

Effectiveness of altered parameters of amplitude modulation-based haptic sensation generation

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Introduction

- Haptic (touch) sensation
 - Enables people to receive information from the environment¹
- Lower limb amputation results in loss of sensation, balance problems^{2,3}
- Artificial haptic stimulation can be used to restore feedback from the environment
- Vibration stimulation commonly used
 - Can generate sensation of target moving across vibration motors
- Amplitude modulation is a stimulation pattern⁴ often used to simulate a moving target
 - Intensity of vibration indicates location of target relative to motor
 - Introduced a **dead band** – Region with no vibration

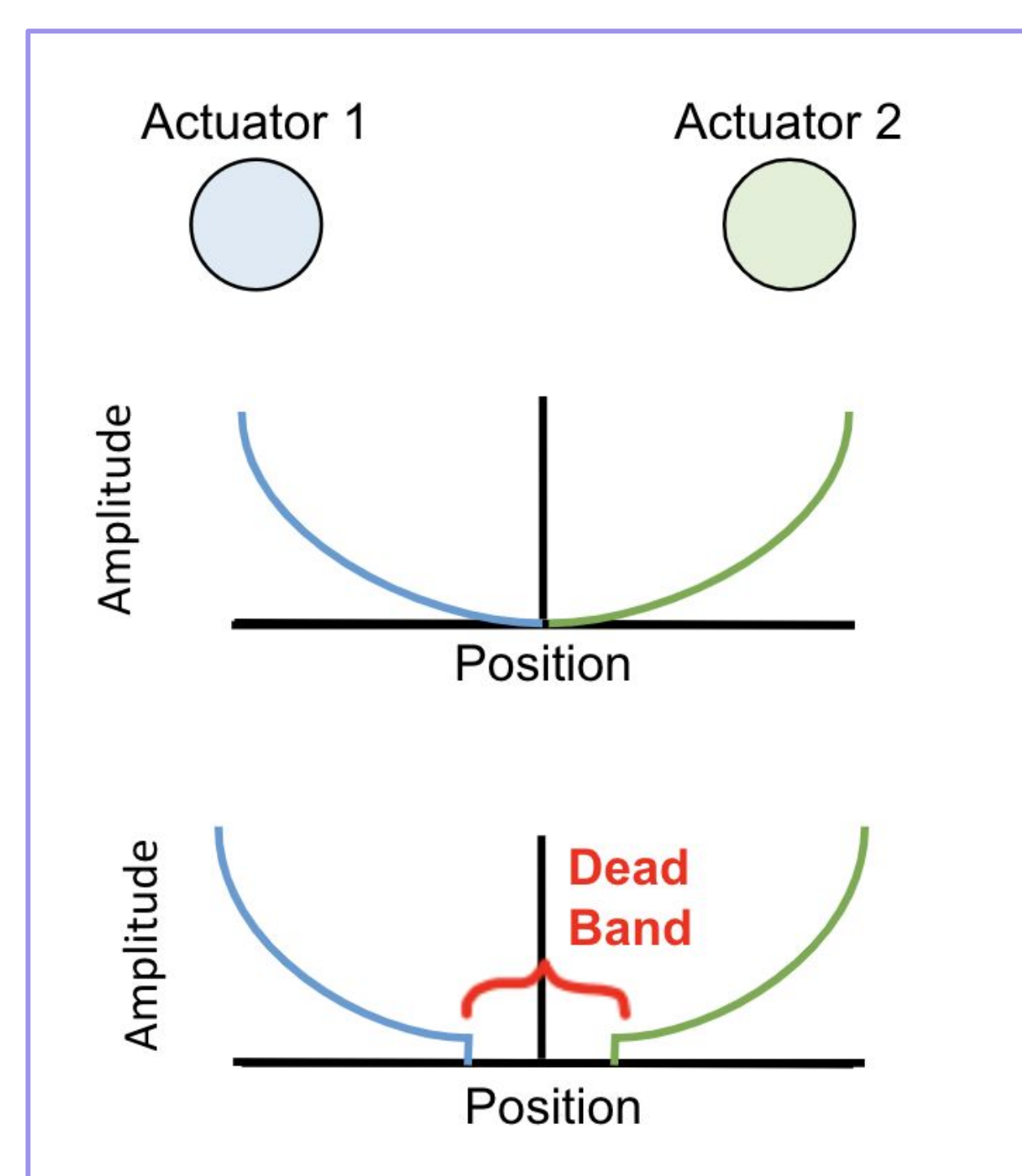
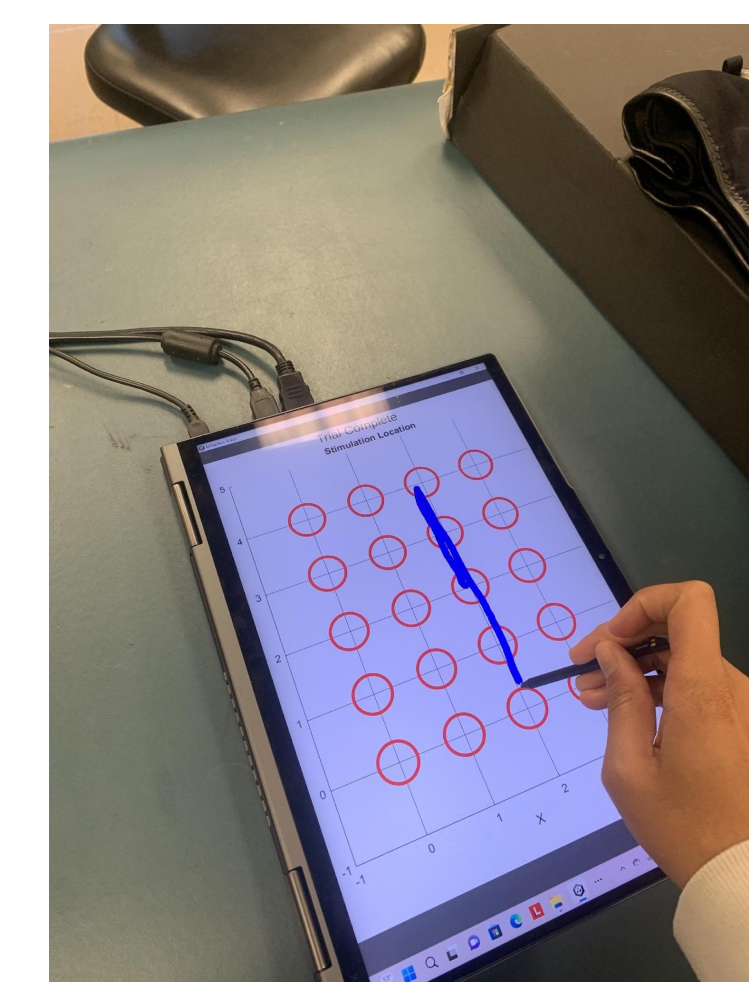


