Walking Support for Improved Mobility And Independence

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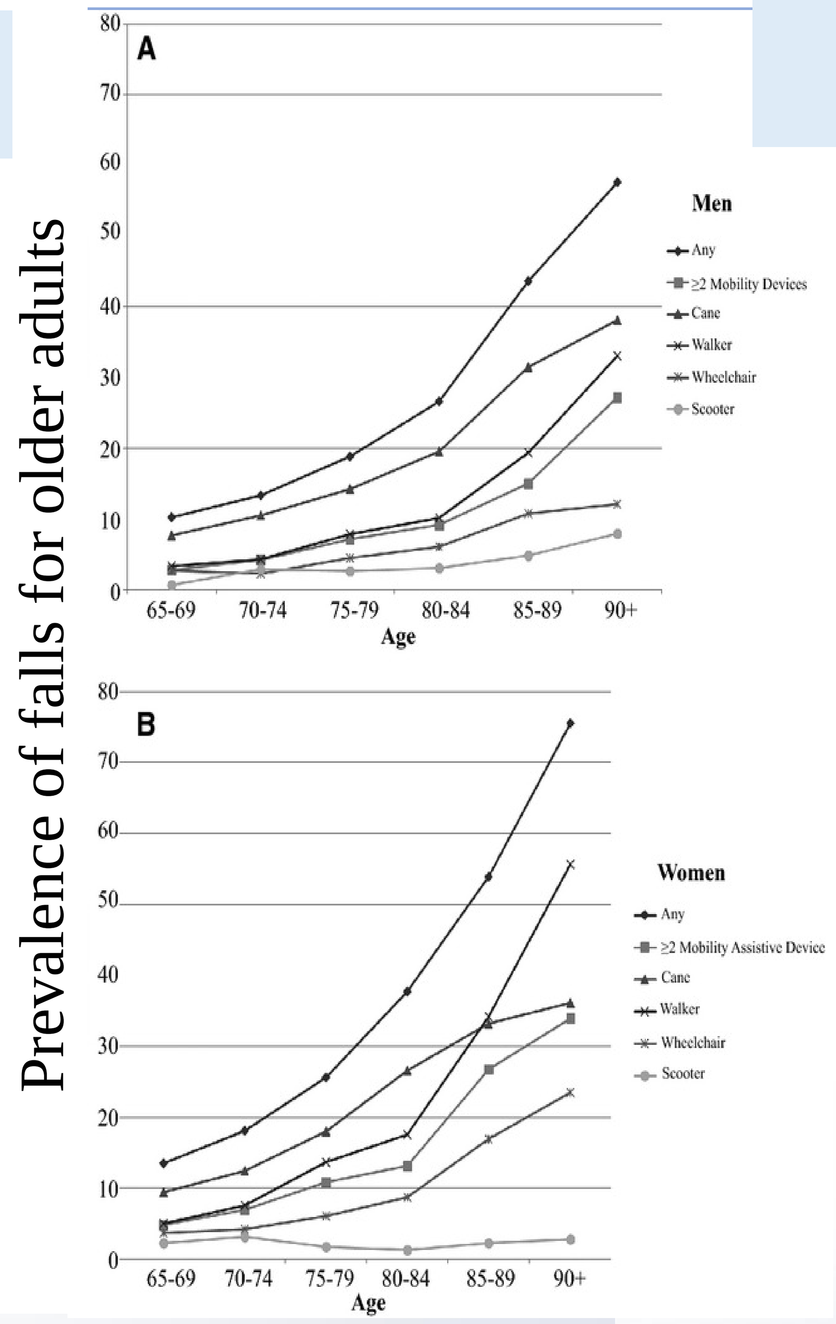
Problem Overview

- Elderly commonly rely on canes or walkers for balance and gait support in response to growing muscle weakness
- However, they force unnatural gait patterns (variability in steppage and stride length) leading to increased vulnerability to falling
    - 1.6%bh for older adults compared to 1.5%bh in younger adults
- Total cost of falls (fatal/nonfatal) adds up $50B (2015)

