Department of MECHANICAL ENGINEERING
THE UNIVERSITY OF UTAH

Handcycle Smart Trainer

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PROBLEM

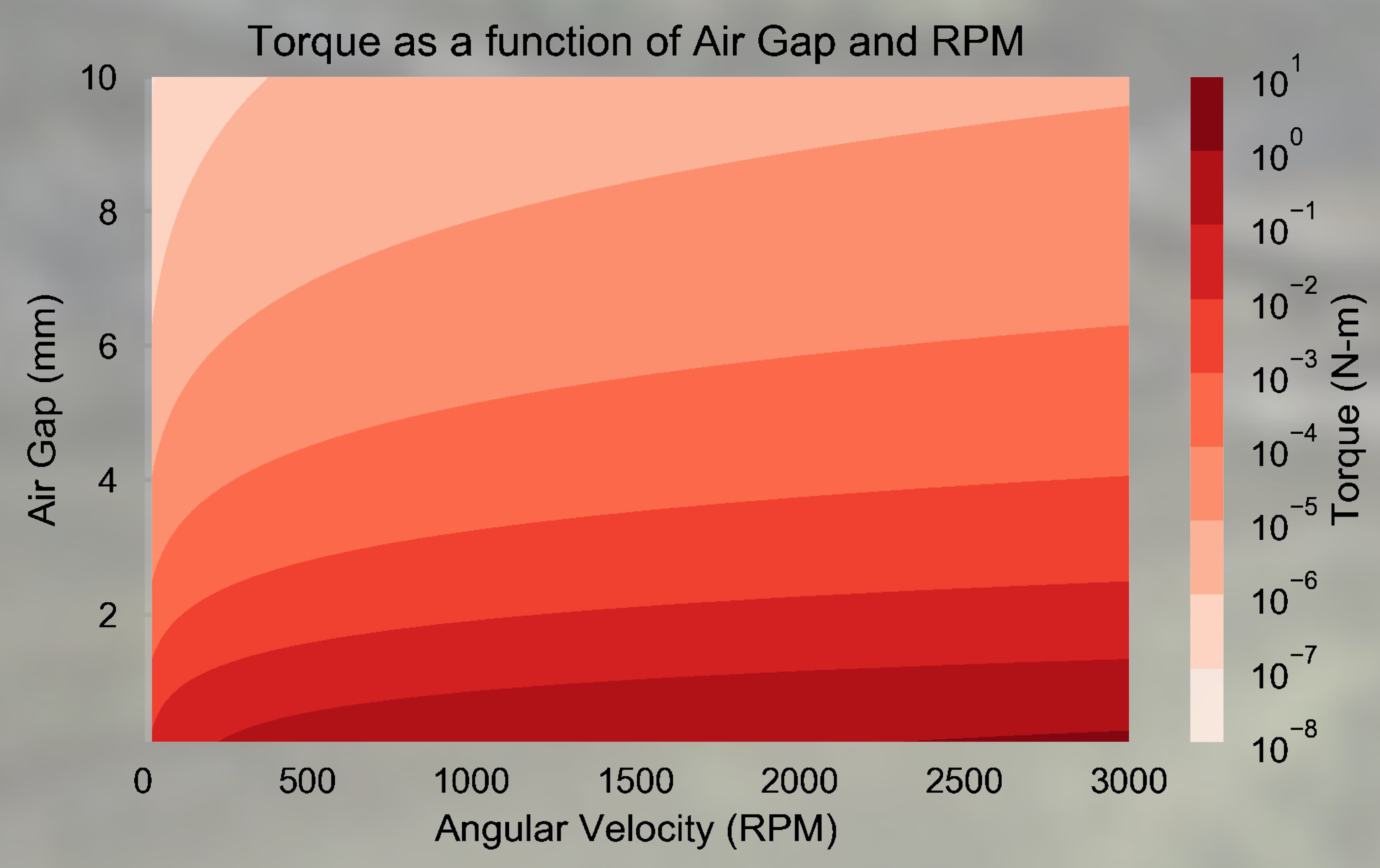
The preferred method of exercise for spinal cord injury patients is handcycling either outside or on a trainer. The main problem with current trainers is that they do not accommodate different handcycles and do not have smart features that improve the exercise experience. Our goal is to fix that by making a trainer that is easy to set up and features a dynamic resistance mechanism that improves the riding experience.

