3D PRINTED LOW-COST UPPER EXTREMITY VISUAL AND TACTILE FEEDBACK SYSTEM

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INTRODUCTION

Upper extremity prostheses (UEP) can never fully replace the function, sensation and expressiveness of a human hand (Dapka, 1997). This is supported by commonly cited reasons for abandonment of use of UEPs, which include user perception of comfort and function (Biddiss, 2007). The ability to "feel" objects (force feedback) provides better function through enhanced control. New technologies attempt to provide this (Catalano, 2014) at high cost or requiring invasive procedures. Lower cost devices have also been attempted (Pylatiuk, 2006).

One of the keys to learning how to effectively use a newly fit prosthesis is to understand the different localizations of sensations (the somatosensory map). This is even more important when force feedback is sought. Cutaneous feedback from the grasping or contact surface is influenced by muscles forces controlling the hand and arm (Jones, 2006). Redirecting these grip forces in prostheses can help create alternate force sensation. The contact cue (temporal aspect) is vital to effective UEP use since our nervous system relies on near-instantaneous feedback. Neurons are influenced by joint position which is reciprocally influenced by both visual and proprioceptive cues (Graziano 1999).

The goal of this project was to design a low cost system that can be retrofitted to existing EUPs and provide grip force feedback at a proximal location on the user's arm, while avoiding complexities inherent in existing systems.

METHOD

When even minimal grip force is applied to the fingertips of the prosthesis, it is translated into visual feedback via an LED on the fingertips as a cue to the user. As grip force increases, it is reflected as grip strength via a force being applied to a mechanism on the residual upper arm at an intact, sensate area.

RESULTS

Because this device is in the alpha prototype stage of development, no results regarding reliability are available. *NOTE: Results will be available at the time the poster is presented, as beta versions are being developed.*

This device is the result of new developments following work of a previous terminal force feedback system prototype presented at last year's academy meeting. This prototype is currently being tested for both acute and long-term use in multiple forms in order to be applicable to both amputees and sound hand users.

DISCUSSION

The ability to wear and properly use this device due to its low cost and simplicity provides the potential to benefit a broad spectrum of UEP users. Current areas of exploration include an attachable design to fit over existing myoelectric and body powered prostheses with sagittal plane grip force with thumb adduction and finger flexion.

CLINICAL APPLICATIONS

This device was designed to improve patient compliance by allowing feedback from the prosthetic limb to produce sensations that creatively mimic a functional, sound hand. Both the patient and the practitioner can benefit from its use, as it can help provide a mutual understanding of the patient's needs and the capabilities of the prosthesis.

REFERENCES

Dapka, R., & Heager, H. *Curr Orthopaed*, 11, 193-202, 1997.
Biddiss, E., Chau, T. Am J Phys Med Rehabil, 86, 977-987, 2007.
Catalano, M.G., Int J Robot Res, 33, 768-782, 2014.
Graziano, M.S. Nat Acdmy of Sci 96(18), 10418-10421. 1999.
Pylatiuk, C., JPO, 18, 57-61, 2006.

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Jones, L. A., & Piateski, E. EBR (1-2), 298-302.
2006.