

CLINICAL FUNCTIONAL EVALUATION OF PROSTHETIC CONTROL WITH NOVEL WIRELESS MYOELECTRIC SENSORS

Todd Farrell, PhD¹, Kiriaki Rajotte, PhD², Anson Wooding¹, Brianna Rozell¹, Abby Hoffman-Finitsis, CP³, Edward A. Clancy, PhD², Benjamin E. McDonald, MS¹



WPI

UNIVERSITY OF HARTFORD



¹ Liberating Technologies Inc. - a Coapt R&D Company, Holliston, MA

² Worcester Polytechnic Institute (WPI), Worcester, MA

³ University of Hartford, Hartford, CT

INTRODUCTION AND BACKGROUND

THE PROBLEM

- Osseointegration addresses socket issues [1] but removes location for sensors.
- More proximal amputations require more joints to be controlled with fewer inputs and physiological information from outside the socket could be used as additional control inputs with conventional socket fittings.
- Powered upper limb orthosis can't wear long sleeves.

OBJECTIVE/AIM

THE GOAL

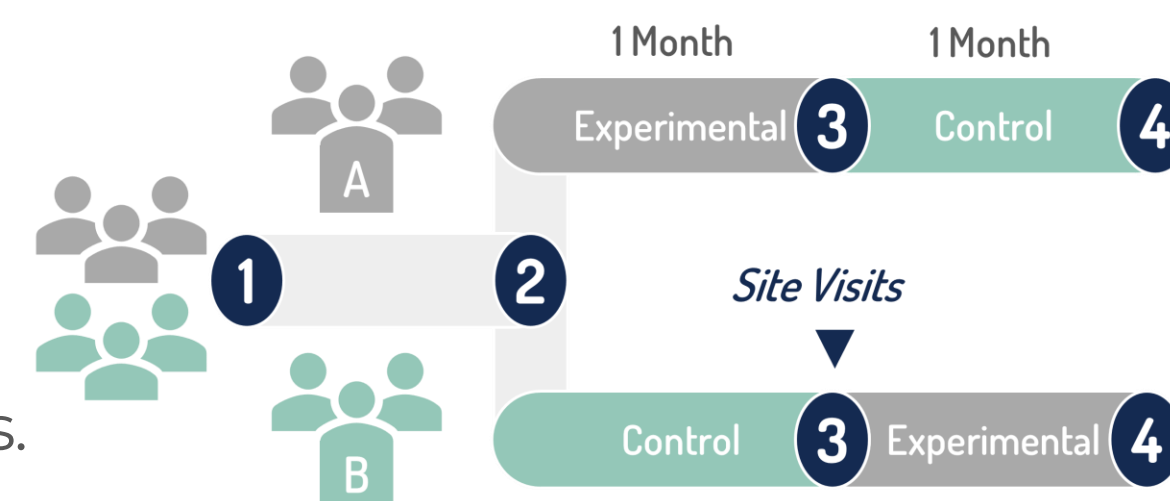
Provide reliable wireless prosthetic/orthotic sensor control to enable remote sensors to support Veterans, Service Members, and civilians.

THE SOLUTION

LTI and WPI have developed a Bluetooth Low Energy (BLE) based wireless EMG sensing platform to improve control and comfort for patients with myoelectrically-controlled orthotics and prosthetics, including osseointegrated limbs. This work evaluates clinical system performance in both laboratory and real-world conditions to evaluate wireless versus wired control.