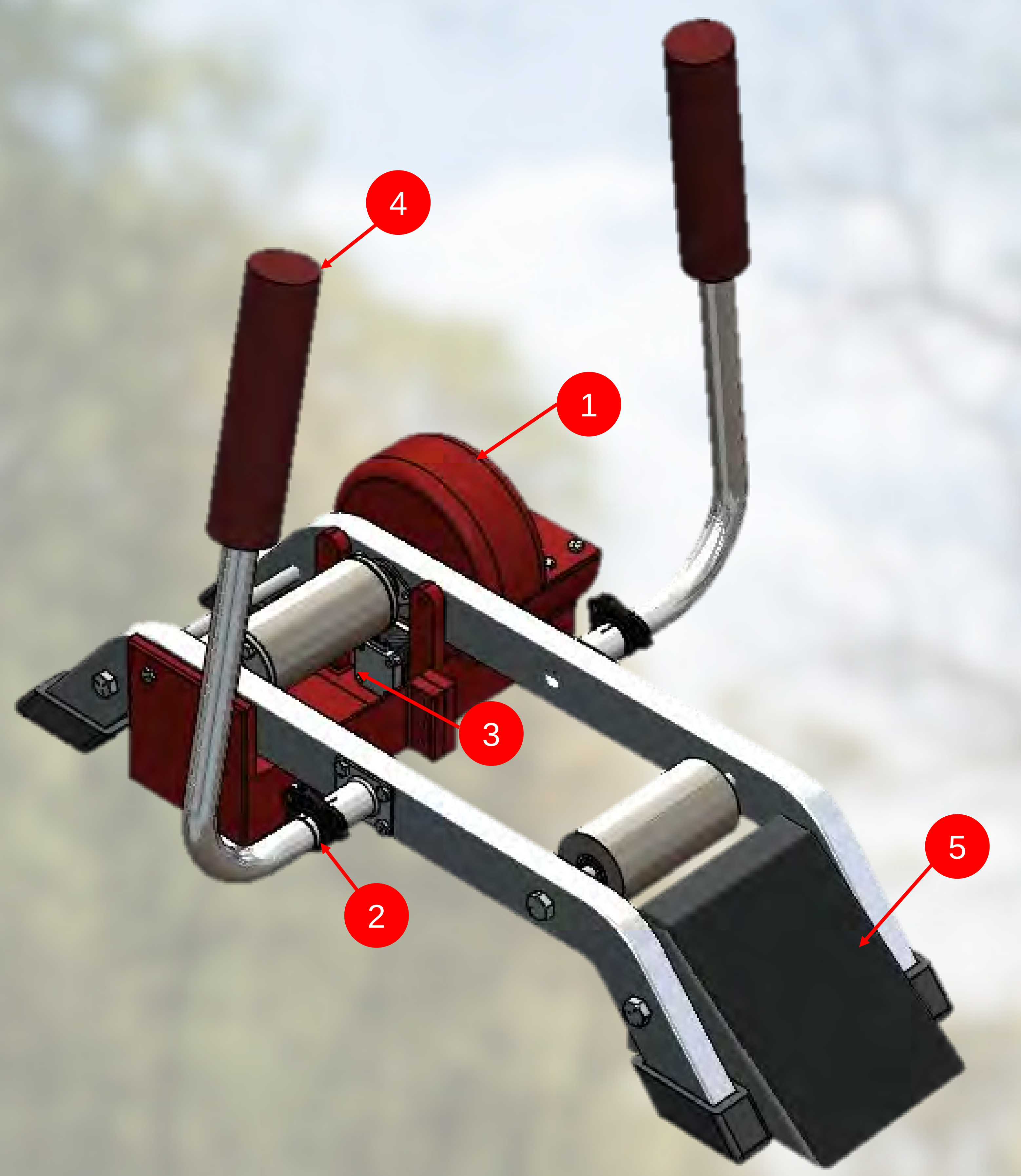
DESIGN SPECIFICATIONS

Objective	Metric	Target Value
Functionality	Adjustable resistance of flywheel	Multiple resistance levels
Ease of Use	Easy to setup for SCI patients	Setup with minimal hand dexterity
Price	Total price of the system	<$500
Weight	Weight of the system	<40lbs
Durability	Holding capacity of the system	>300lbs

