



# SIMPLE, LOW-COST UPPER EXTREMITY TERMINAL DEVICE FORCE FEEDBACK SYSTEM

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## INTRODUCTION

Regardless of how intricately it is designed, an upper extremity prosthesis (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 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 tactile-map). This is even more important when force feedback is sought. Another key to using a UEP effectively is the contact cue (temporal aspect), since near-instantaneous feedback is how our nervous system works. Perception of magnitude of sensation (force) is also important.

The goal of this project was to design a low cost system that can be retrofitted and provide physical pressure feedback at a remote location on the user’s arm, while avoiding the complexities inherent in existing systems.

## METHOD

When force is applied to the tips of the digits, the fluid in the bladders at the tip of each finger and on the thumb is displaced into the cuff around the upper bicep (Figure 1).

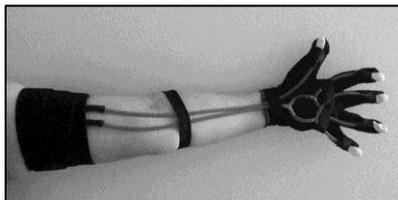


Figure 1. Device (alpha v0.5) demonstrating separate feed lines for thumb and grouped remaining digits, worn by one of the authors.

The amount of fluid displaced is directly related to the amount of pressure that is transmitted to the arm cuff. This is to mimic sensory input of a non-artificial limb.

## 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.*

Ongoing work will lead to the development of multiple iterations of prototypes, each of which will be tested for reliability under both acute and long-term use.

## DISCUSSION

Being able 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. Future areas of exploration include altering the design to optimize localization of sensation.

## CLINICAL APPLICATIONS

In developing this device, both the patient and the practitioner themselves will benefit from its application and use. It will seek to create a relationship between the patient and the practitioner that is centered on a mutual understanding of the patient’s needs and the capabilities of the prosthesis.

## REFERENCES

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