

The Hip Exoskellie

MCG 4322 - Computer Aided Design

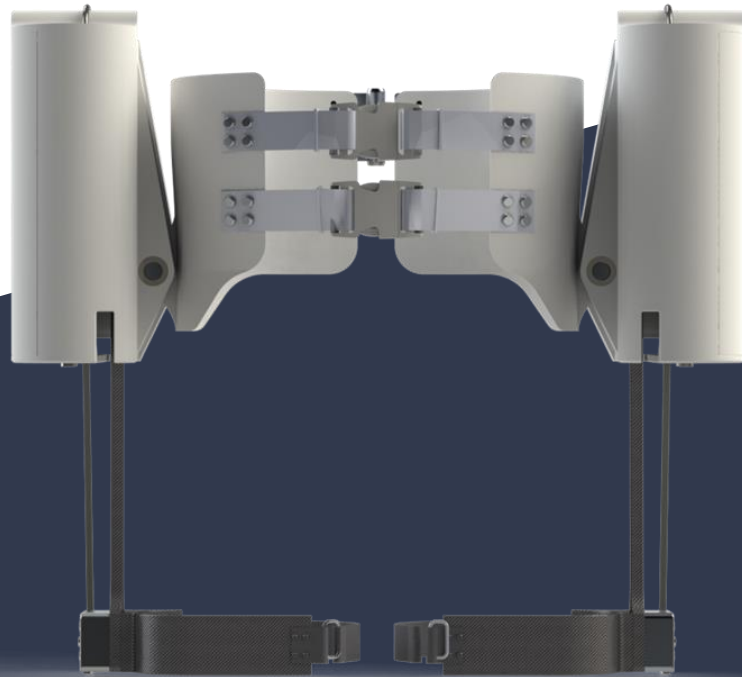
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Agenda

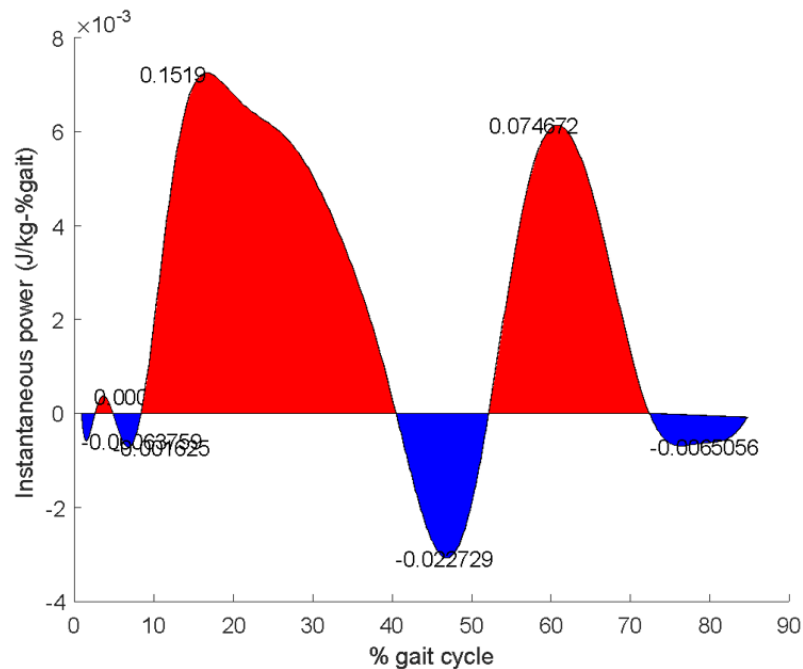


- Introduction
- Gait assist strategies
- Full Design
- Sub Assemblies: Main, Timing, Thigh, Hip and Waist
- Simulation and Validation
- Parametrization: GUI
- Conclusion

Introduction

- Target user - seniors over 65 without significant lower limb joint diseases.
- Target action:
 - Provide up to 8% stance phase energy assistance in sagittal plane.
 - Stabilize hip joint to a safe range of motion.
- Adaptable design - level, incline, and stair gait assistance.

Sagittal Gait Strategy: Level Ground



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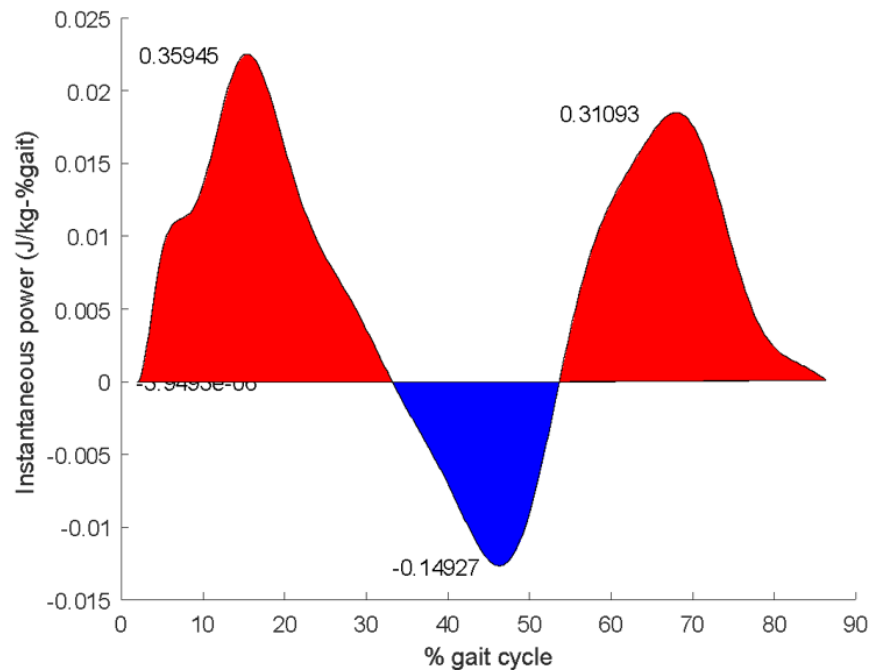
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Sagittal Gait Strategy: Incline Ascent



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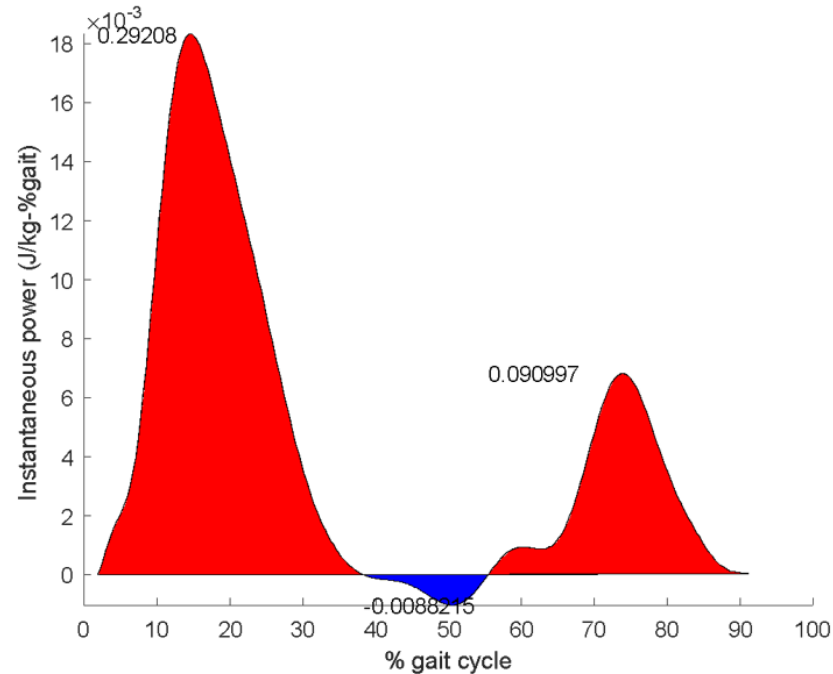
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Sagittal Gait Strategy: Stair Ascent