METHODS

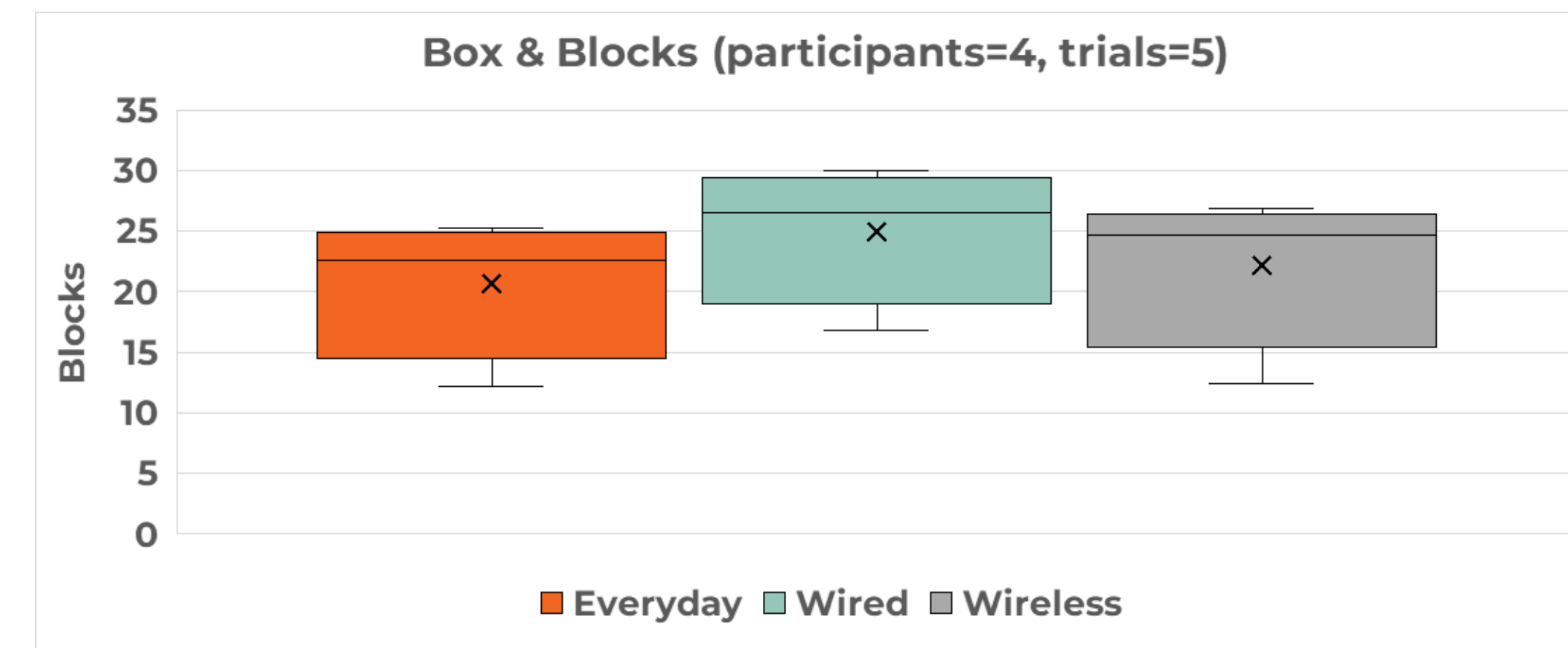
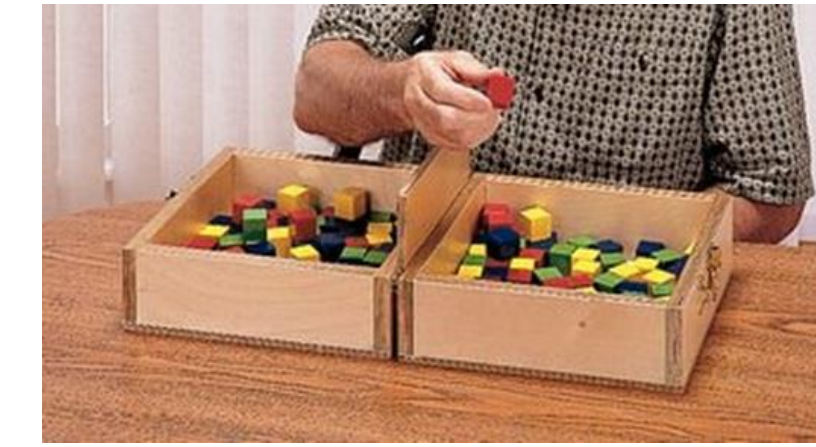
- 2x2 randomized crossover design.
- Double blinded (patient and evaluator).
- Consented 4 transradial amputees.
- Duplicate sockets fabricated incorporating wireless system.
- 1-month at-home use per condition.
- **Box and Blocks (B&B)** test [2] functional outcome measure chosen for its sensitivity to latency. Five repetitions of the **B&B** are administered for three conditions (Everyday Socket, Experimental Socket – Wired, Experimental Socket – Wireless)
- Surveys: OPUS-SD [3], Custom Survey
- Daily logs
- The system recorded: power cycles, cumulative wear time, delayed/dropped wireless packets.



