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Navigating Adaptive Design: Advancing the Body-Machine Interface for 6D Control in Assistive Applications

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Introduction

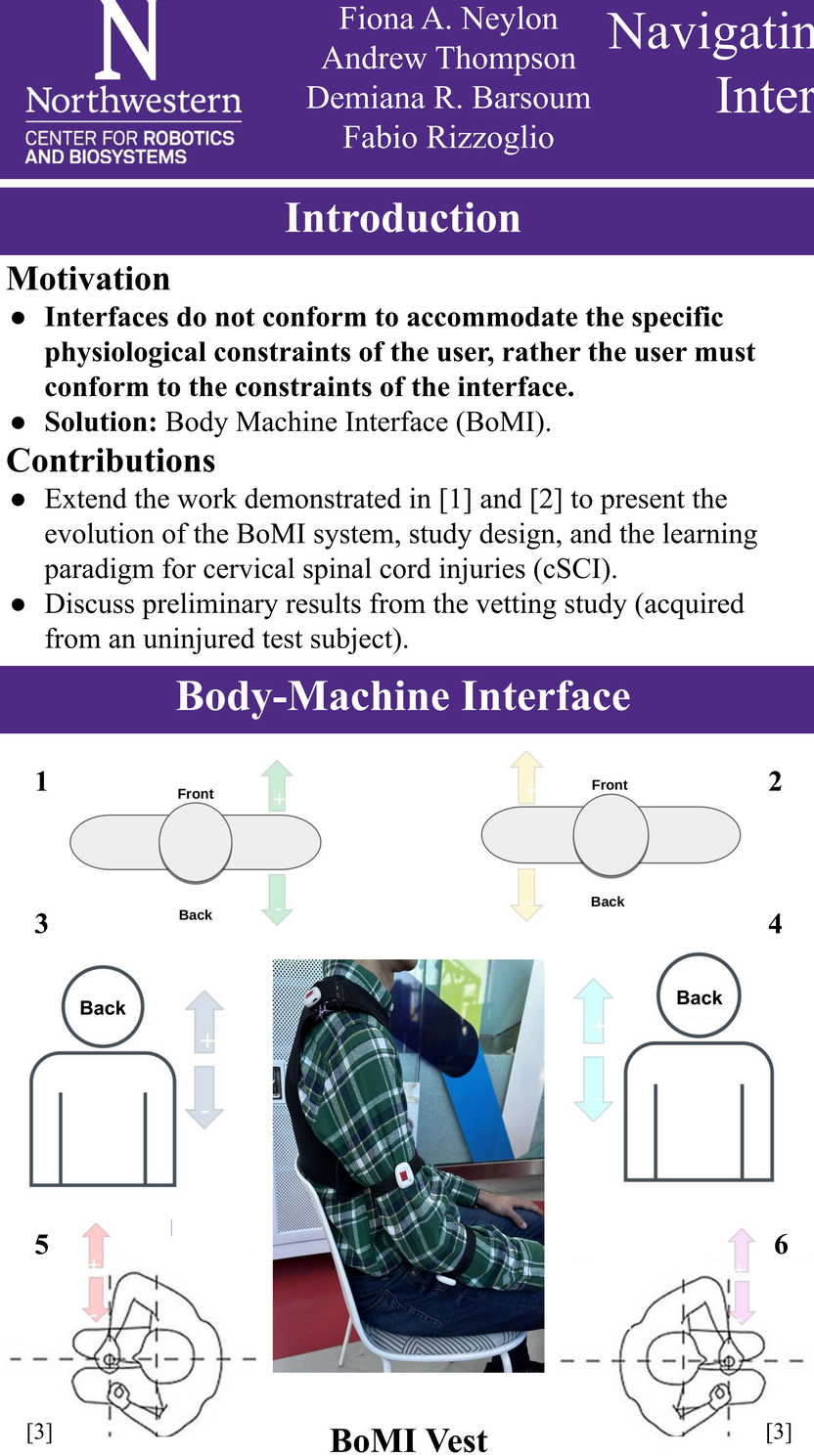
Motivation

- **Interfaces do not conform to accommodate the specific physiological constraints of the user, rather the user must conform to the constraints of the interface.**
- **Solution:** Body Machine Interface (BoMI).

Contributions

- Extend the work demonstrated in [1] and [2] to present the evolution of the BoMI system, study design, and the learning paradigm for cervical spinal cord injuries (cSCI).
- Discuss preliminary results from the vetting study (acquired from an uninjured test subject).

Body-Machine Interface



Scoping Study

Participants C3 Complete, C4 Incomplete, and C5 Incomplete (3M, age 63 ± 20.4).

Motivation

- Validate enough variance in cSCI population.
- Compare the curl and elbow prompts.
- Gain feedback on system from end users.

Conclusions

- Lack of understanding of how curl prompt differs from shoulder Fw/Bw, and discomfort when performing the prompt.
- Motion prompts are viable for cSCI populations.
- Elbow prompts were selected over curl prompts.