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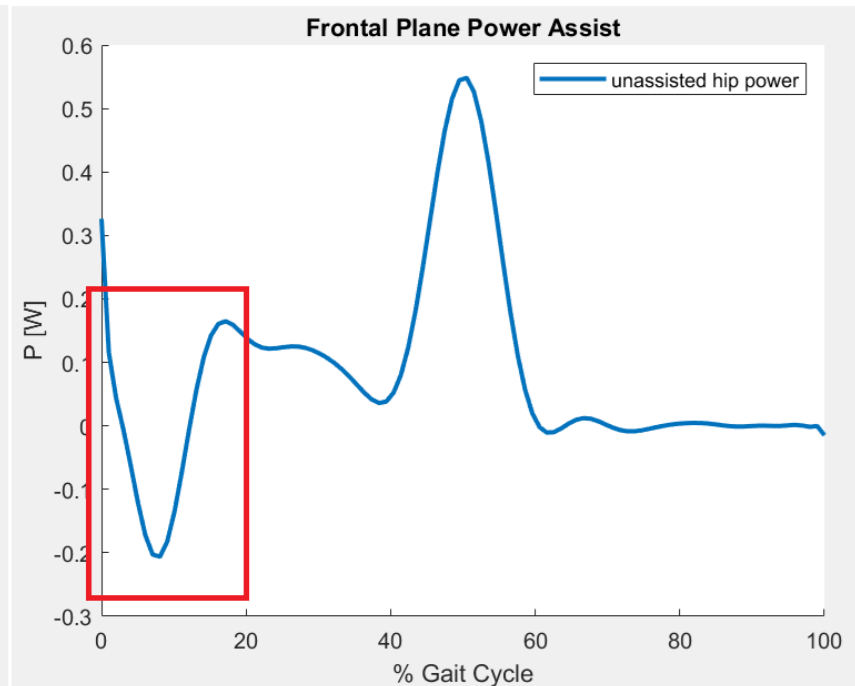
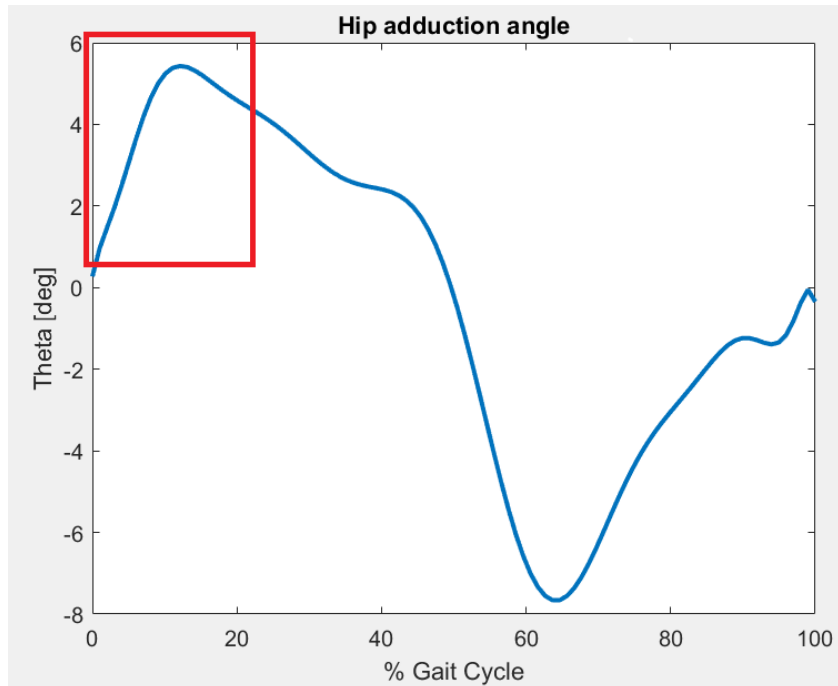
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Frontal Gait Strategy: Level



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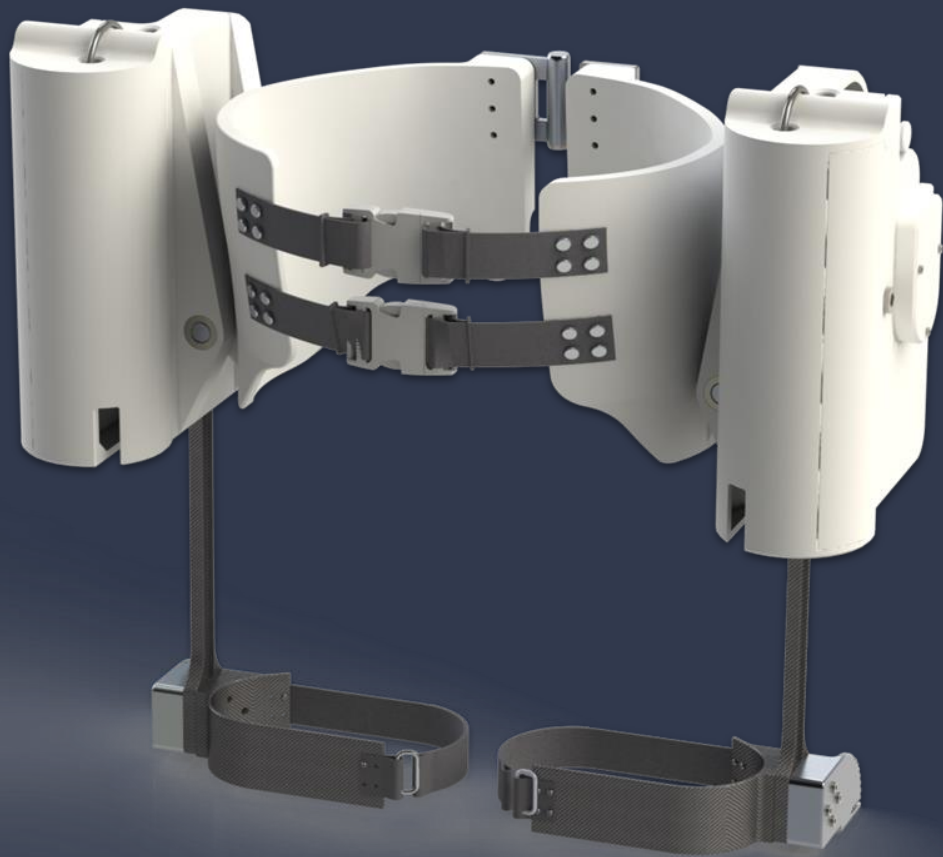
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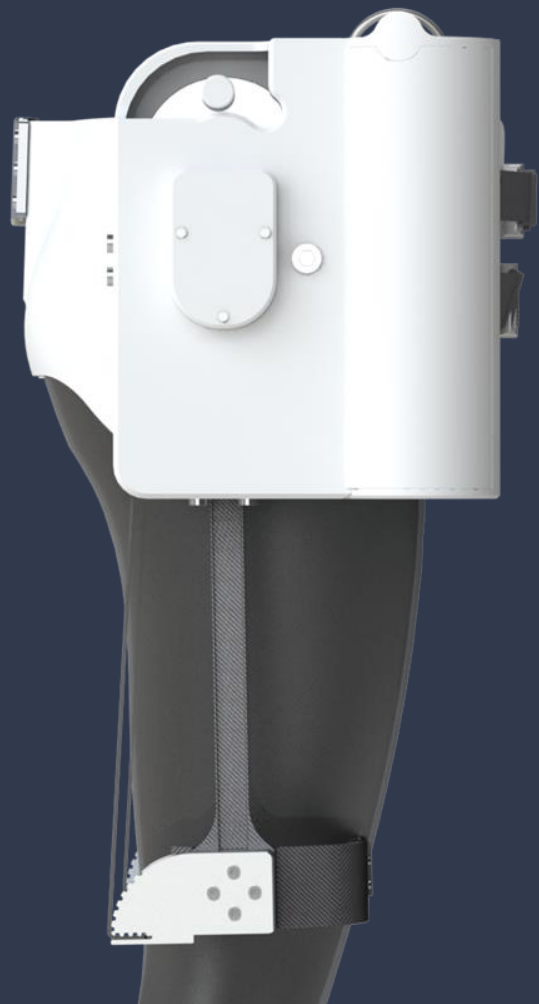
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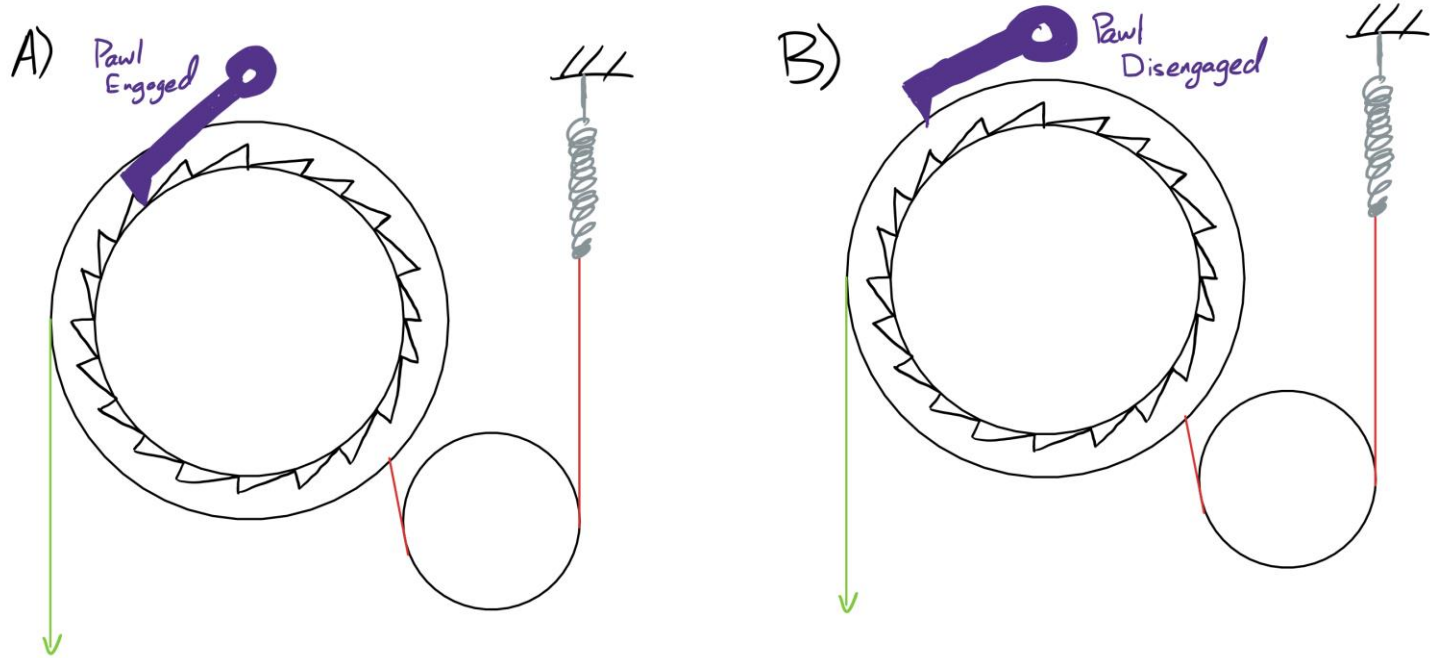
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Main Energy Subsystem



