14 Revolutionizing Accessibility: An Adaptive Kayaking Mechanism For All

EMBRY-RIDDLE Aeronautical University

Gregory Dsouza, Brooke Mueller, Levi Blumer, Lucia Westgate

Mechanical Engineering Department, Embry-Riddle Aeronautical University, Daytona Beach, FL 32114

Abstract

Access to adaptive recreational equipment remains limited for individuals with mobility impairments, such as paraplegics and quadriplegics. This project presents a custom system designed to securely attach an improved adaptive watersports recreational device to a kayak, tailored for paraplegics and quadriplegics while enhancing safety, comfort, and ease of use. A PID control system enables active assistance to support their rehabilitation. The design was refined through iterative testing and user feedback from the Oceans of Hope Foundation, to maximize its stability and accessibility, helping expand recreational solutions available for paraplegics and quadriplegics.

Objectives

1. Refine assistive kayaking device to enhance safety, comfort, and independence.
2. Integrate automated control system for rehabilitation support.
3. Test and optimize stability, waterproofing, and usability based on user feedback.

Requirements

Safety: Emergency release under 2.5 seconds

Stability: Tipping angle < 30°

Ease of Use: One person setup.

Durability: Saltwater- and corrosion-resistant

Non-Permanence: Non-invasive modifications

Active Assistance: Reduces user fatigue.

Accessibility: No obstruction or rubbing user

Adjustability: Scalable – fits multiple kayak types and user sizes

Convenience: Each section ≤15 kg.

Acknowledgements

OCEANS OF HOPE FOUNDATION

Special thanks to Dr. Victor Huayamave, Dr. Christine Walck, Dr. Marc Compere, Sheridan Perry, & Mario Gomez for their time and valuable contributions.

System Overview and Component Integration (Not to Scale)

