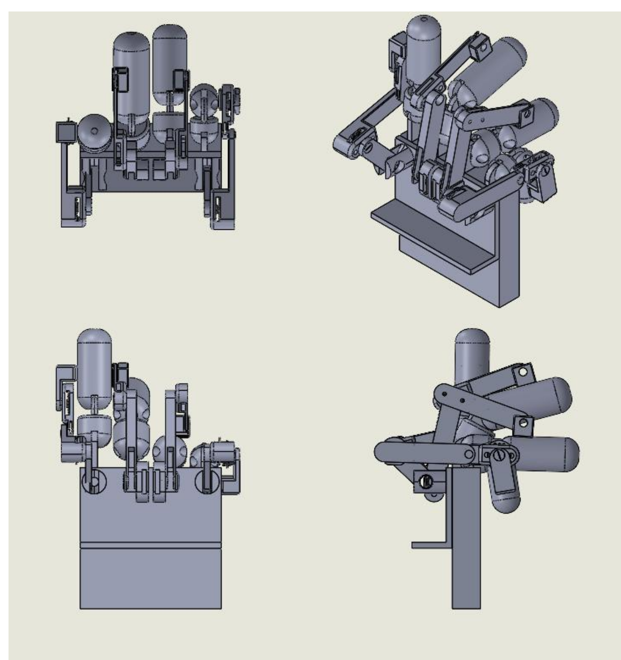
- Developed a wearable glove to track finger-joint motion and control a robotic hand in real time.
- Used encoders and a 9-DOF IMU for precise mapping of hand movements to robotic articulation.
- Focused on modularity, ergonomics, and manufacturability through iterative design and testing.

The images above show the latest SolidWorks CAD version of the robotic hand mechanism. This design integrates encoders with fully 3D printable parts and structural supports to track natural finger motion without hindering the user.

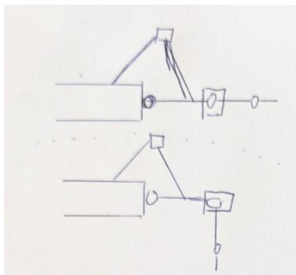
My Contributions:

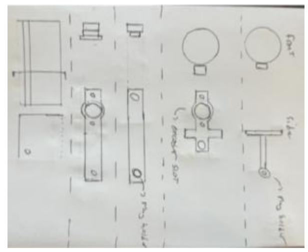
• Independently modeled full design in SolidWorks for the first prototype. While also using On Shape for sharing cad documents and design reviews.
• Managed all initial prototyping using 3D printing and laser cutting for rapid iteration and prototyping.
• Currently leading a 3-person subteam to improve comfort, efficiency, and finalize rapid-prototyping integration and build the fully functioning product.



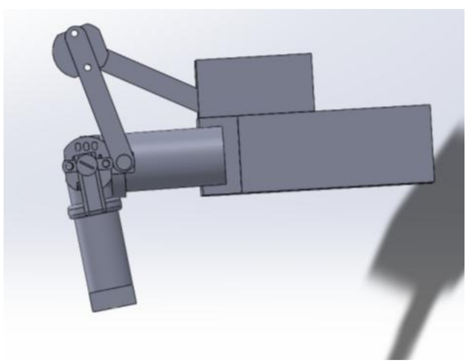
Robotic Hand Input Device – Design Process

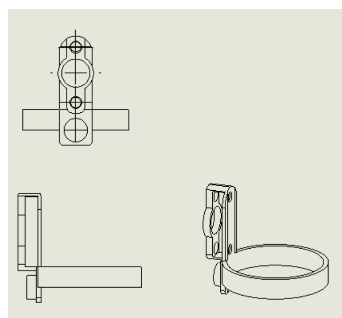
The robotic hand input device was developed to serve as a wearable control interface, allowing natural finger movement to directly drive a robotic manipulator. The design process centered around ease of use for the user, comfortability, and achieving a high level of prototype detail though designing for 3D printing.





- Sketched early finger linkage concepts and encoder placement to map rotational motion.
  - The first rough sketch can be see to the right, the squares represent encoders and the circles finger joints

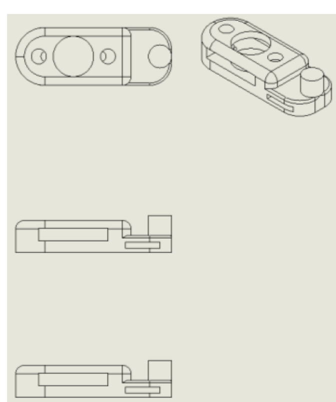


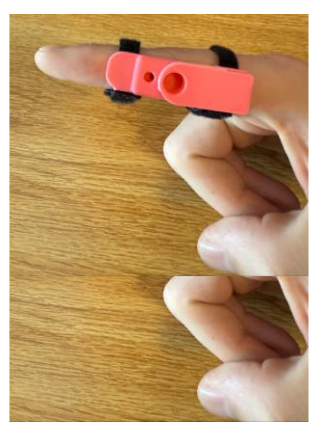


• Designed the first index-finger tracker to record joint motion with dual encoders.
• Early prototypes failed due to **excessive overhangs** and **thin tolerances**, making the part unprintable.
• Redesigned the model for stronger walls and improved print orientation