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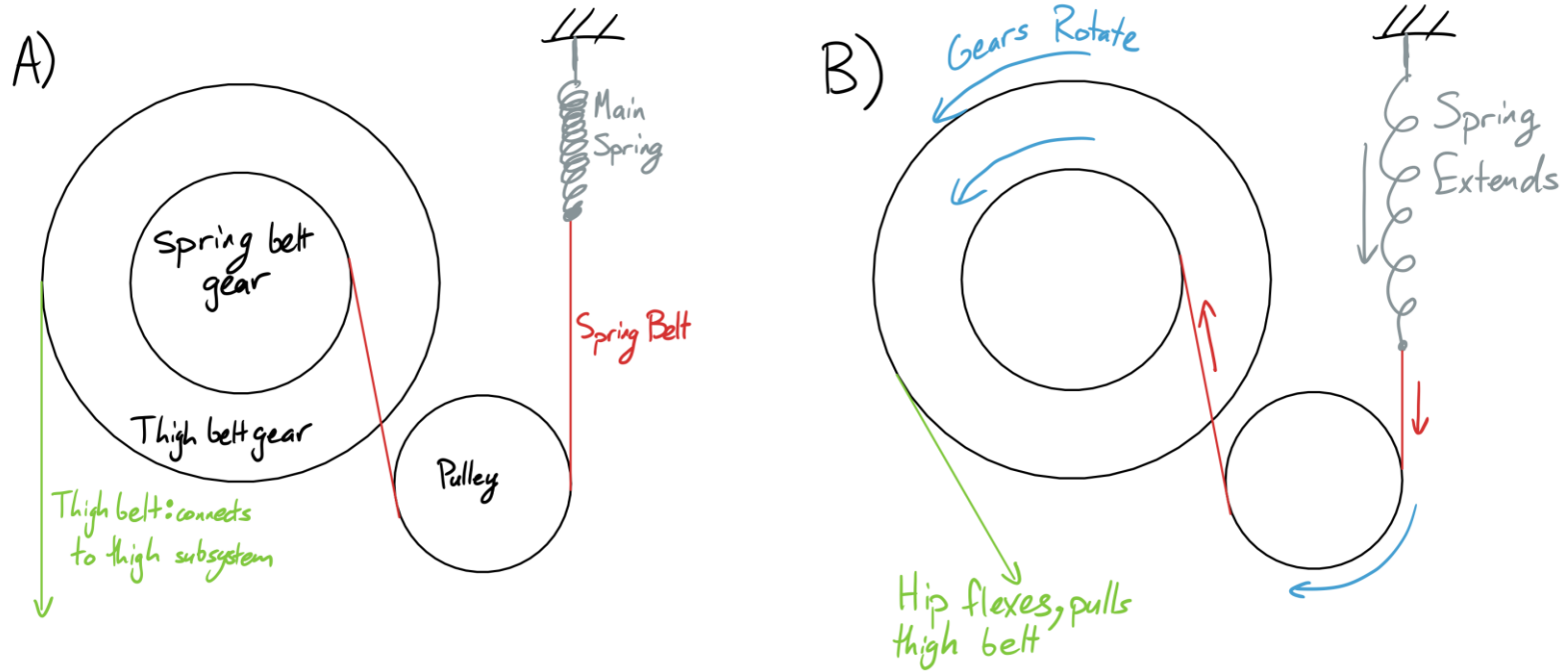
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Main Energy Subsystem



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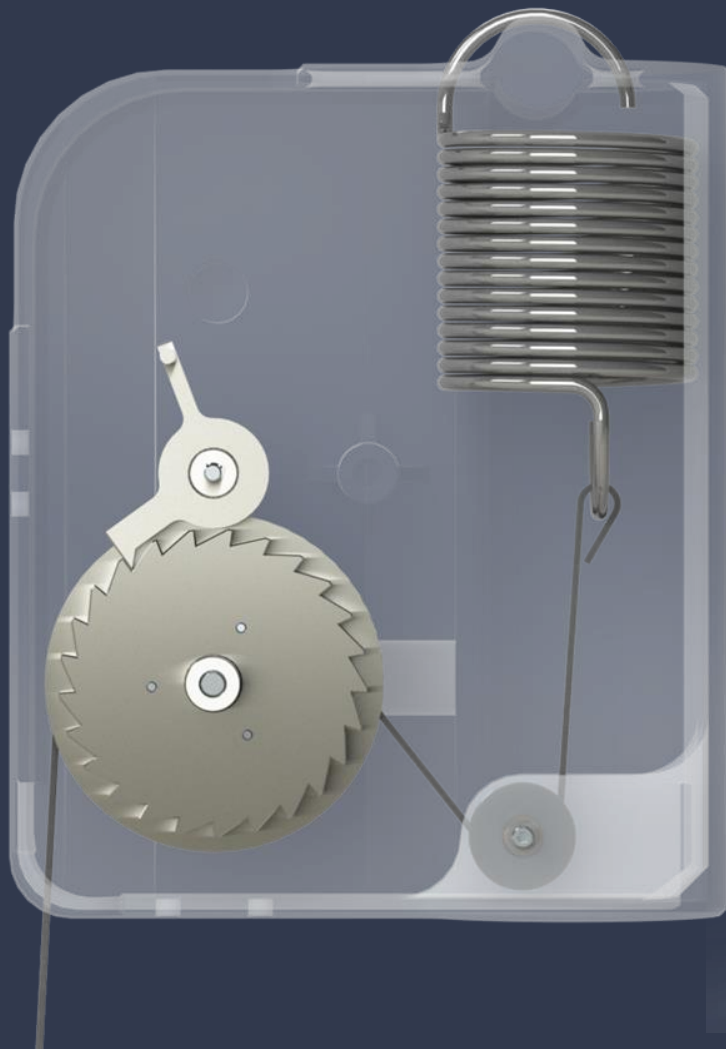
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Timing Subsystem