RESULTS

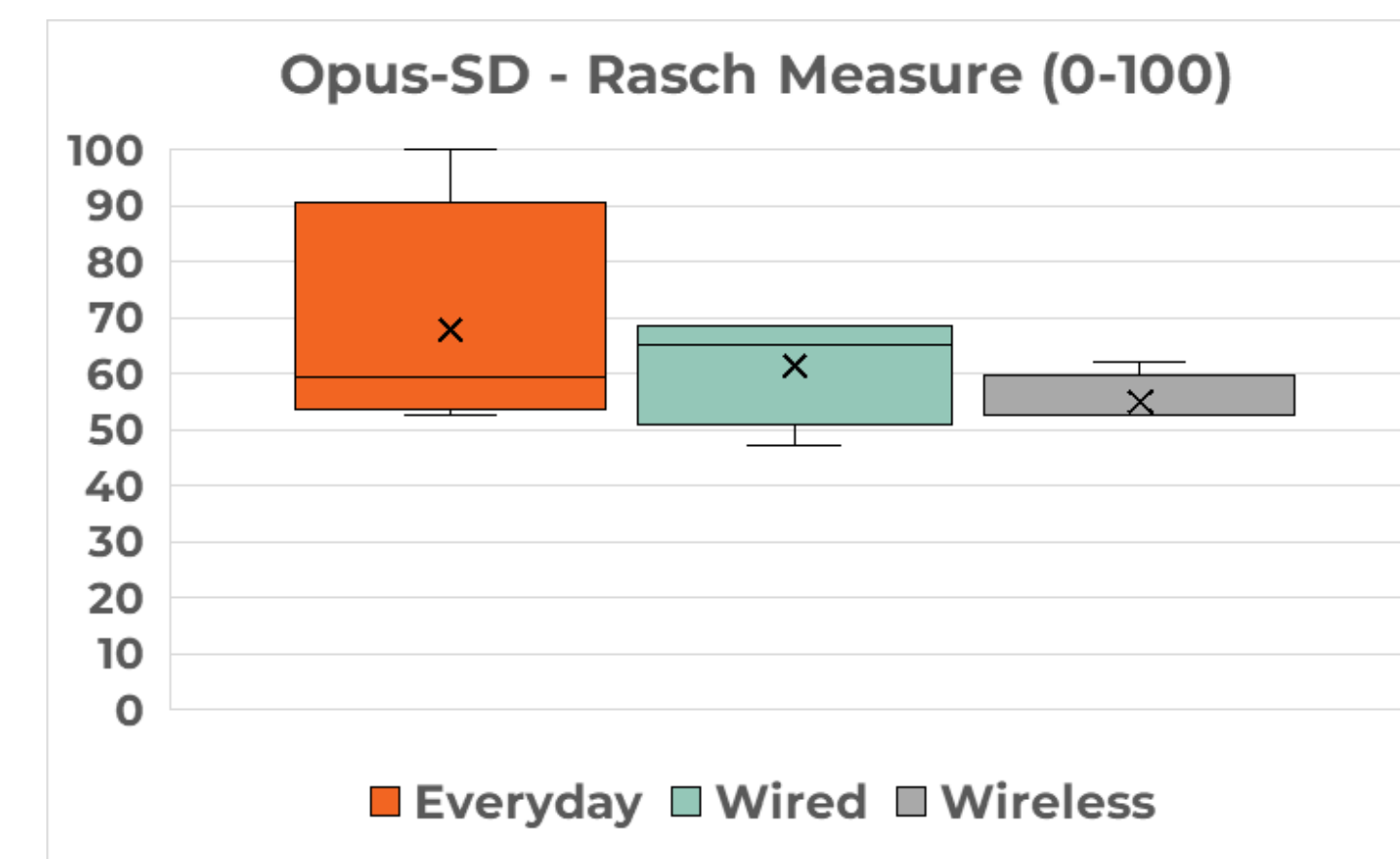
B&B

- Wireless equivalent to wired and everyday. Post-hoc pairwise comparisons all $p > 0.05$ after RM-ANOVA.
- Learning effects observed across participants.