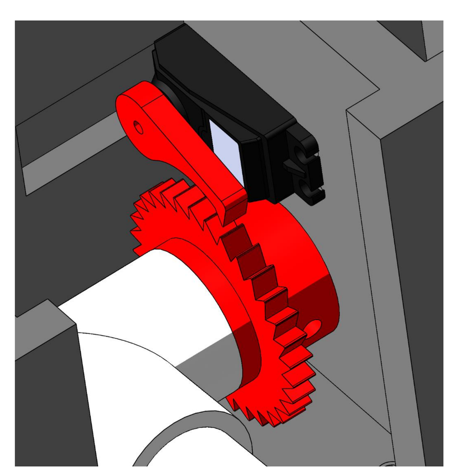


Figure 1. Ratchet & Pawl System

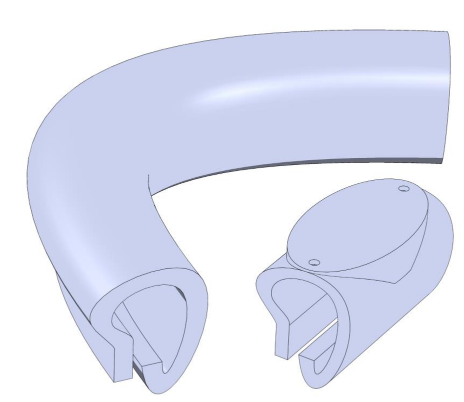


Figure 2. Non-permanent Side Clip and Front Clip

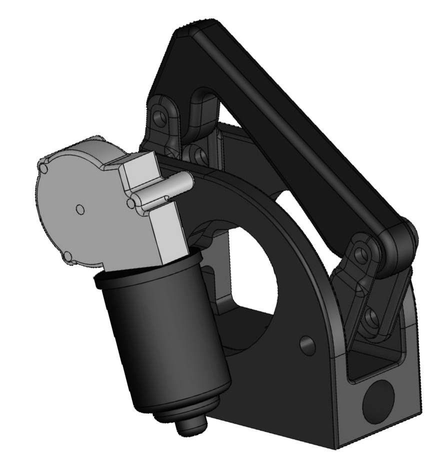


Figure 3. Motorized Linkage

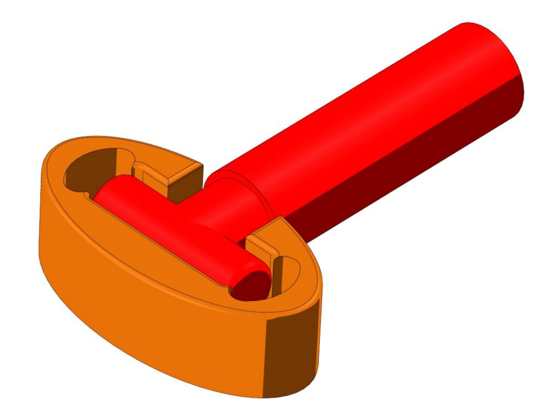
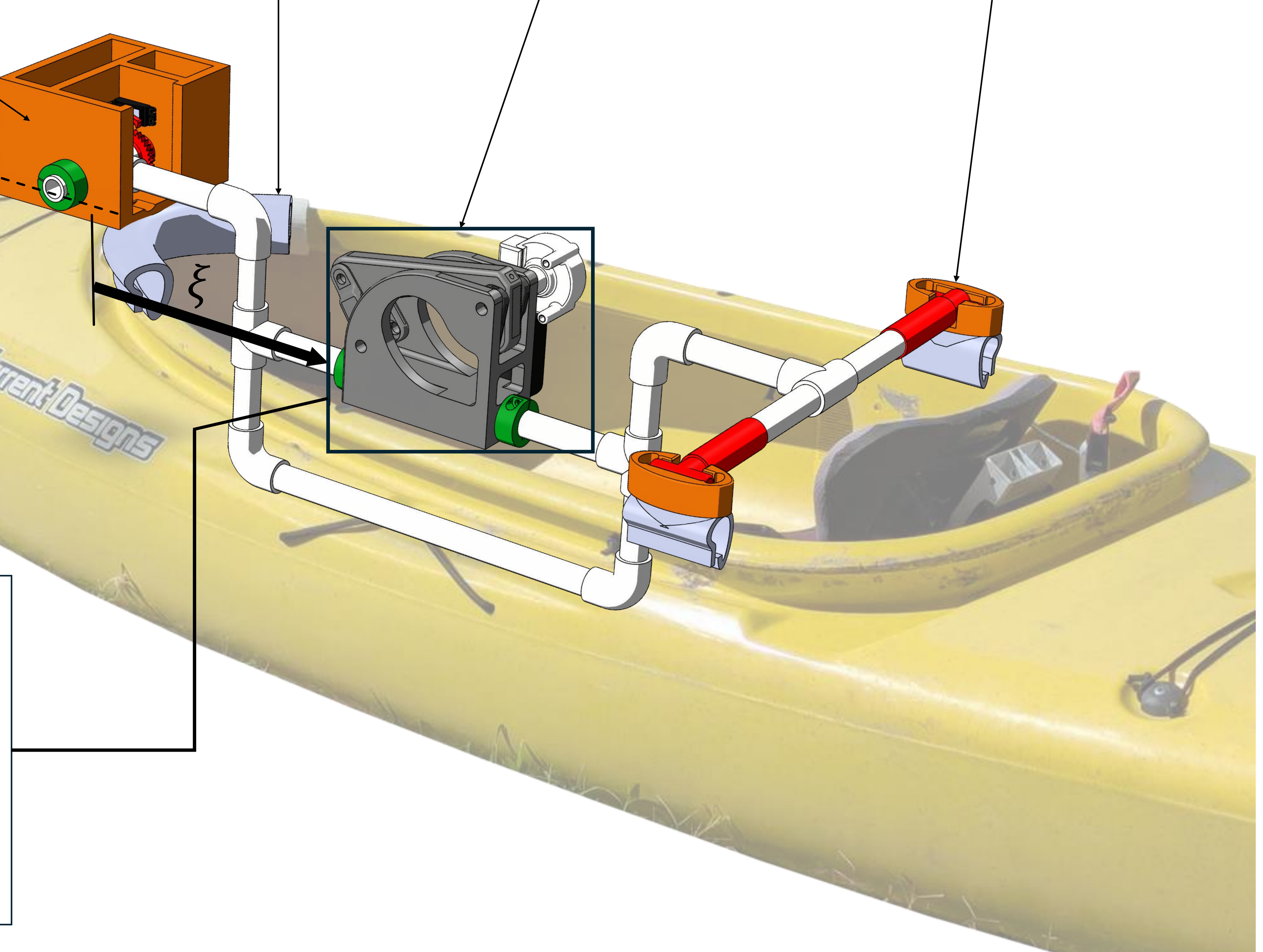


