A UNIVERSAL, LOW-COST TRANSRADIAL SOCKET FOR VALIDATING NOVEL MYOELECTRIC PROSTHETIC CONTROL STRATEGIES

THE UNIVERSITY OF UTAH
DEPARTMENT OF BIOMEDICAL ENGINEERING

Craig H. Neilsen REHABILITATION HOSPITAL UNIVERSITY OF UTAH

Abigail R. Citterman[1,2], Taylor C. Hansen[1], Eric S. Stone[1], Troy N. Tully[1], Christopher M. Baschuk[2], Christopher C. Duncan[3], Jacob A. George[1,3,4,5]

abbycitt@gmail.com

[1]Department of Biomedical Engineering [2]Handspring, Salt Lake City, UT [3]Department of Physical Medicine and Rehabilitation
[4]Department of Electrical and Computer Engineering [5]Department of Mechanical Engineering, University of Utah, Salt Lake City, UT

Motivation

Up to 50% of individuals with upper-limb loss abandon their prostheses. More dexterous myoelectric control could improve prosthesis acceptance. However, the validation of novel control strategies is limited by the time, cost, and expertise needed to fabricate a traditional custom-fit socket with embedded electrodes.

The development of a more accessible socket may constitute an important step towards expanding the involvement of those with upper-limb loss in myoelectric control research.

Materials & Methods

Computer-Aided Design → **Mechanical Testing** → **Functional Testing** → **Analyses**

Prioritize accessibility, adaptability, durability, and patient comfort

Vertical and horizontal loading in extreme-use cases with replica limb

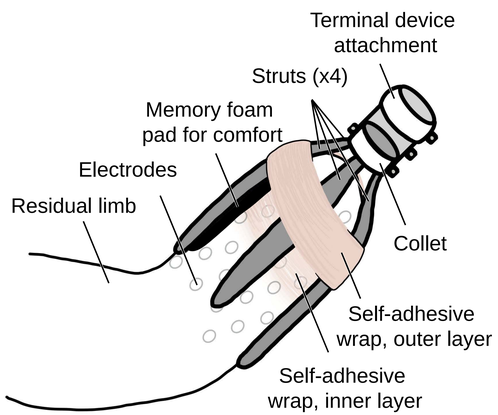
Signal-to-noise ratio, target-touching task, box and blocks test, and socket comfort

Comparing the socket- and the no-socket cases w/ paired t-tests

Table 1: Cost Analysis

3D-printed components (i.e., filament)	$3.50
Hardware (i.e., nuts and bolts)	$1.00
Self-adhesive wrap	$3.00
Memory foam	$0.50
Total	**$8.00**
vs	
Traditional socket	$3,000 [1]
Low-cost alternative	$200 [2]

Three transradial amputees with high-count surface electromyography (sEMG) control



Device Development

Accessibility

- No prosthetist expertise needed
- Inexpensive, widely-available materials (Table 1)
- No protracted laboratory visits required (Table 2)

Table 2: Time Approximation

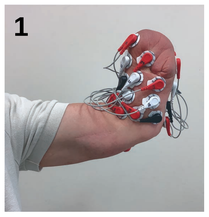
Fabrication (3D printing)	6 hours, 30 minutes
Fitting (molding struts)	10 minutes
Donning	<1 minute
Doffing	<1 minute

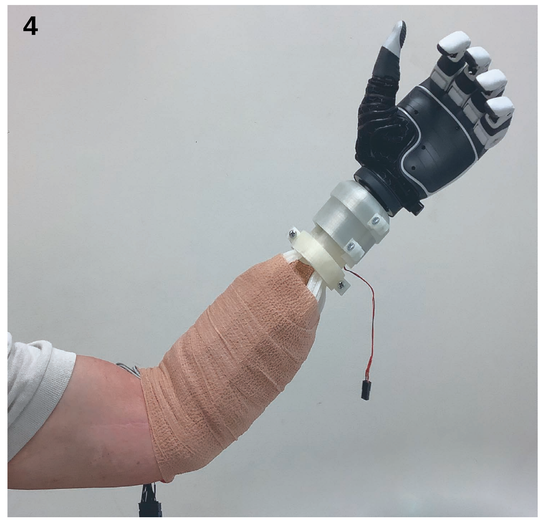
Adaptability

- Access to skin for various data acquisiton (DAQ) methods (electromyography, magnetomyography, sonomyography, etc.)
- Moldable struts accommodate limb differences (volume fluctuations, bone protrusions, neuromas, wounds, etc.)
- 3D-printed collet interfaces with any terminal device

Durability

- Increased surface area distributes weight and pressure
- No slippage and <1º deflection observed with 8 kg load

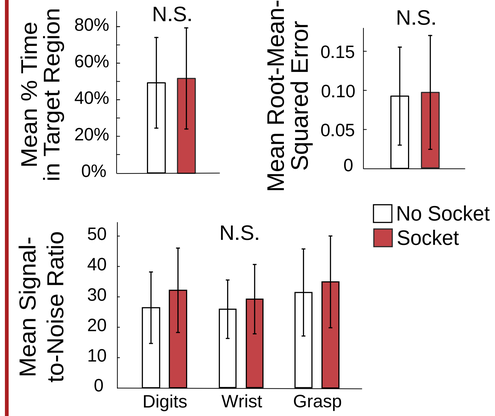


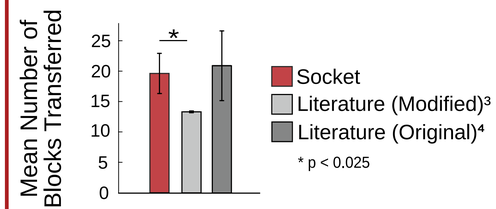


1. Outfit residual limb with sEMG electrodes
2. Wrap in disposable self-adhesive bandage
3. Heat, mold, and cut struts to desired length
4. Don socket, wrap again, fit with prosthesis

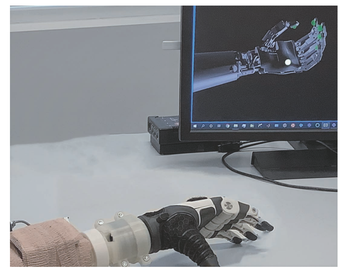
Socket Did Not Impede Functional Performance; Comfort Remained Adequate

Functional Performance Was Not Hindered by Low-Cost Socket.

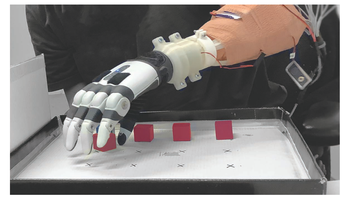




Target-Touching Task

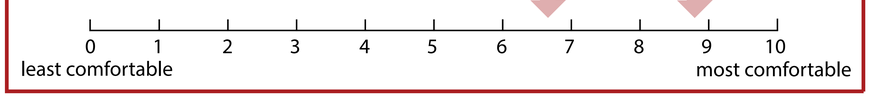


Box and Blocks Test



Socket Comfort Was Acceptable Throughout the Experiment.

Our Socket **6.7 ± 1.2** | Traditional Socket **8.8 ± 1.3**



Future Work

To further increase end-user involvement, expand implementation to:

- **More varied limb presentations**
- **Additional levels of amputation**

References & Acknowledgments

[1] L. Frossard, et al. *J. Prosthet. Orthot.* 2017.
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