School of Biomedical Engineering

Design of an Adjustable and Scalable Transradial Prosthesis Socket

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Background / Problem

Transradial (below elbow) amputees use prosthetic sockets that are not adjustable, which poses a challenge as the residual limb fluctuates in volume throughout the day by up to 3% [1,3]. This reduces user comfort, and for myoelectric systems, reduces EMG (electromyography) contact and leads to poor signal acquisition [2].

Needs and Requirements

- The prosthetic socket should be **adjustable** to fit different arm sizes and shapes. It must also **integrate** UBC HuMBL's EMG equipment and securely attach the signal amplifier while maintaining the **functionality** of a regular myoelectric socket.
- Requirements:
  - 24 of 32 electrode channels in contact
  - Scalable parameters
  - Easily adjustable
  - Load bearing of 7kg
  - Limb volume accommodation of +/- 3%
  - Socket accommodates limb lengths greater than 8cm

Scope

The scope of this project is the physical design of the socket and EMG sleeve. EMG signal collection will not be considered in the scope of this project, and all signal collection are performed following the standards provided by UBC HumBL. Our design is designed for UBC HuMBL for experimental and testing purposes. Therefore, no testing is performed on human volunteers.

Our Solution

Our socket is adjustable using a lacing system and incorporates UBC HuMBL's EMG equipment with a custom-made sleeve.

Socket

- 3D printed with PETG (Polyethylene terephthalate glycol)
- Lacing system tightened by twisting the knob

Figure 1: Socket over the sleeve donned on the dummy

Sleeve

- 3 sizes to accommodate majority of users
- Velcro allows for flexible electrode placement