Figure 4. T Style Adjustable Assembly Clip



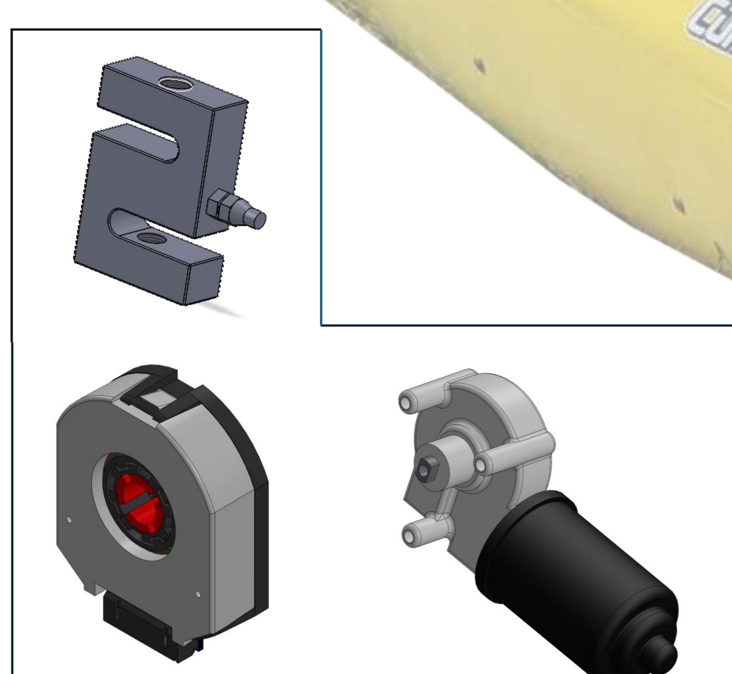
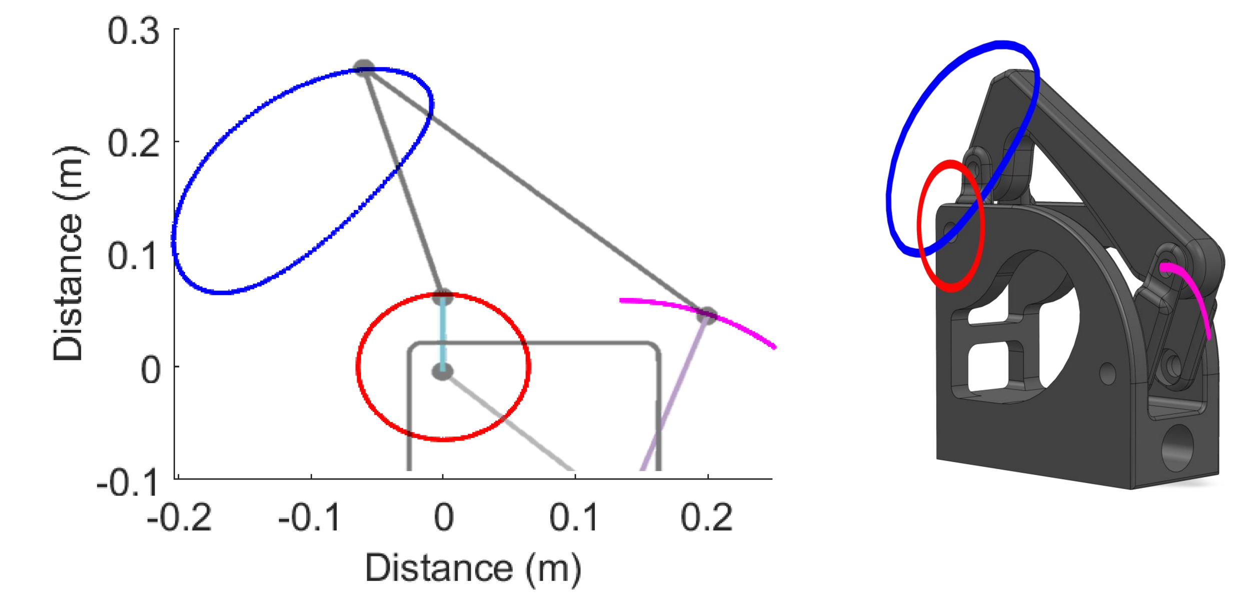


