Pre-Prosthetic Training with Haptic Feedback

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Problem

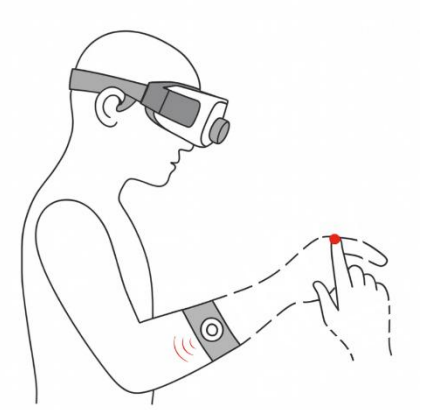
- Natural socket vibrations transmit finger-specific tactile information (Ivani et al., 2024).
- Users often fail to reliably interpret these subtle cues.
- This gap limits their ability to fully benefit from natural feedback and slows adaptation to advanced prostheses.

Proposed Idea

A game-based pre-prosthetic training system that combines EMG-controlled virtual arm movements with socket-level haptic feedback. The goal is to help users practice decoding natural tactile cues in a safe, engaging environment before prosthesis fitting.

Concept

- AR-based Virtual Arm → users see and control a prosthetic arm through EMG.
- Virtual Touch Events → the game "touches" or "taps" specific fingers.
- Haptic Feedback → actuators on the socket deliver vibration/force patterns.
- Training Task → users guess which finger was touched; over trials, the brain learns to associate vibration cues with finger identity.



Expected Benefits

- Improved Perception: Trains users to attend to and interpret natural socket vibrations.
- Faster Adaptation: Hypothesis — trained users will adapt more quickly when fitted with a real prosthesis.
- Low-Stress Learning: Gamified design encourages engagement without fatigue or discomfort.

- Experimental Utility: Provides an alternative, controlled way to deliver tactile stimuli for research.

Future Potential

- Incorporation of real IMU vibration data into the game.
- Exploration of feedback amplification strategies.
- Integration of machine learning classifiers for more robust feedback.
- Testing across diverse participant groups in realistic scenarios.

References

Ivani, A. S., Catalano, M. G., Grioli, G., Bianchi, M., Bicchi, A., et al. (2024). Tactile Perception in Upper Limb Prostheses: Mechanical Characterization, Human Experiments, and Computational Findings. IEEE Transactions on Haptics, 17(4). DOI: 10.1109/TOH.2024.3436827.