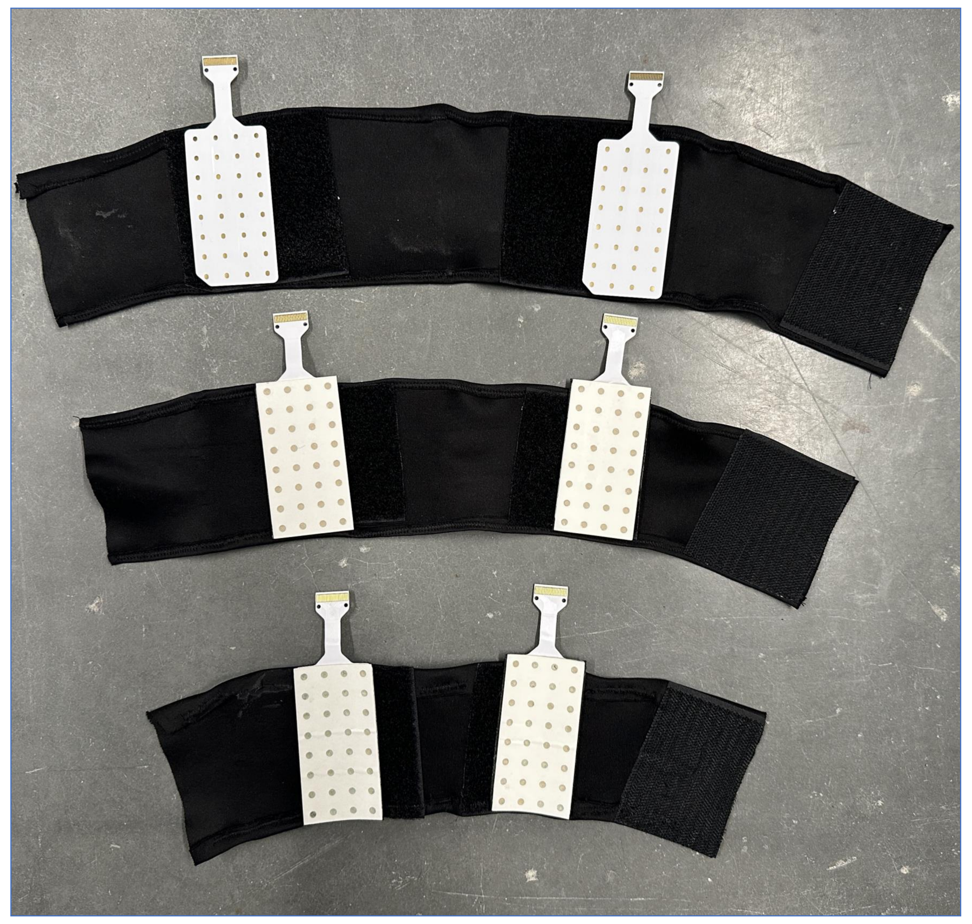

Figure 2: EMG Sleeve of 3 Different Sizes

Demonstration of Tests and Client Feedback

- Figure 3 shows the collection of EMG data to all channels with the custom sleeve design.
- Figure 4 shows a supported a 7kg load with 10 loading cycles on the dummy limb when combined with the sleeve and EMG sensor.