Figure 6. Load Cell (Top), Linkage Encoder (Left) and Linkage Motor (Right)

Encoder-Based Stroke Tracking and Assistance

- Uses encoder-measured crank angle θ as input
- Determines position on Stroke Profile
- Adapts assistance actuation using force readings



$$\vec{r_C} = \beta \cdot \left(\bar{R} \cdot \frac{\vec{r_{B/A}}}{|\vec{r_{B/A}}|} \right)$$

Figure 7. Stroke Profile and Driving Equation

Optimal Shaft Length

Collar Design Statistic	Position (ξ) (cm)
Farthest Position	12.2
Nearest Position	31.8
Mean Position	23.4
Standard Deviation	6.6

Data collected from various users provided validation for the shaft length, providing optimal comfort and stability.

PID

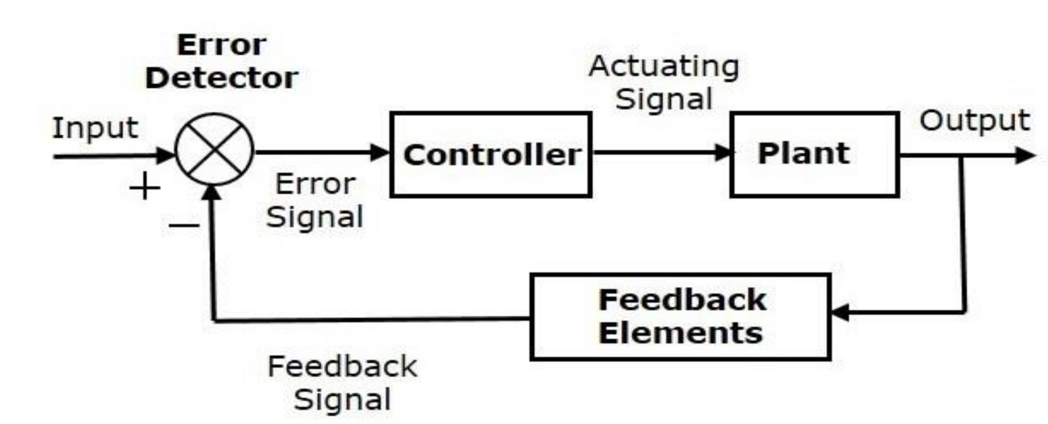


Figure 8. PID Controller Loop

Using a PID enables a user-controlled system with smooth, efficient linkage motion, improving upon the otherwise erratic motion.

Future Work

- Exploring the implementation of a “struggle” factor to drive the linkage
- Testing various materials for durability and reliability
- Adjustable side clips that adjust to different kayaks
- Streamline front assembly design
- Different modes for different skills and strength: Rehab Mode, Leisure Mode, Exercise Mode