High-Dimensional Control

2D PCA Embedding

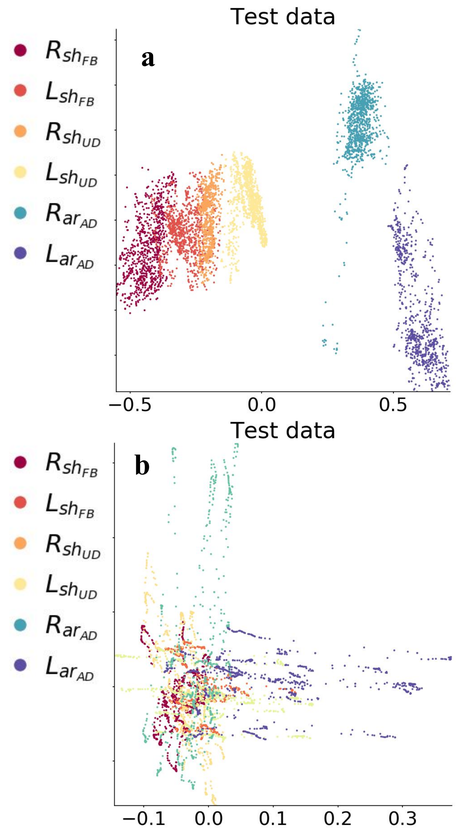


Fig. a C5 Incomplete (Scoping Study)

- Spread along x-axis (IMU drift)
- No overlapping clusters
- No perpendicularity
- No symmetry

Fig. b C7 Incomplete (Vetting Study)

- All axes overlap for a portion (deadzone)
- Perpendicularity with respect to sides of the body.
- Symmetry of two sides of the body.

Vetting Study

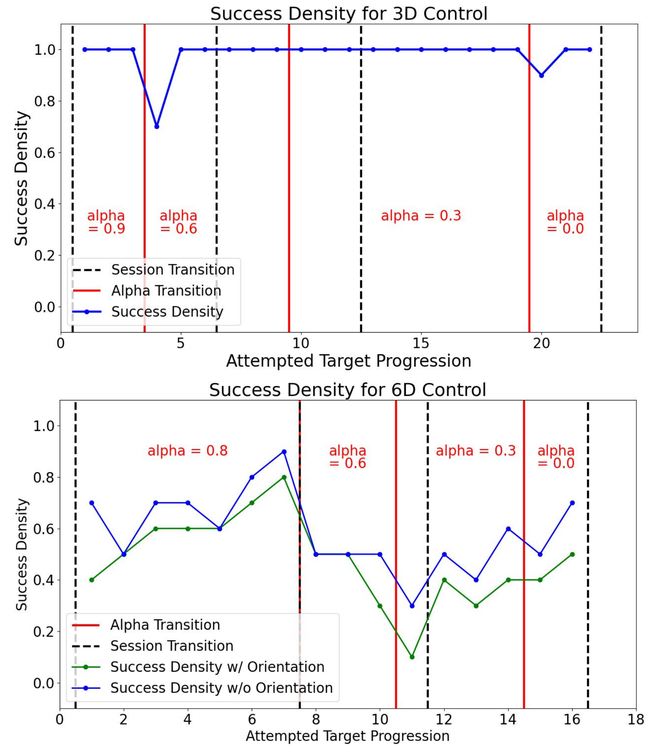
Participant Uninjuried 45 year-old male.

Methods

- Unlocking control dimensions to the user, and additionally engaging adaptive robot autonomy to assist with learning during a sequential reaching task.

Conclusions

- Participant is able to achieve a final success density without autonomy comparable to their starting rate.



References

[1] Jongmin M. Lee, Temesgen Gebrekristos, Dalia De Santis, Mahdieh Nejati-Javaremi, Deepak Gopinath, Biraj Parikh, Ferdinando A. Mussa-Ivaldi, and Brenna Argall. 2023. An exploratory multi-session study of learning high-dimensional body-machine interfacing for assistive robot control. In Proceedings of the IEEE-RAS-EMBS International Conference on Rehabilitation Robotics (ICORR).

[2] Andrew Thompson, Fabio Rizzoglio, Fiona A. Neylon and Demiana R. Barsoum, Lucy E. Ammon, Maximum N. McCune, and Lee Miller and Brenna Argall. 2024. An evolution of assistive robot control to meet end-user ability. Human-Robot Interaction. doi: 10.1145/3610978.3640565.

[3] Park, Jeong-Ho & Shin, Joon-Ho & Lee, Hangil & Roh, Jinsook & Park, Hyung-Soon. (2021). Alterations in intermuscular coordination underlying isokinetic exercise after a stroke and their implications on neurorehabilitation. Journal of NeuroEngineering and Rehabilitation. 18. 10.1186/s12984-021-00900-9.

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