ANALYSIS & METHODS

An initial model of a rider was first developed to inform our system requirements for speed and resistance dynamics. An eddy current brake (ECB) was then selected as the resistance method due to its low frictional wear, power requirements, and easily adjustable resistance. A mathematical model of the ECB was then developed to properly size, design, and test the system. After rigorously testing the dynamics and behavior of the ECB, we were able to develop a data driven model to control our final system.



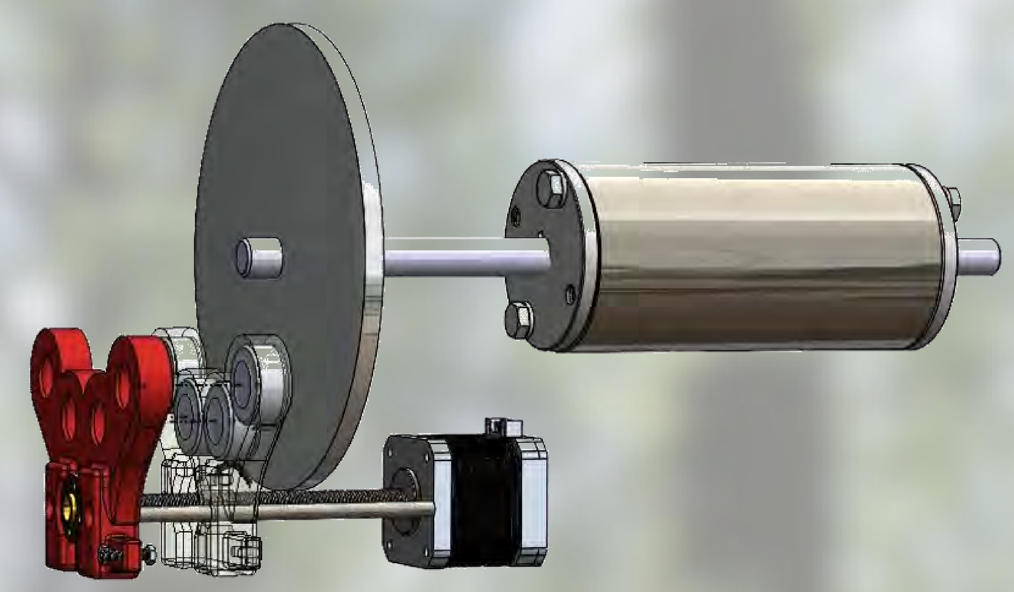


KEY COMPONENTS & FUNCTION

Call Out	Components	Function
1	Resistance Flywheel	Provides inertia for a realistic riding experience
2	Friction Lock	Provides adjustability
3	Stepper Motor & Magnet Housing	Magnet moving system
4	Guide Rails	Handcycle stability
5	Ramp	Accessibility