Functions:

- Control the pawl, engaging it and disengaging it depending on phase of gait
- Change gait modes (level, incline, stairs)

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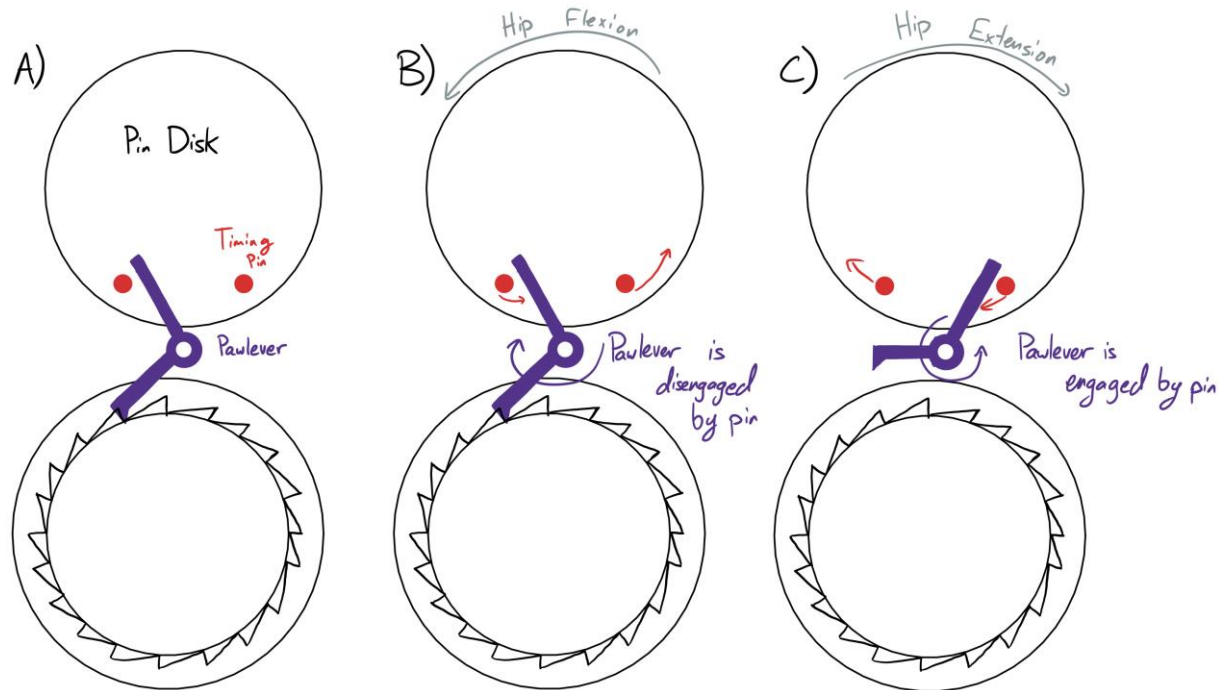
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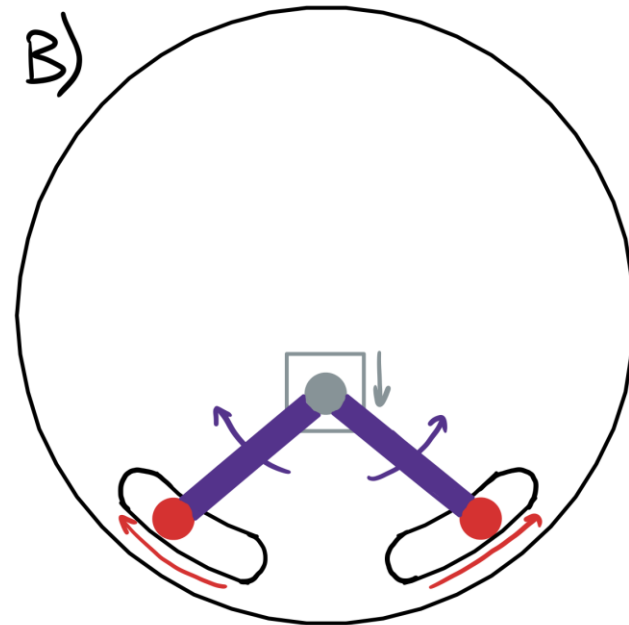
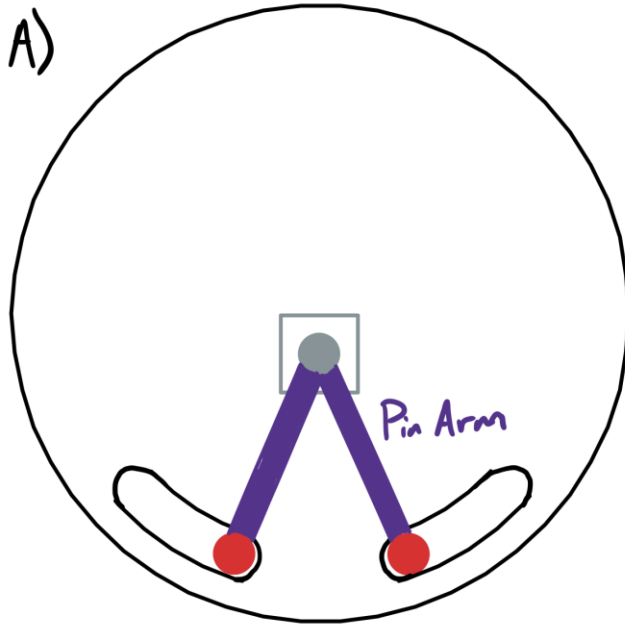
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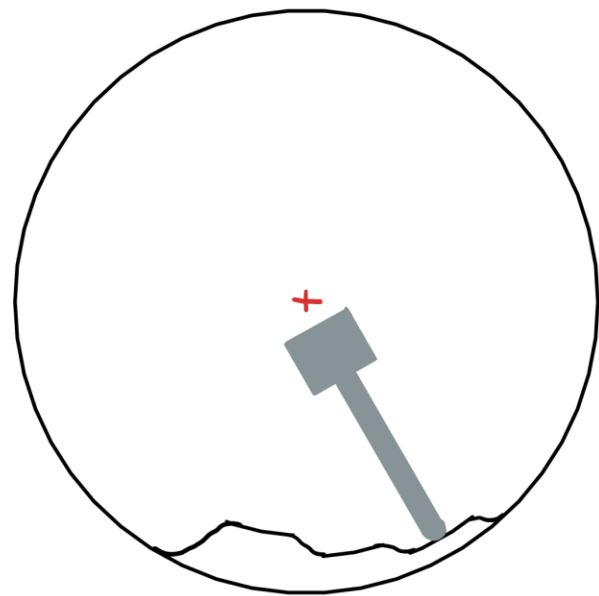
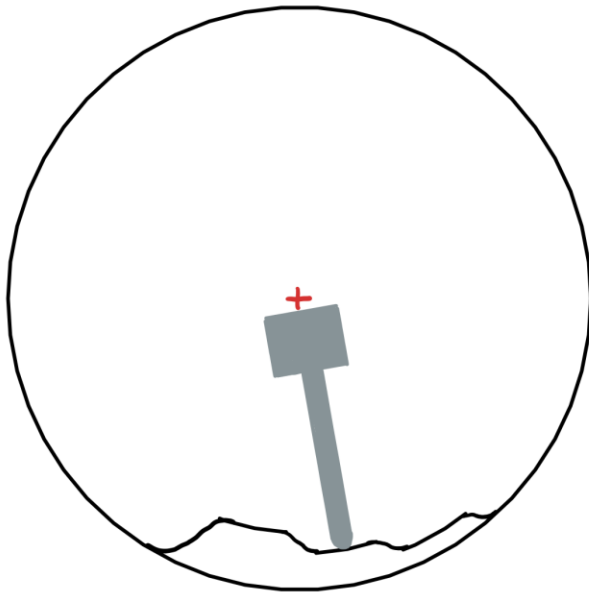
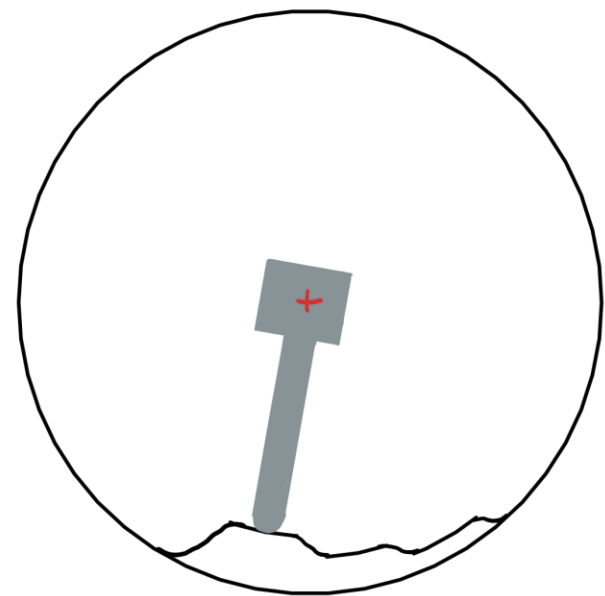
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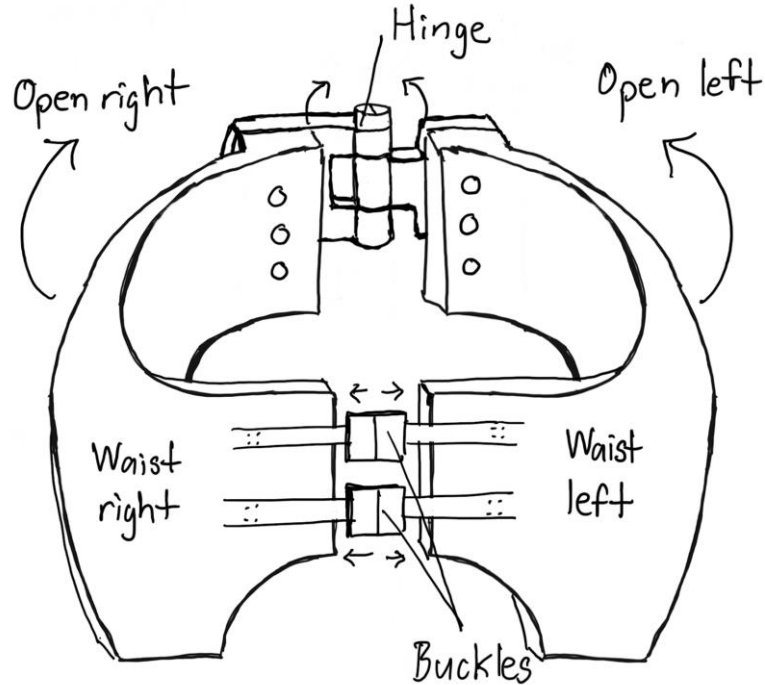
Thigh Subsystem