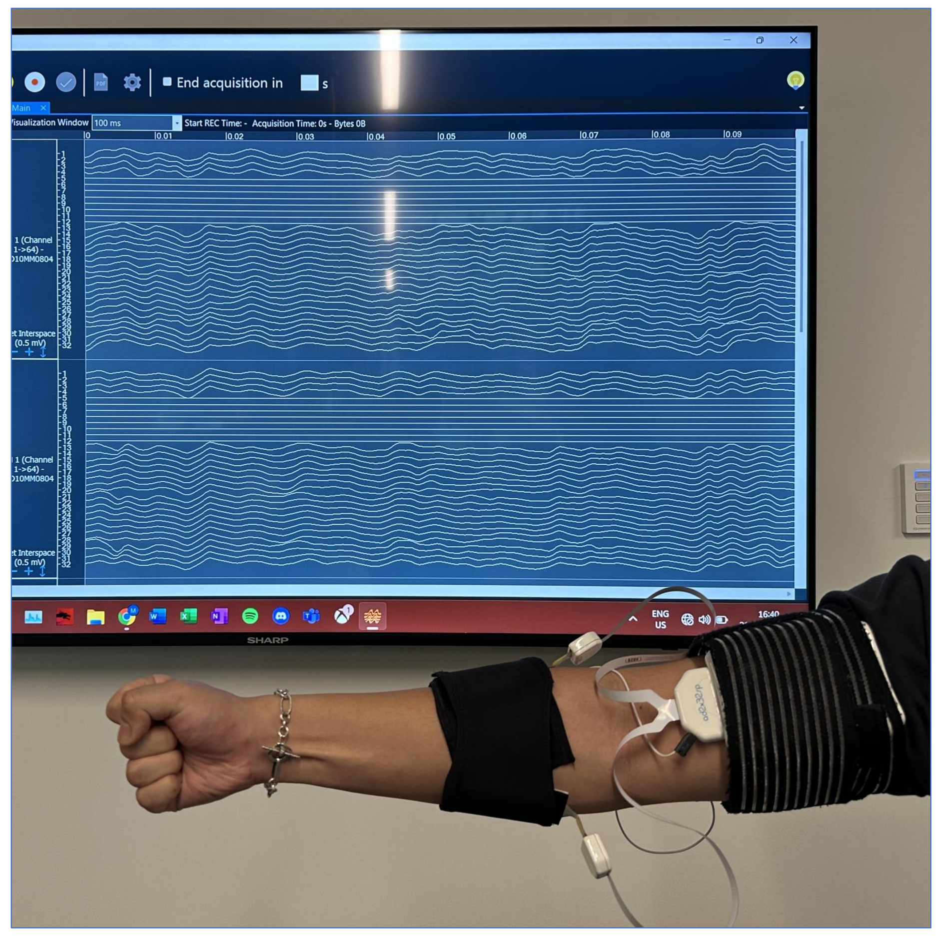

Figure 3: Live EMG Data Collection with Sleeve

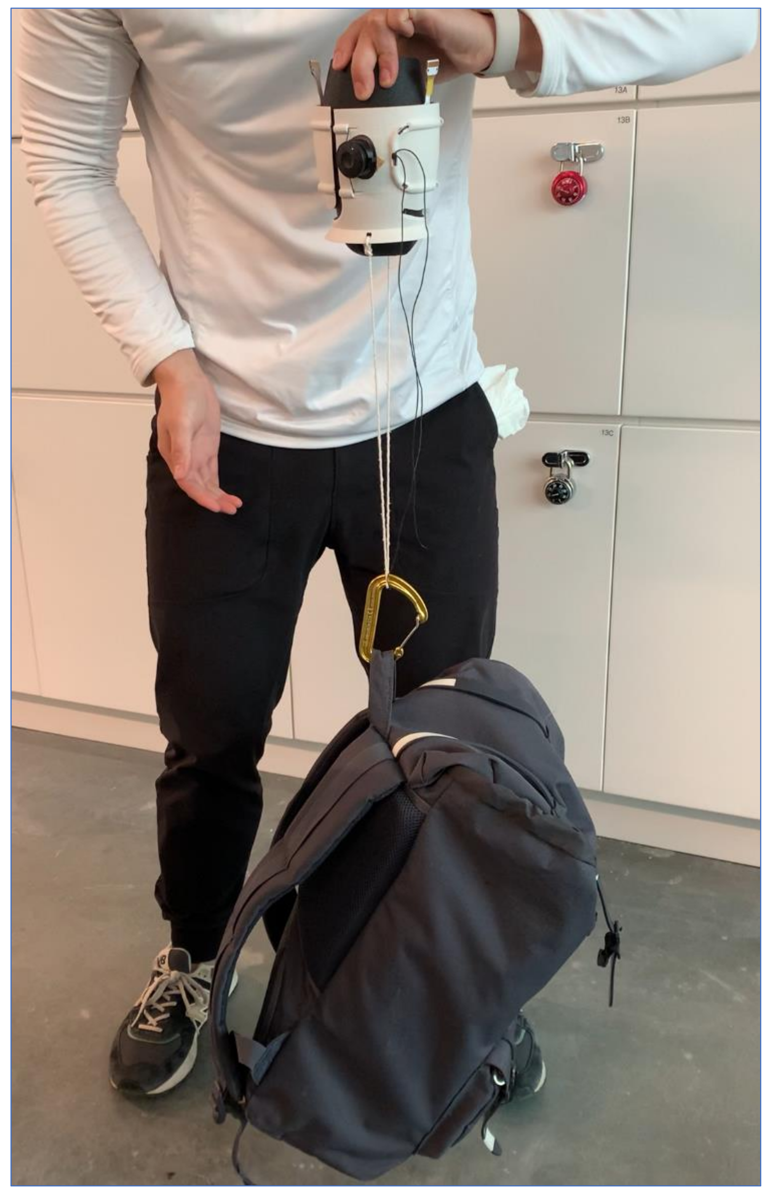

Figure 4: Validation of Load Bearing with a 7kg Backpack

Assumptions and Limitations

1. Assumes load-bearing validation with dummy limbs translates to biological stumps.
2. Assumes client has an accurate model or understanding of stump geometry to modify CAD files appropriately.
3. EMG signal is only qualitatively validated via device's data visualization software.
4. Assumes user has a functional arm to don and doff the sleeve and socket.
5. With no access to human volunteers, dummy limbs were used for testing.
6. The dummy limbs used for testing were not validated to be biofidelic.

Future Improvements

1. Quantitative EMG analysis with the socket on human volunteers
2. Replicating the design on traditional socket manufacturing processes.
3. Improve fit by increasing customizability, e.g. adding measurement points or 3D scanning

Reference / Bibliography

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