Diagram of amplitude modulation.

Methods

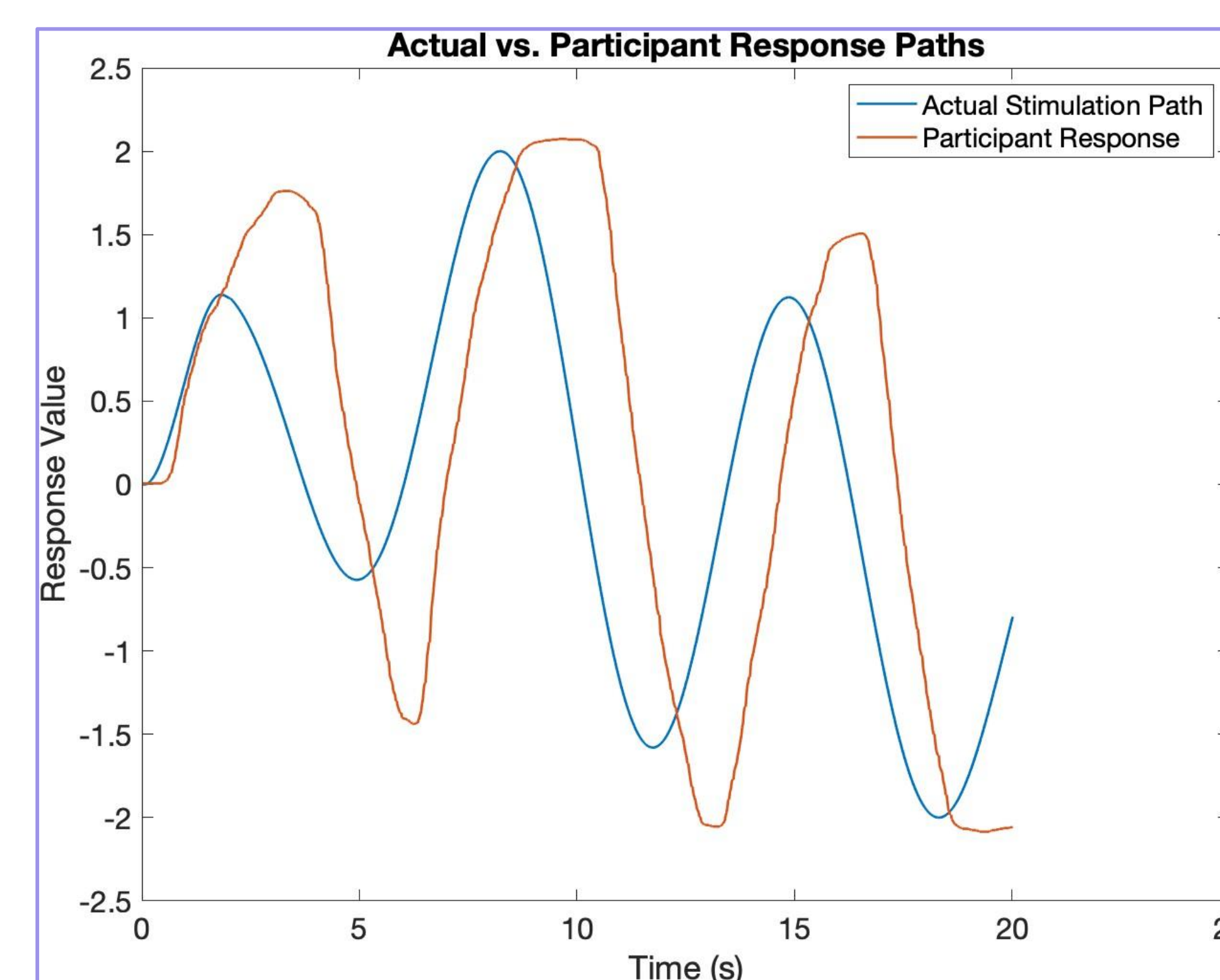
- 6 able-bodied subjects from Neuromuscular Rehabilitation Engineering Laboratory (IRB 20647)
- bHaptics Tactsuit used to deliver vibration stimulus through vibrating motors
- Unity used to program user interface



bHaptics vest with embedded motors.