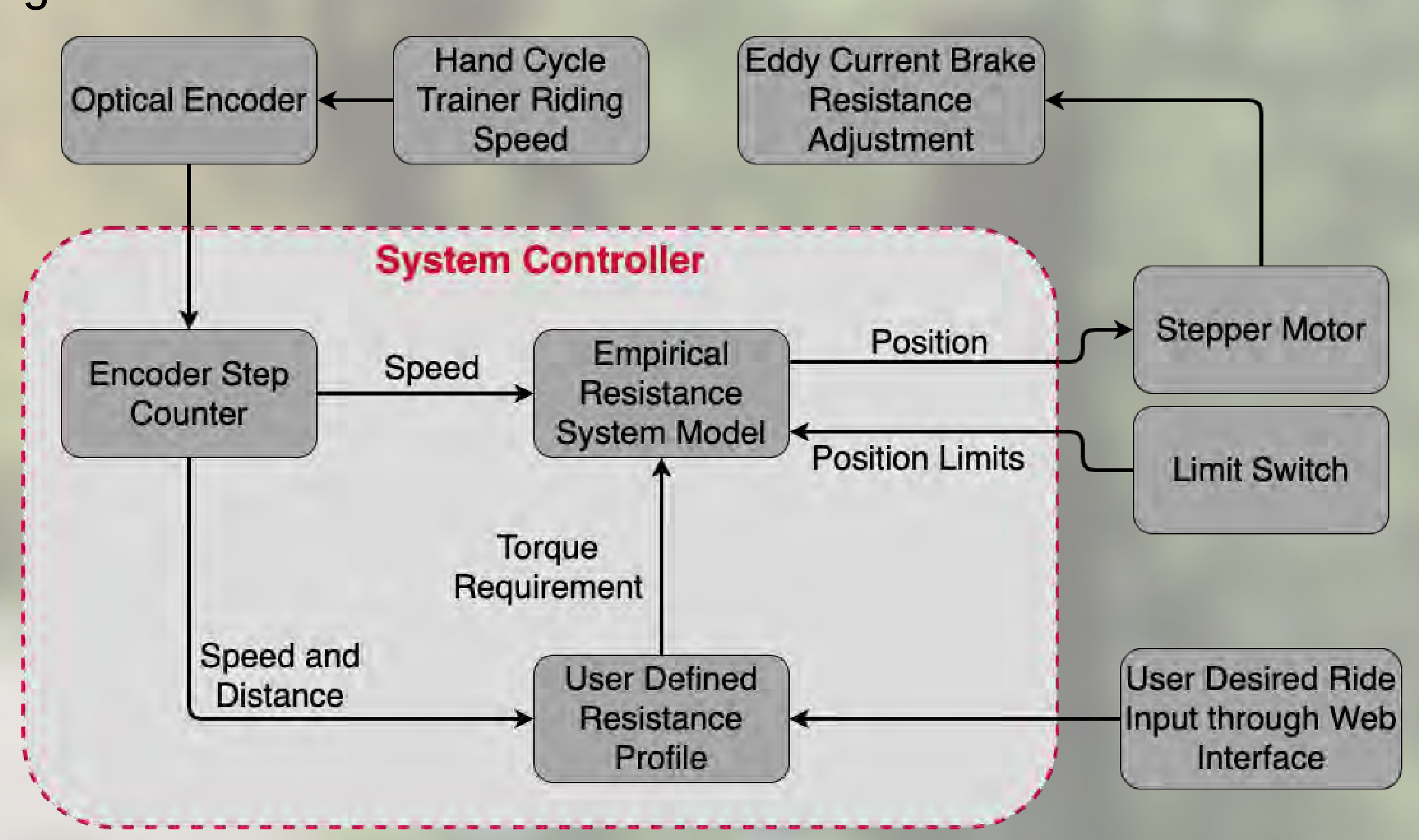
RESISTANCE MECHANISM

To control the resistance the design utilizes an eddy current brake. Using a linear step motor, we can control the distance our magnet array is from an aluminum flywheel. The rider spins the flywheel, and the magnets create a resistive torque. The closer the magnets the more resistance the rider feels.



CONTROL SYSTEM

The user can select a predefined workout that simulates air resistance and different hill grades as if they were riding outside. Then based on the rider's speed we can calculate the resistance the rider should feel and move the magnets to simulate it. The onboard electronics continuously check the speed and update the resistance accordingly throughout the ride.



CONCLUSIONS

This hand cycle trainer is the first of its kind that features ergonomic considerations for the rider and real-time resistance adjustment. Looking forward, the existing trainer prototype will be integrated with riding platforms such as Zwift or Peloton to make riding more engaging and fun for patients.

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