Functions:

- Connect to the thigh belt to transfer energy to and from the main spring
- Connect to the timing system to rotate timing disks



Waist Subsystem



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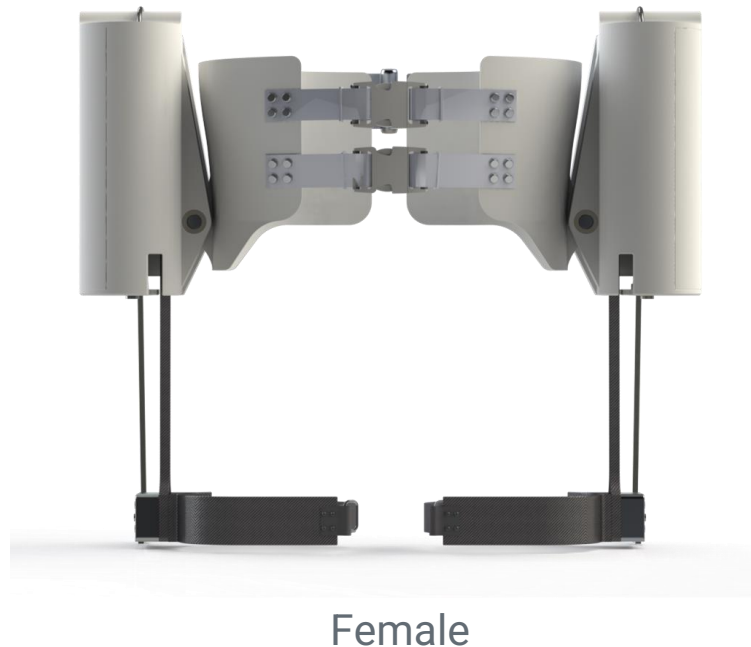
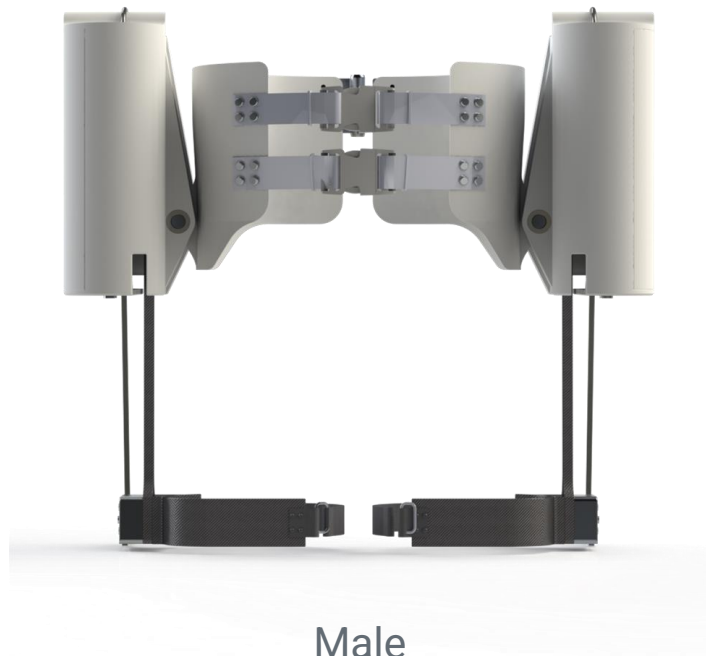
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Waist Subsystem