• to improve wearability among different sizes of hands the rings were replaced with Velcro straps

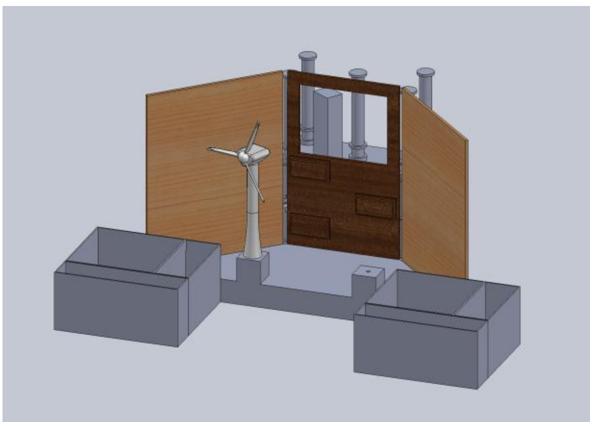
• with the new design rapid prototyping was now more viable as the print quality was higher





Portable Educational Windmill game – Overview

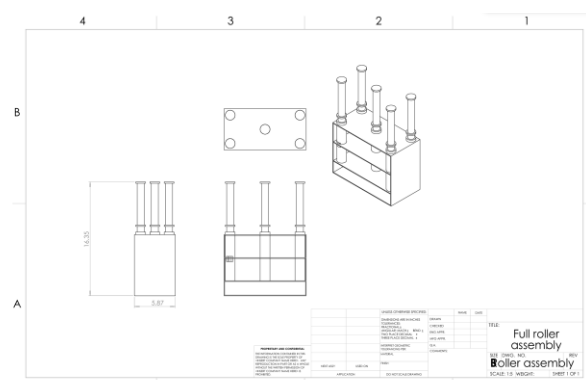
- Developed an interactive, portable museum exhibit for children (ages 6–11) that teaches renewable energy through hands-on engagement.
- Users compete to build the most efficient wind turbine by selecting components such as blades, motors, and bases.
- The system uses Arduino microcontrollers and MATLAB to log user inputs and display simulated energy output in real time.



The final version of the game included educational blurbs about wind energy that was meant to inform the user as to the best options when picking their windmill pieces. The exhibit was built using laser-cut MDF panels, 3D-printed turbine components, and magnet-based assemblies for rapid setup and teardown.

My Contributions

- **Team Leadership:** Managed the four person team in charge of the prototype fabrication and coordinated with teammates to optimize assembly workflow and improve durability.
- **CAD & Fabrication Lead:** Designed the full exhibit structure in SolidWorks and AutoCAD; laser-cut every MDF component and designed & 3D-printed turbine parts, the rotating paper display, and button assembly.
- The **roller display system** was designed using bearings and a DC motor, ensuring consistent motion and user feedback working in tandem with a calibration system that allowed the exhibit to run automatously.
- **Testing & Evaluation:** Designed and conducted user surveys at the EXPO, collected engagement data, and analyzed the results for exhibit improvement.



Soft robotic Knee sleeve research – Overview

I am working in a lab focused on developing a soft robotic knee sleeve that dynamically adjusts stiffness and support for individuals with arthritis-related instability. It will Combine granular jamming materials, textile-based sensing, and human-centered design to create a responsive, wearable support system. The sleeve stays flexible during normal motion but stiffens instantly during instability offering comfort, protection, and confidence for older adults.

Materials, Sensors, and Soft Robotics

- Led the lab's shift toward granular jamming materials for adaptive stiffness.
- designing flexible jamming pods along the knee's medial, lateral, and posterior regions, enabling targeted support where instability is most common.
- Working with other northeastern labs to integrate stretch-based fabric sensors and inertial measurement units (IMUs) to monitor knee motion, detect risk events, and trigger real-time stiffening.
- The resulting system aims blends soft robotics and wearable sensing — eliminating the need for rigid braces or motors while maintaining medical-grade control.

Human-Centered Design

- Guided by a focus on real-world usability rather than theoretical performance.
- Every design iteration emphasizes comfort, breathability, and wearability for older adults.
- The control system adapts automatically to daily activities — such as walking, stair use, and standing — without user intervention.
- This approach ensures the sleeve is not just a research prototype, but a clinically relevant assistive device.

Co-Design and Interdisciplinary Collaboration

- The project follows a co-design framework, integrating feedback from patients, physical therapists, and researchers throughout development.
- Collaborates closely with the Custom Fabrics Lab to test textile integration methods for sensors and air channels.
- Partners with physical therapy and rehabilitation labs to assess biomechanical effectiveness and user comfort during real-world movement.
- This multi-lab collaboration ensures that engineering advances translate directly into functional healthcare solutions.