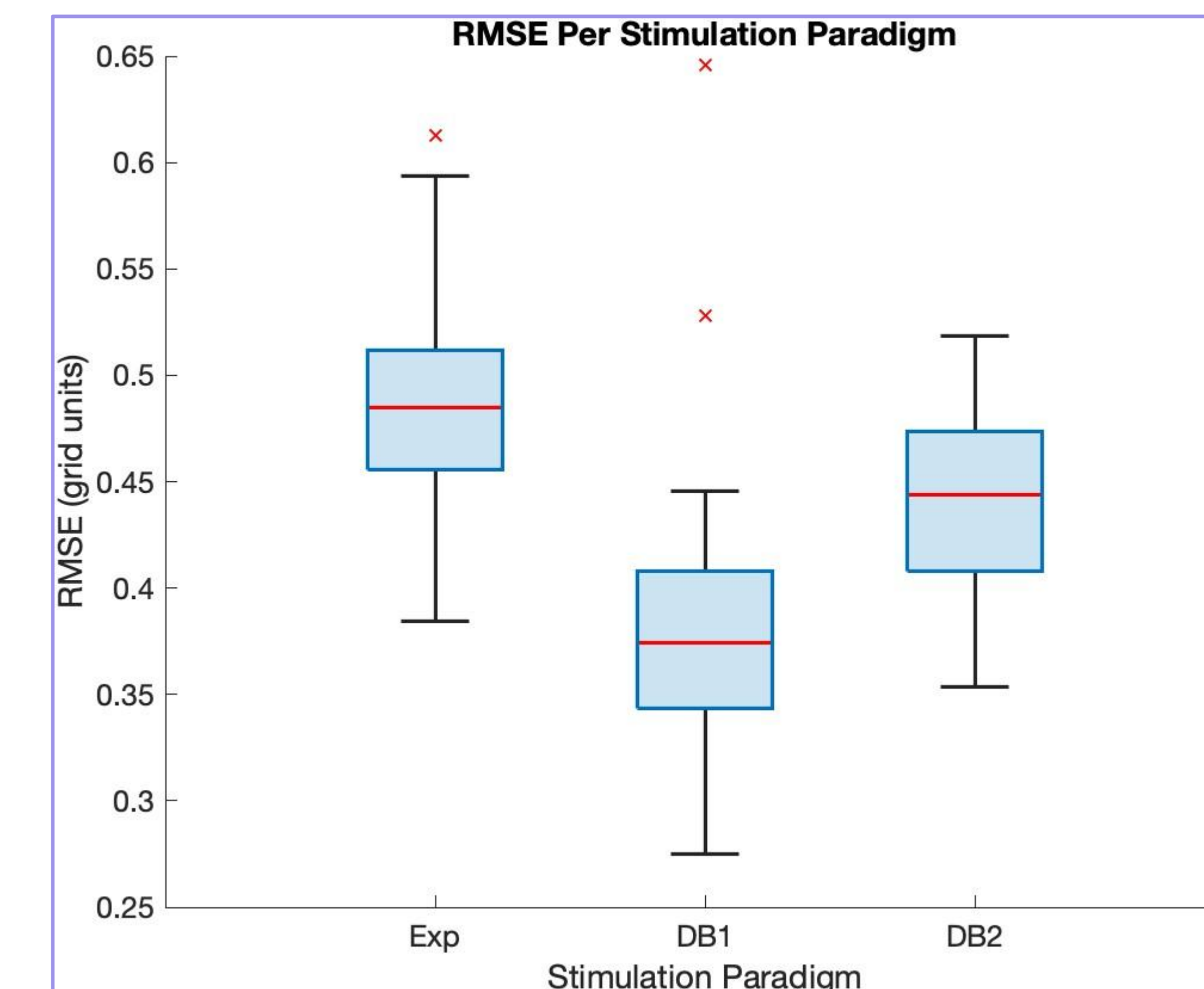
Unity interface for user response.

- 3 amplitude modulation variations tested – no dead band, small, large dead band
- Vibration stimulus used to generate illusion
- Participants instructed to follow movement of sensation on grid
- Calculated reaction time, accuracy, and smoothness