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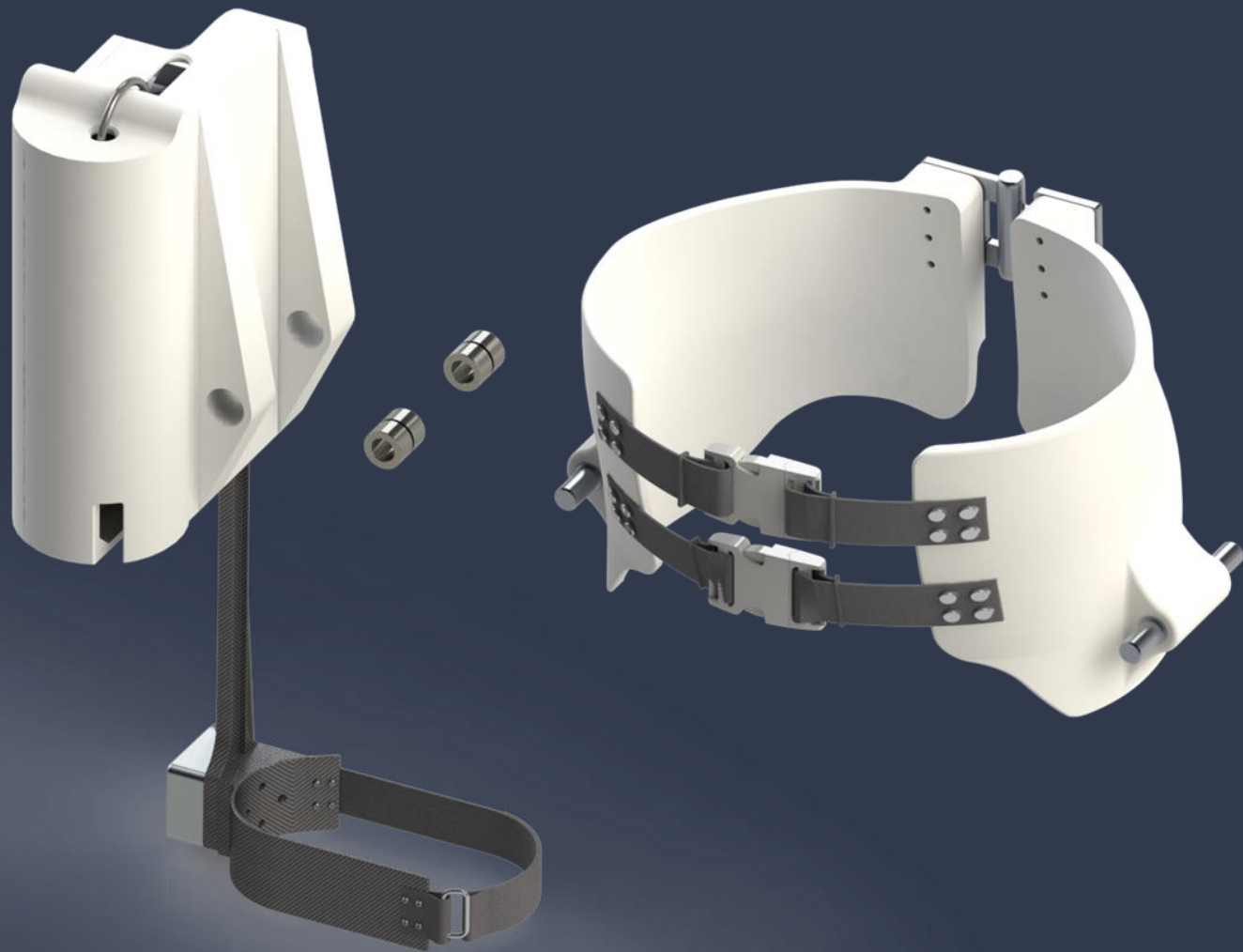
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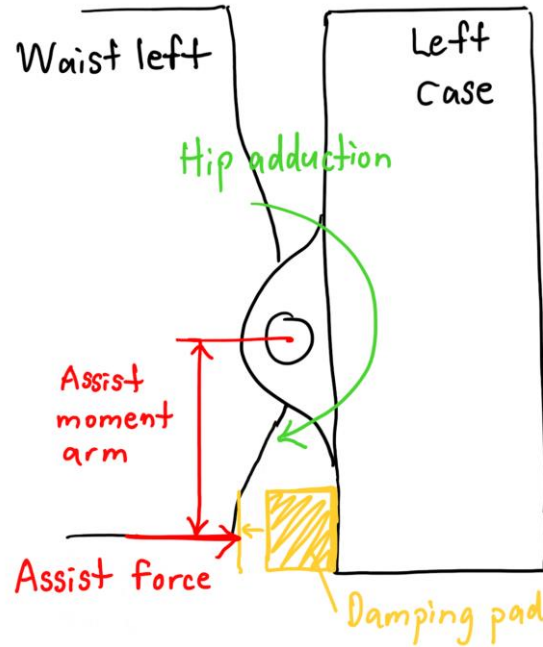
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Waist Subsystem



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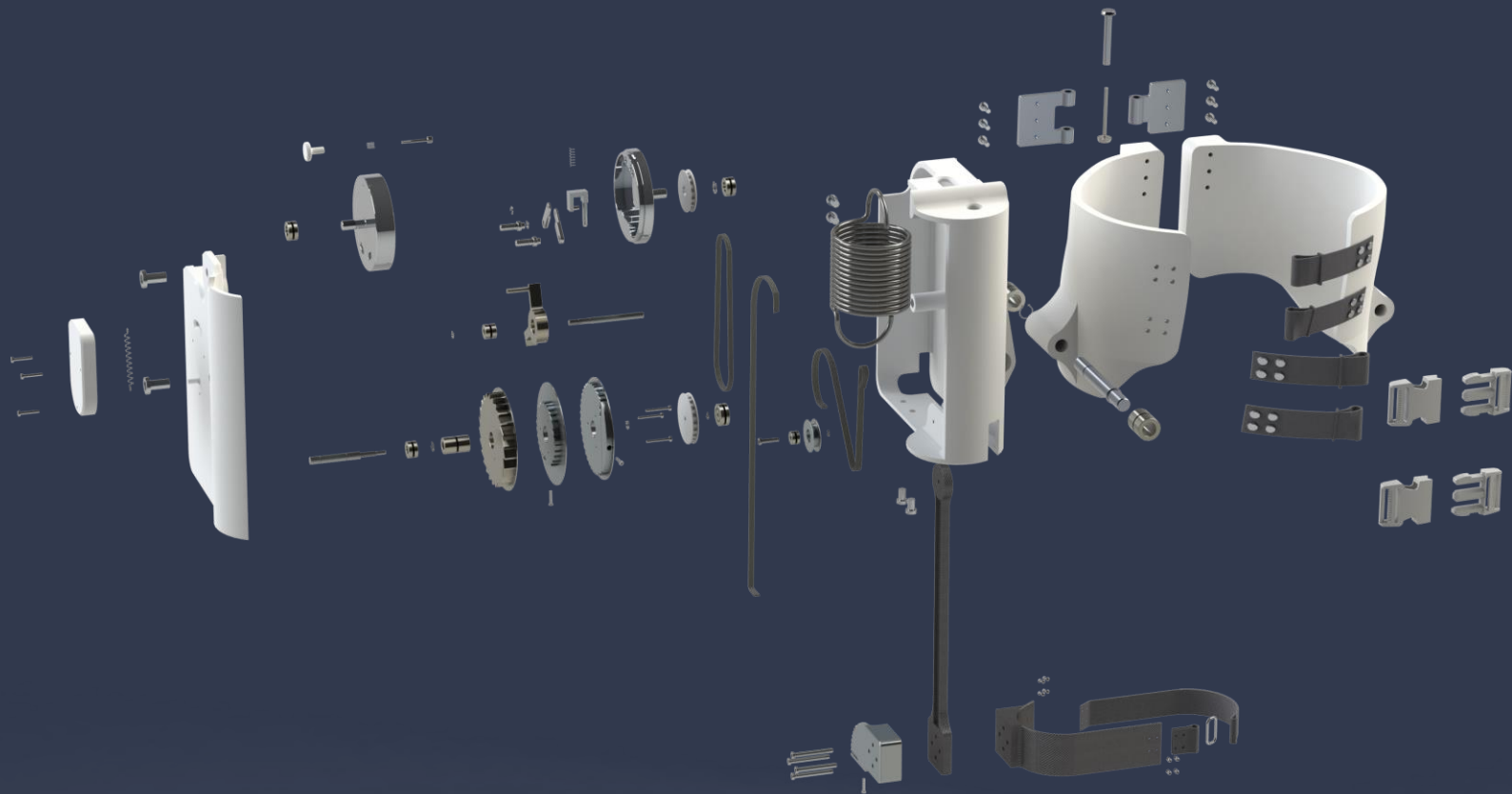
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Simulation and Validation

- Three elderly gait data sets:
 - Law (2013) stair ascent
 - Vickers (2008) incline gait
 - Winter (1990) flat gait
- MATLAB simulation and optimization
 - Kinematics
 - Dynamics
 - Stresses
- SolidWorks FEA

