Jonnson School UG
Research Award Recipient

Development of Universally Adjustable Human-Robot Interfaces for Powered Lower Limb Exoskeletons

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Introduction

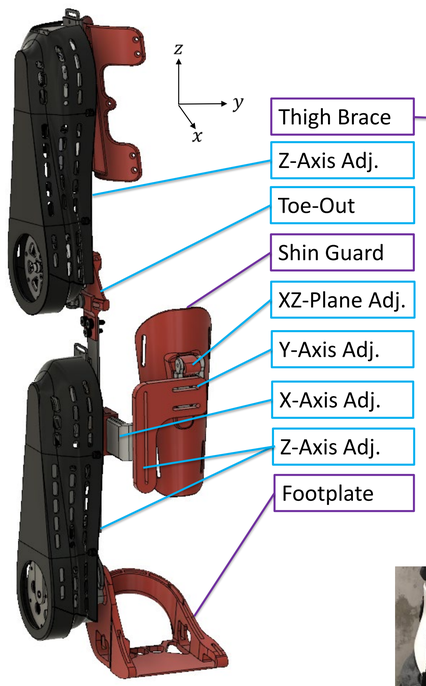
- Every year, over **795,00** people in the US **experience a stroke**[1].
- Stroke is a leading cause of serious long-term disability. Stroke **reduces mobility** in more than **half of stroke survivors** [1].

Rehabilitation: Exoskeletons to Combat Reduced Mobility

- Typically, exoskeletons are custom-built to fit one person because of the anthropometric differences among human subjects. An ill-fitted human-robot interface will cause a patient discomfort and reduce the effectiveness of transmitting an actuator's torque to the subject.
- To determine the effectiveness of the interface for ComEx 1, human subjects will take a survey as part of an IRB approved study.

ComEx 1 – Knee/Ankle Actuated Exoskeleton

ComEx 1 utilizes **four attachments** and **eight adjustments** to secure the exoskeleton to the subject in approximately five minutes and remove it in under thirty seconds.

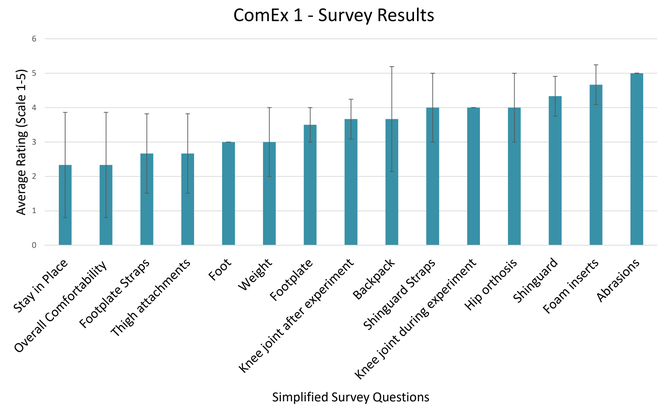


ComEx 1 CAD Model

ComEx 1

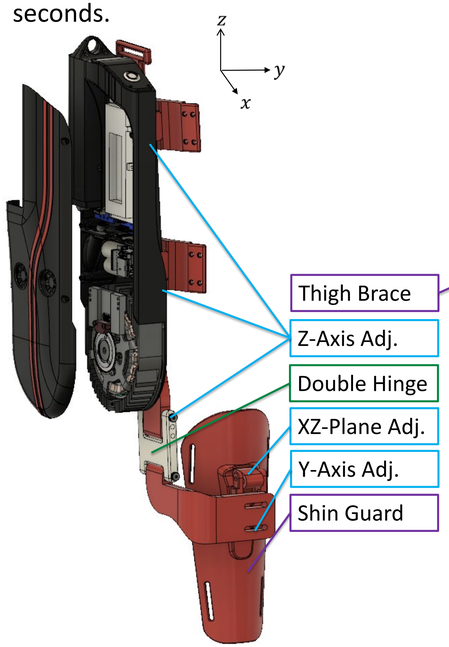
ComEx 1 – Human Trials

- Survey constructed as part of a study run by a PhD Student
- Able-bodied subjects (n=3) wearing ComEx 1 for unpowered acclimation period, followed by 5 min. powered treadmill walking
- Subjects filled out survey, which rates comfort level of different interface elements
- Survey results display which elements need improvement
- Elements are rated from 1 to 5, unsatisfactory to satisfactory
- Error bars represent standard deviation

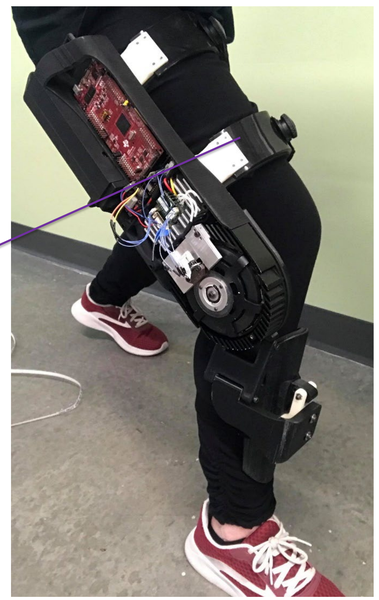


ComEx 2 – Knee Actuated Exoskeleton

ComEx 2 utilizes **three attachments**, **six adjustments** and **one dynamic degree of freedom** to secure the exoskeleton to the subject in approximately two minutes and remove it in under twenty seconds.



ComEx 2 CAD Model



ComEx 2

- The thigh braces are 3D printed using flexible material allowing the brace to conform to the conical shape of the subject's thigh.
- The hip orthosis uses the subject's hips as a constraint, preventing the exoskeleton from sliding down the subject's leg.
- The double hinge allows the distance between the shin guard and the actuator to vary during locomotion.

Future Work

ComEx 1

- Improve method for adjusting toe-out mechanism to reduce stress on knee joint
- Add silicon interface to thigh attachment to reduce slippage
- Weight reduction of oversized components
- Conduct more human trials to expand data pool

ComEx 2

- Begin conducting human trials and implement design changes based on results

Summary

- The results of the human subject trial prove that ComEx 1 is adequately comfortable for able bodied users of various sizes.
- Comex 2 is ready to begin testing

References

[1] "Stroke Information," *Centers for Disease Control and Prevention*. [Online]. Available: https://www.cdc.gov/stroke/index.htm. [Accessed: 08-Apr-2019].

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