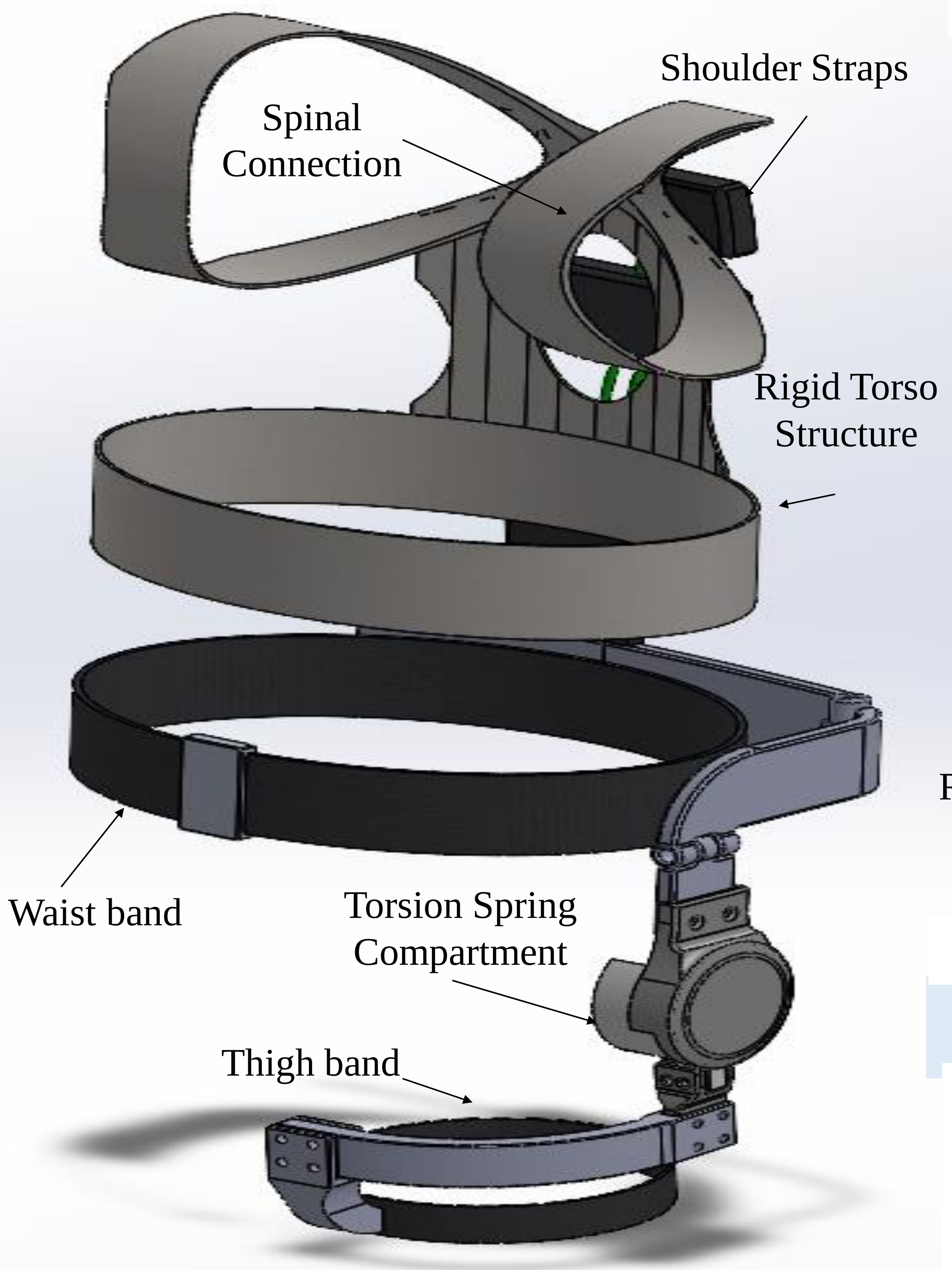
Mission Statement

Our team aims to create a passive-assistive rehabilitation device for the elderly population to decrease step variability, increase hip/torso movement, and realign thoracic curvature of the spine.