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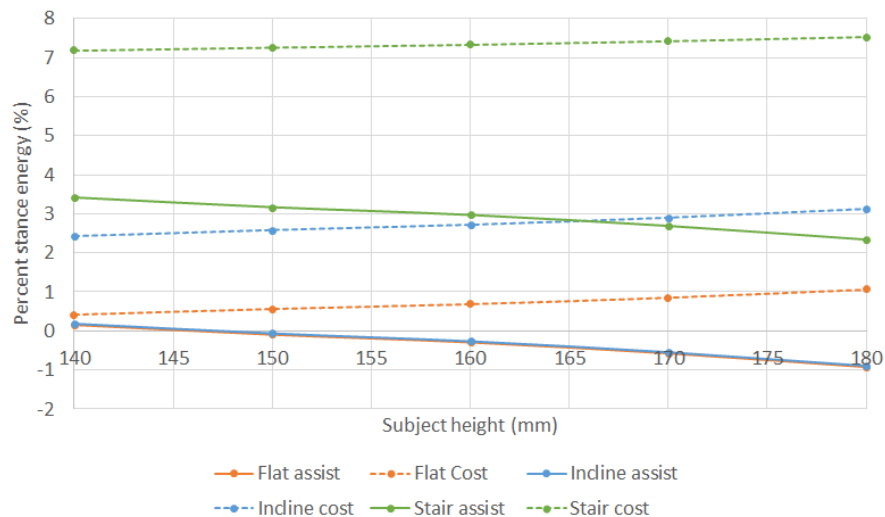
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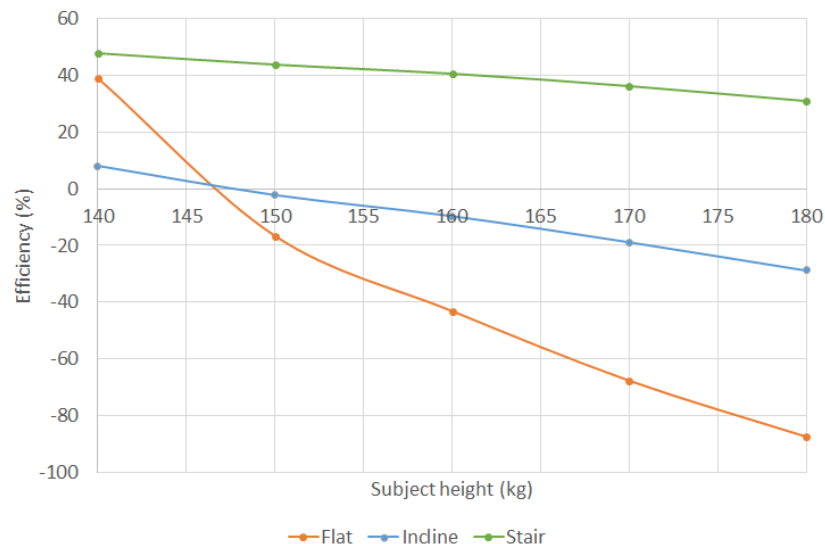
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Simulation and Validation – Device assist

Stance assist percent and stance assist cost for 65kg F with varying height



Stance assist efficiency for 65kg F with varying height



Parametrization: GUI

UI Figure

UserInputPanel

Hip Exoskellie Parametrization App

Enter the measured user parameters and click the GO button to generate and analyze a personalized Hip Exoskellie device.

Gender: ☒ Male ☐ Female

Body mass (kg)

Height (cm)

Number of optimization iterations (2 suggested):

Hip and Waist Dimensions (cm) - Provide hip and waist dimensions using the image as reference

Hip 'a' value: Waist 'a' value:

Hip 'b' value: Waist 'b' value:

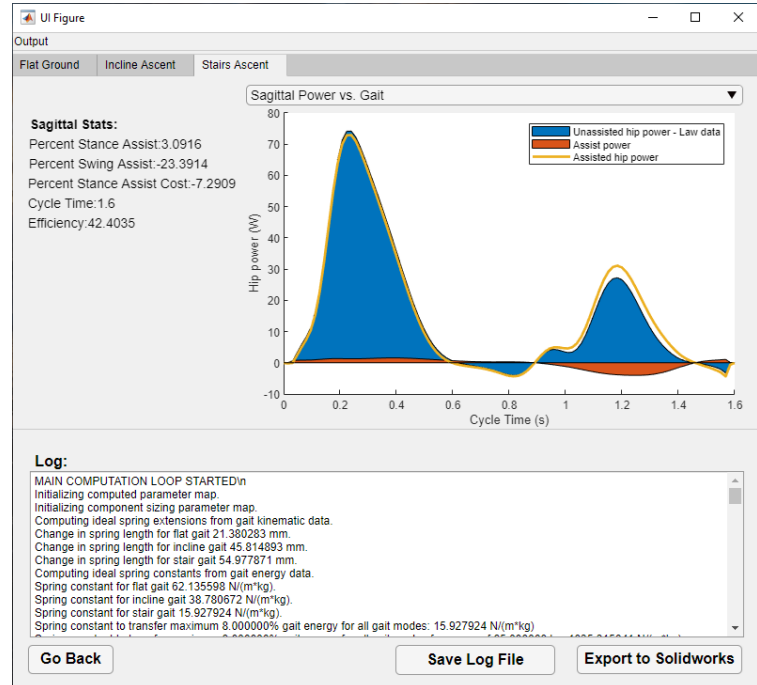
Limb dimensions (cm)

Foot length:

Shank length:

Thigh length:

GO



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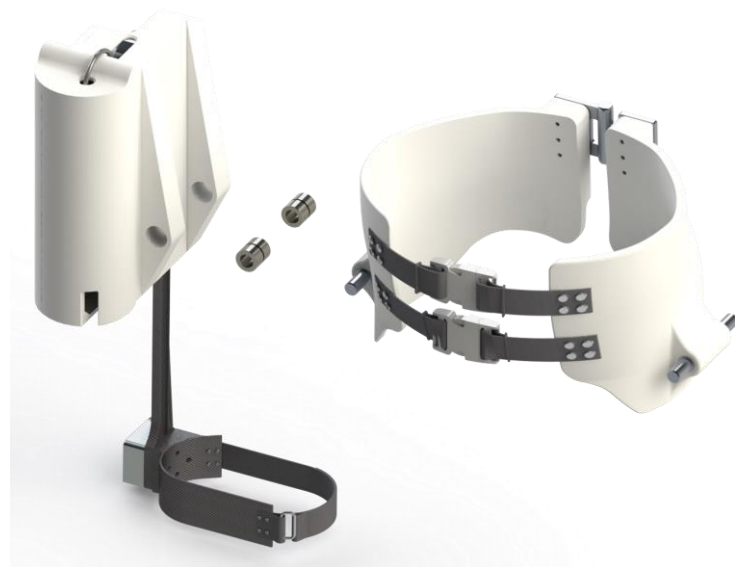
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Takeaway:

- Works for stairs, sometimes works for incline and flat

Future work:

- Further optimization of device mass and size
- Improve power transfer system efficiency



Questions

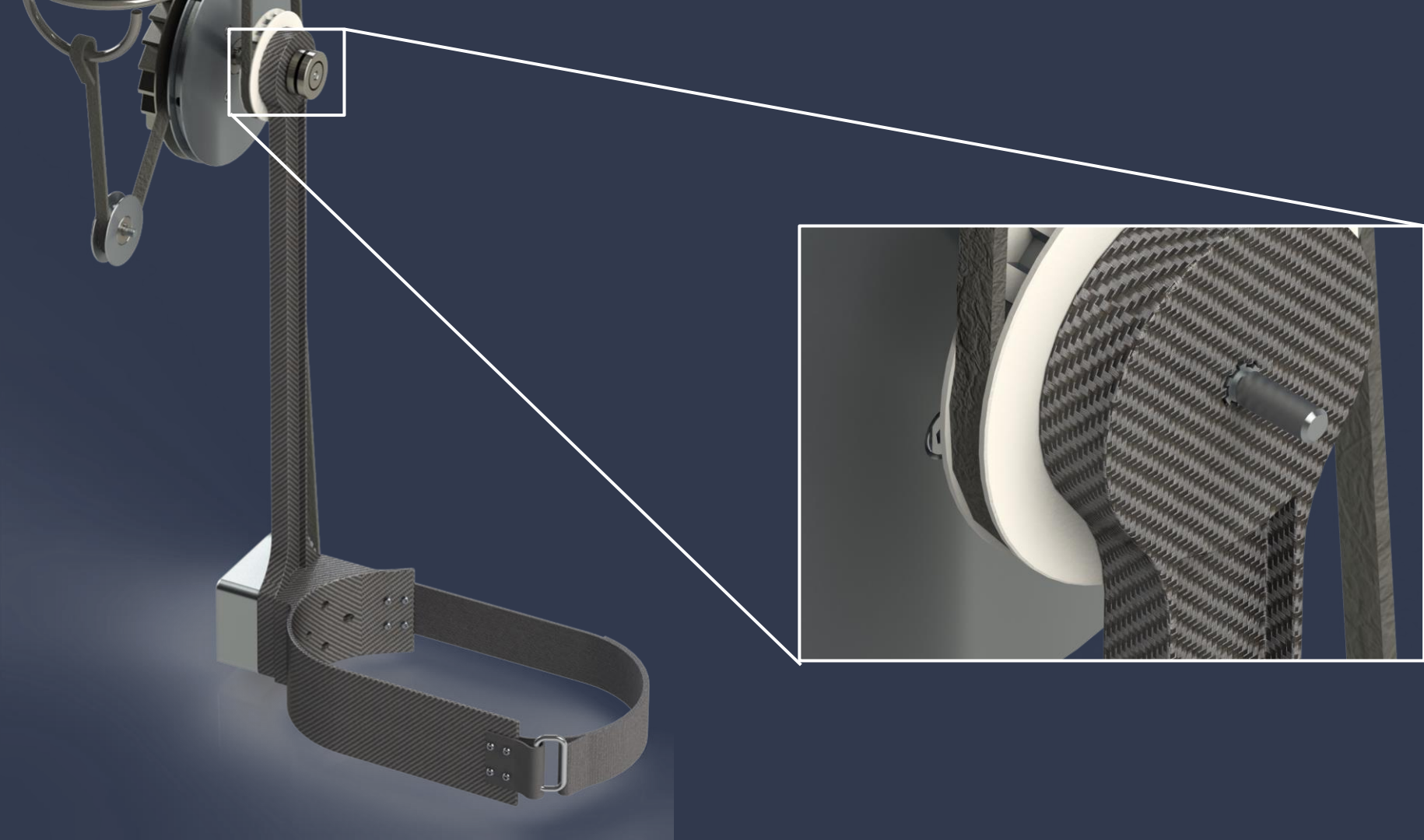
Question? Comments?