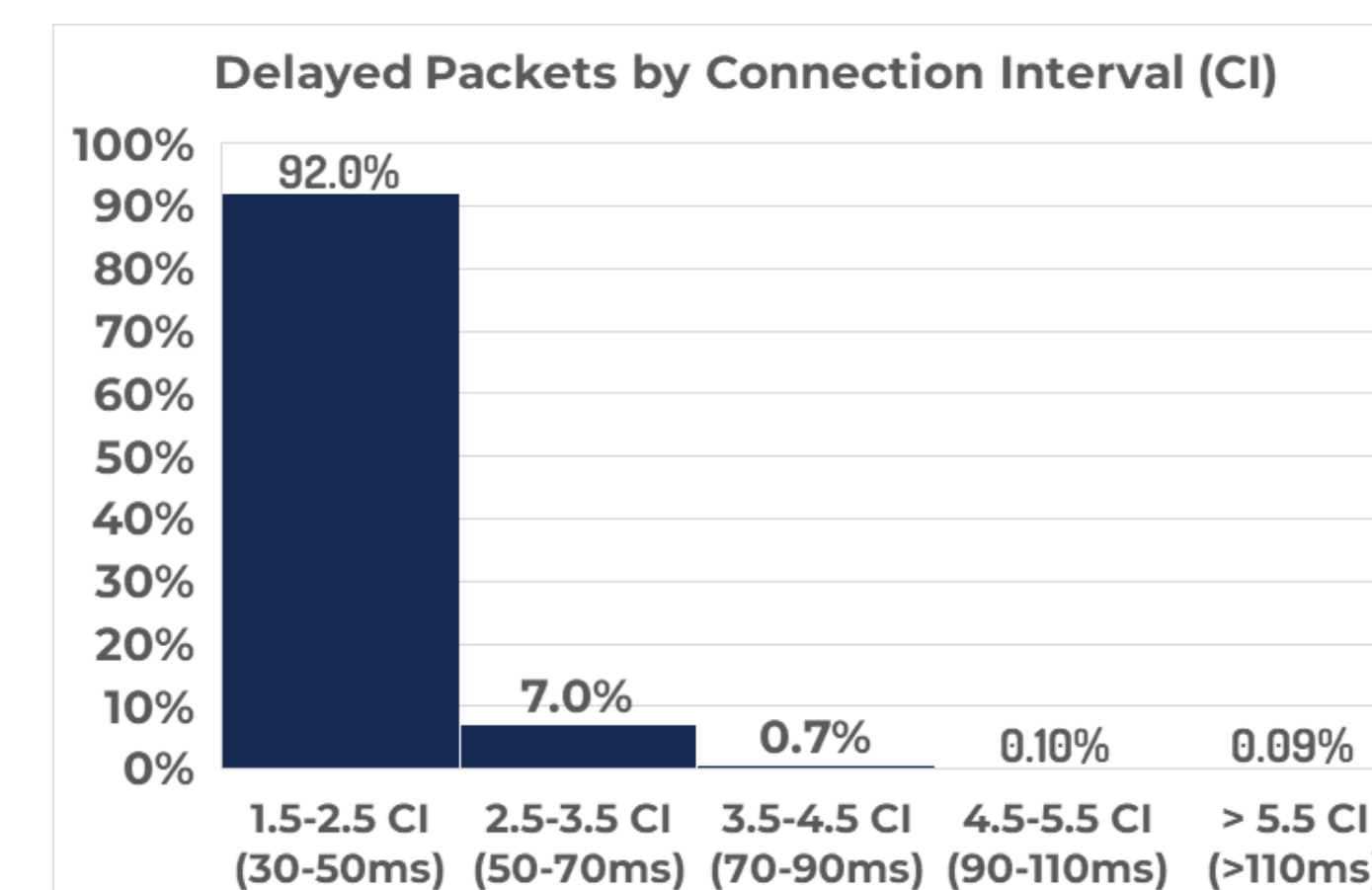
Opus-SD

- Equivalent mean satisfaction with each device/condition (RM-ANOVA $p = 0.43$).
- Higher variability with everyday socket.



Delayed Packets

- Over 7 million packets transmitted.
- ~11% packets delayed.
- 92% of delayed packets within 2 CI (~40ms).
- 0.09% delayed > 5.5 CI (~100ms).
- 99.9% arrived within 100ms [5].



Wear time – Wear time was highly variable between participants and between conditions. Socket comfort likely source of variability as wear time increased post socket adjustments.

Power Cycles – Results were highly variable between participants but within 1 cycle/day between conditions showing equivalence in usage.

Participant Preference – Neutral, slight preference to wireless. Wired (n=0), wireless (n=2), and no preference (n=2).

DISCUSSION

- The wireless system demonstrated minimal additional system delay during benchtop testing [4] and during at-home use.
- Anecdotal feedback and experimental results indicated equivalence between wired and wireless conditions.
- Likely learning effects observed in B&B data, mitigated by randomization.
- Wear time and usage directly related to socket comfort. Future studies will include 1-2 week break-in period to allow for socket adjustments before starting at-home trials.
- Participants observed startup delay in wireless system at power on.

CONCLUSIONS

- Results show novel wireless EMG system performed functionally equivalently to wired systems in both the real-world and laboratory environments.
- Even with observed packet delays, latencies from months of use outside the lab are acceptable (< 100-150ms).

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