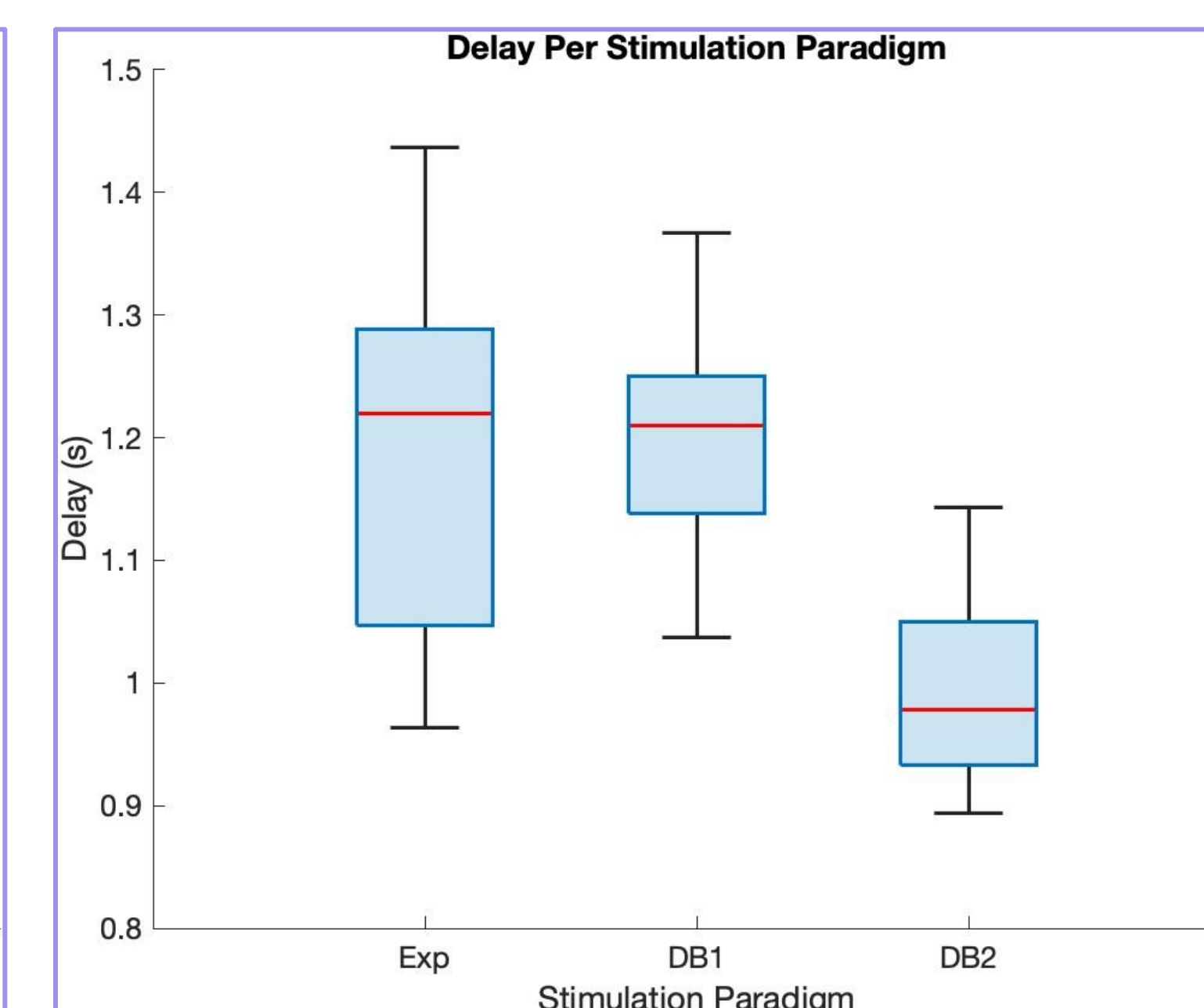
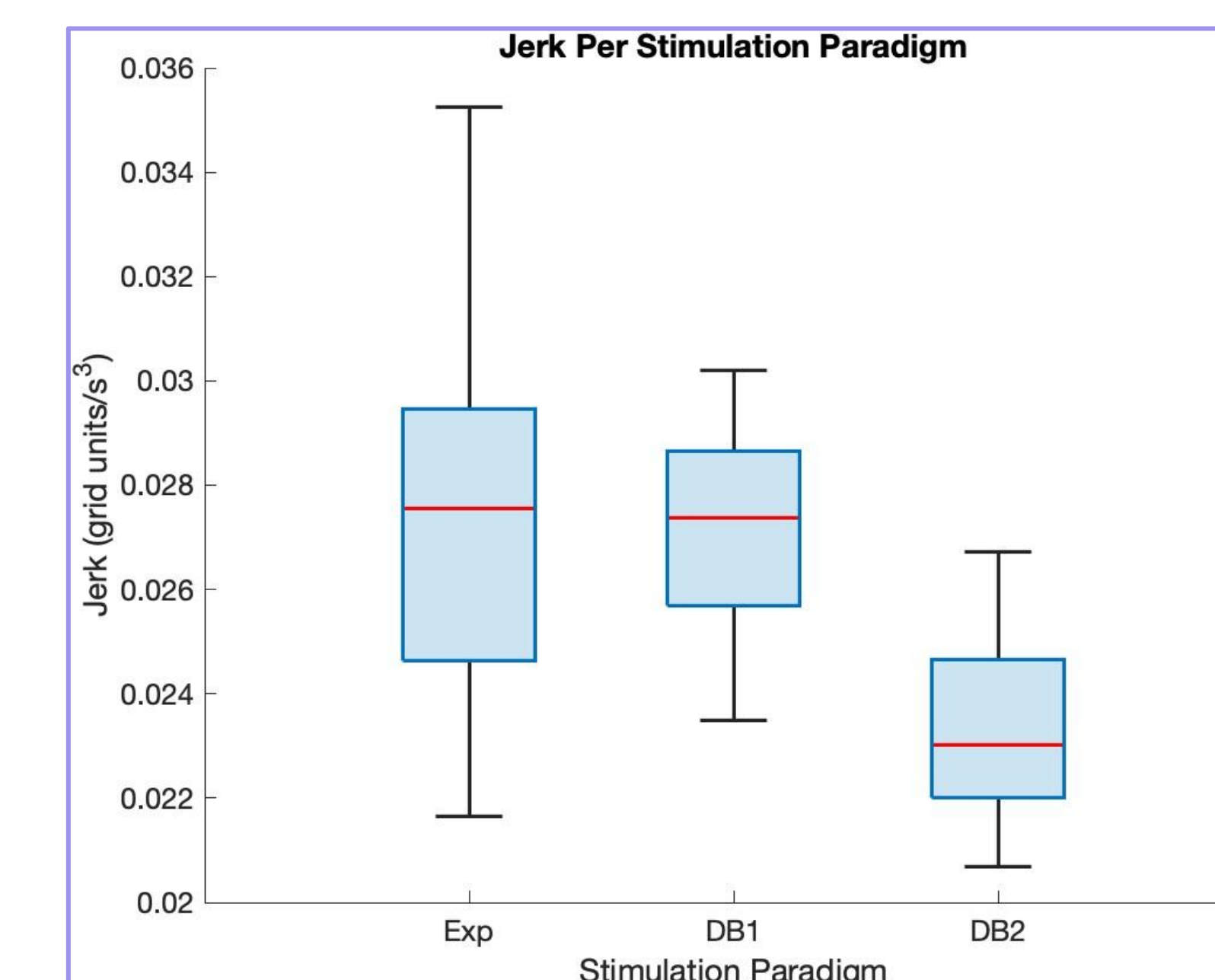


Raw user input against actual illusion movement on vest.

Results



RMSE per stimulation paradigm to assess accuracy of subject response relative to actual illusion movement. Statistically significant relationship found ($p < 0.05$).



Jerk and delay per paradigm for smoothness and reaction time. No statistical significance observed.

Discussion

- Statistically significant difference between stimulation paradigms and RMSE
 - Dead band creates an artificial reference point
 - Stimulation difference between center and top/bottom
- No relationship between stimulation paradigm and delay or jerk
 - Smooth motion induced by less feedback for DB2
 - Information lost in dead band
- Accuracy vs. delay-focused training

Acknowledgements

This work was partially supported by the NSF award 1954587. I would like to thank the Joint Department of Biomedical Engineering at UNC Chapel Hill and N.C. State University for allowing me to complete this project as a Senior Honors Thesis.

Motivation

- No previous literature on effect of dead band for user perception to haptic stimulation
 - Effect of dead band on accuracy, reaction time, smoothness of response curves
 - Testing with 1-dimensional tracing task

References

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