Timing Subsystem

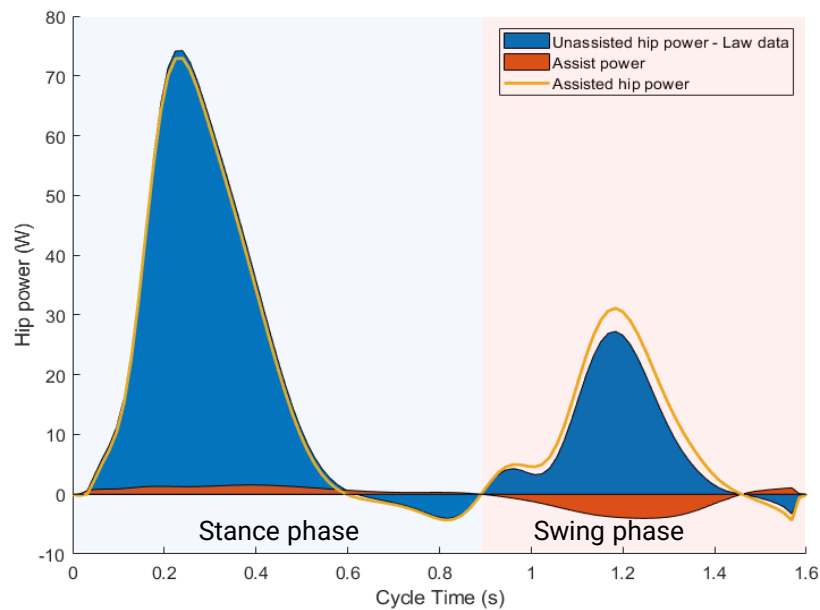
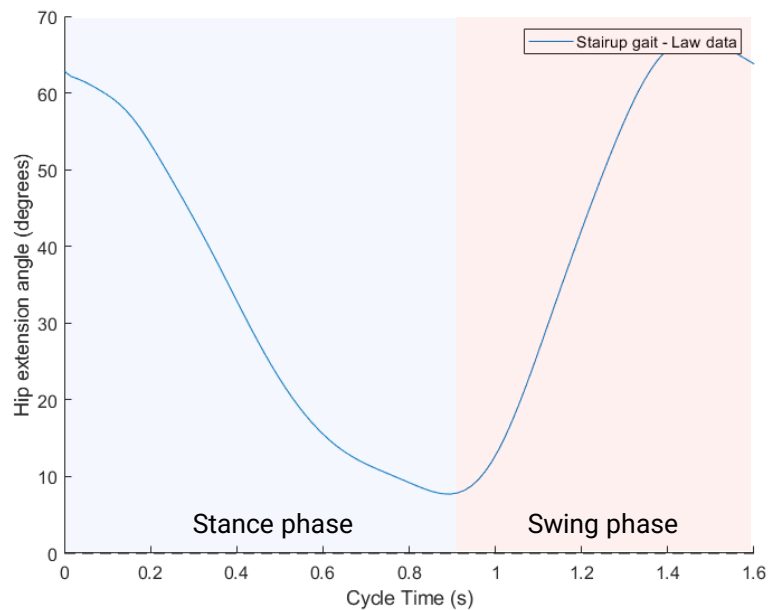








Simulation and Validation – Data Example



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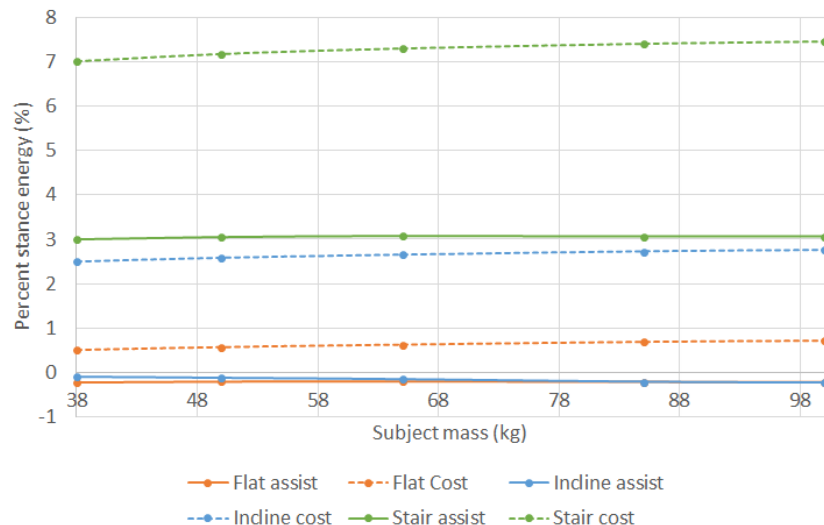
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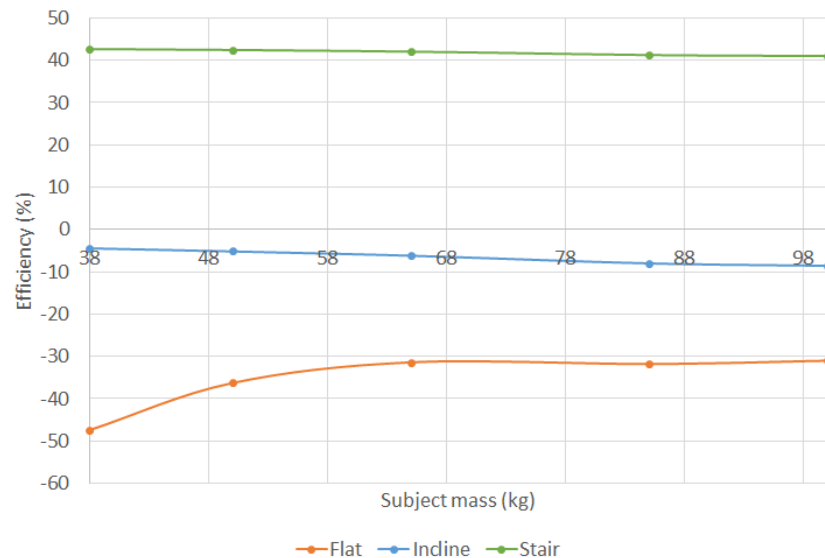
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Simulation and Validation – Device assist

Stance assist percent and stance assist cost for 1.55m F with varying body mass



Stance assist efficiency for 1.55m F with varying body mass



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