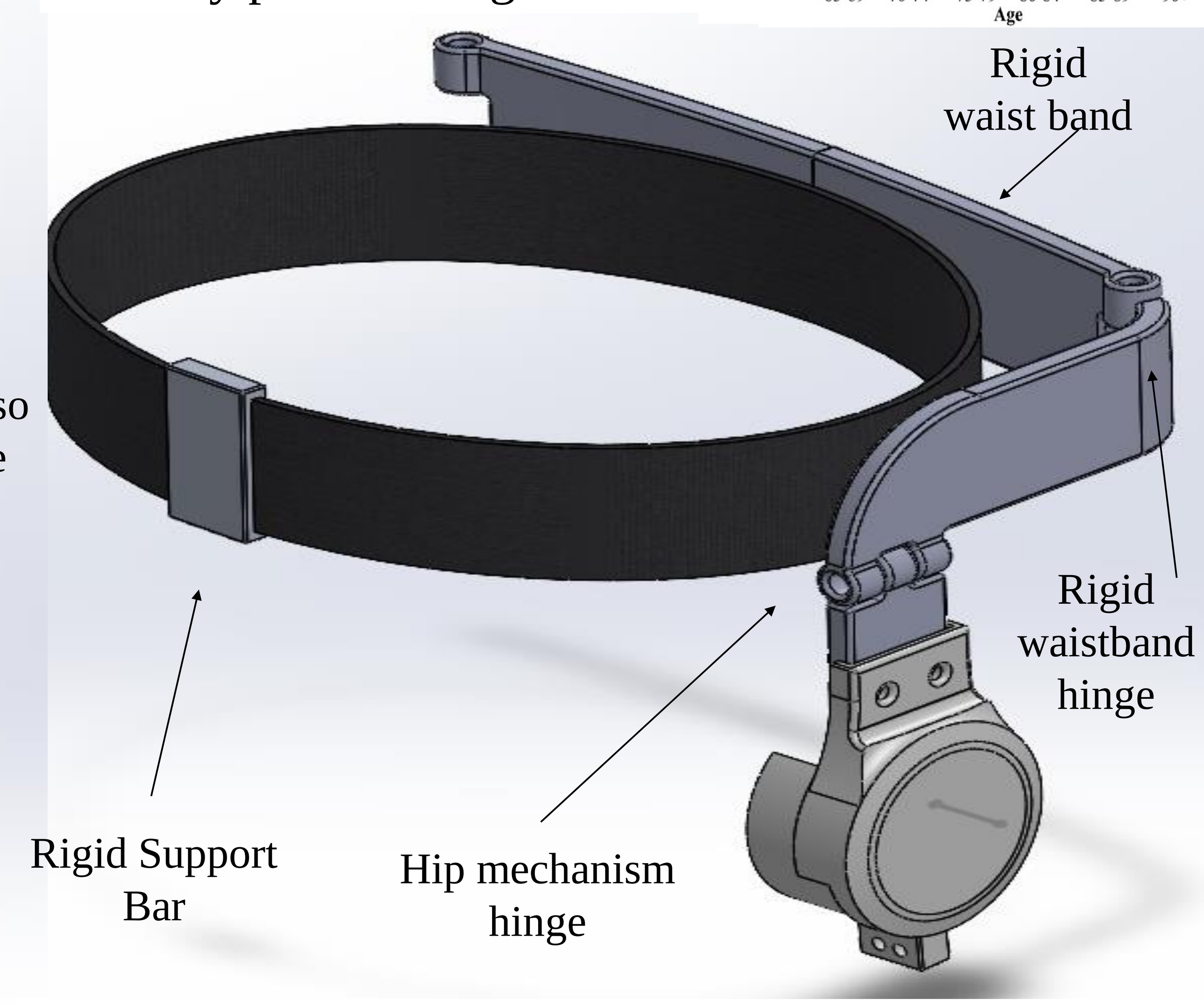
Elderly person using walker



Design Solution



Isometric view of the device



CAD of Hip Mechanism

Design Attributes

Hip Mechanism

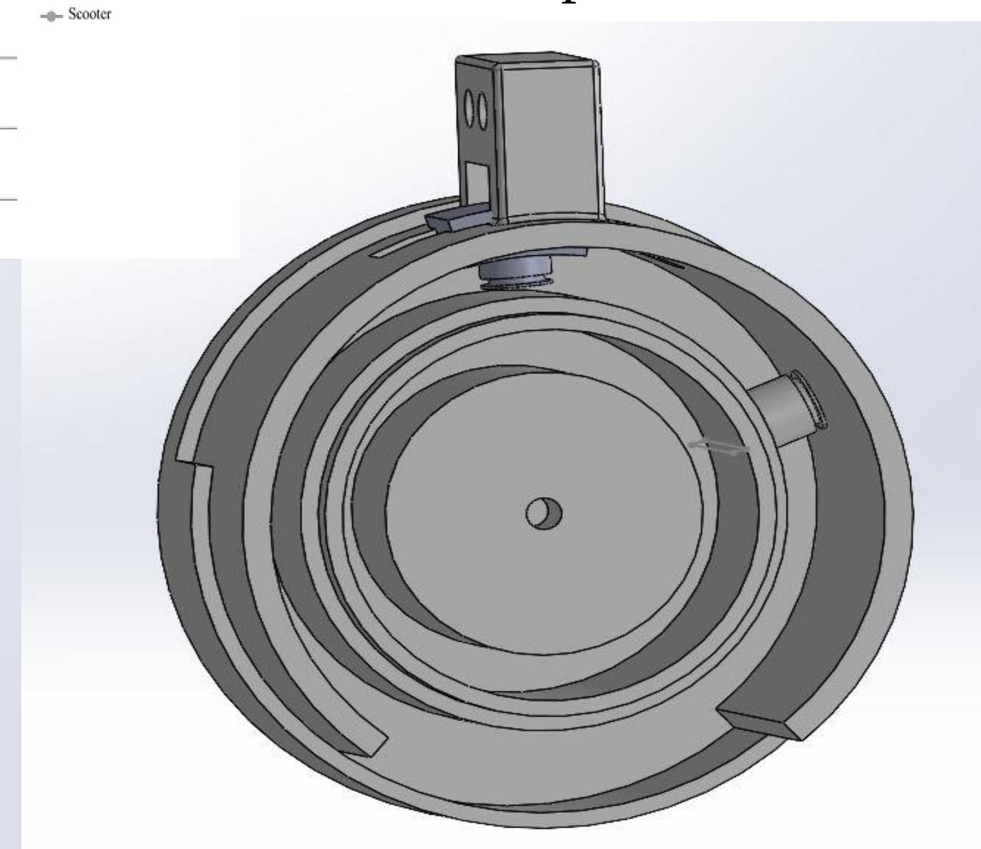
- Rigid structure located around the soft waistband to wrap around the user to the thighs
- Includes torsion springs which provide a torque of 32 Nm to achieve desired joint angles and step length variability to meet hip joint angle of +/- 75 degrees
- Limits step length variability to a healthy older adult average of 1.6 +/- 1.1 %body height

Spinal Attachment

- Connects rigid torso structures of the device to reach a desired thoracic curvature angle of 30 +/- 10 degrees and lumbar thoracic angle of 33.2 +/- 12.1 degrees

Semi Rigid Torso Structure

- Consists of rigid and soft material to provide postural stability for the user's spine, manufactured through 3D-printing and OTS components
- Back strap is attached to spinal attachment and rigid waist structure



CAD of joint mechanism

Calculations

Shear stress of the rigid structure

Length from hip joint to knee joint: 40.9 mm

Torque: 32 N*m

$$r = 40.9mm$$
$$8Nm/40.9mm = 195Nm$$
$$32Nm/40.9mm = 782.4Nm$$
$$782.4N - 195N = 587.39N$$
$$2\pi r = 92.79mm$$
$$587.39N/92.79mm = 6.33Nmm = 0.0823Lbs/mm$$

Conclusions and Future Work

For Winter 2023, work was done to alleviate rigidity of the torso piece and waist band, increase degrees of the freedom, and adjust the stiffness of the spring to meet design requirements. For future work, it would be crucial to also consider the psychological implications of the current device's design, and work towards simplifying components of the device to promote user friendliness. The design process was a consistent revisional process. In conclusion, application of engineering concepts and engaging in professional design discussions allowed for a challenging, yet rewarding experience, giving a glimpse into work within the industry.

References/Acknowledgements

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