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TITLE: A Prosthesis to Train the Proprioceptive Capabilities of the Residual Limb of Military Personnel Recovering From Lower Limb Amputation

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14. ABSTRACT Learning to walk following lower limb amputation takes many months owing largely to the fact that new amputees cannot perceive when the prosthetic foot is in contact with the ground. To overcome this limitation, we have developed a system that detects foot pressures and relays this information to the residual limb. To data, a prototype sensor/stimulator system was been developed and we are preparing for human subjects tests.					
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Introduction

One of the major obstacles amputees must overcome during post-operative rehabilitation is learning to maintain balance. Over time, amputees learn to substitute tactile feedback discerned from pressures imparted on the residual limb by the prosthetic socket to control balance [1], but during the post-operative period the lack of afferent feedback from the ankle and foot poses challenge. To compensate for the lack of afferent feedback, amputees look down at the prosthesis to sense body position [1, 2] and continue to do so for up to eight months post-surgery [1]. Visual dependence is problematic since it may cause amputees to miss obstacles that need to be avoided. Furthermore, the visual feedback is not as effective as somatosensory feedback. As such, falls are frequent [3] which can cause injury to the surgical site, further delaying the rehabilitation process [4] and increasing costs.

In an effort to improve post-operative gait training for lower limb amputees, we have developed a vibrotactile sensory feedback system (Fig 1). This system uses sensors placed on the prosthetic foot to measure loading, process this information, and output it to vibrotactile stimulators that communicate both the level and location of the load. It is our hope that by including this capability in a prosthesis, we may be able to help new amputees learn to walk in a more timely manner.

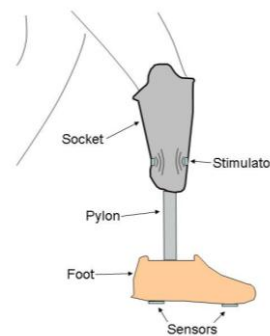


Fig 1: Supplementary Feedback System

Body

The research proposed for this project included three specific aims: 1) Design and fabricate a vibrotactile sensory feedback system (two months), 2) Investigate appropriate body sites for sensory feedback, and 3) Investigate the ability of the system to help amputees modulate body position in response to sensory feedback (two months together for Aim 2 and 3).

To date, we have developed a bench prototype (Fig 2) sensory feedback device. The device uses an external power supply and takes input from a Tekscan Flexiforce sensor. The sensor output is processed by a microprocessor, and then the appropriate voltage is released to the vibrating stimulator. Vibration amplitude is proportional to sensor pressure. Regulatory approval has been secured for this study and recruitment will begin shortly.

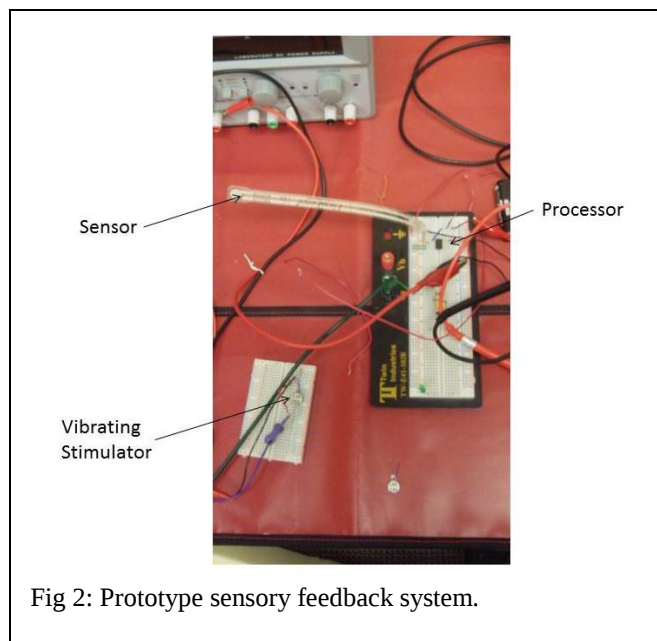


Fig 2: Prototype sensory feedback system.

Key Research Accomplishments

- Completion of prototype benchtop sensory feedback device.
- No data has yet been collected, and as such cannot be presented to maintain a record of research progress. We anticipate another two months to finish a prototype 4-channel sensory feedback system upon which recruiting for the experiments will begin. It is anticipated that Aims 2 and 3 will require another two months of work to complete. We will re-submit the DoD-approved IRB to our local IRB shortly to ensure regulatory approval for recruitment as soon as the technology is ready.

Reportable Outcomes

A provisional patent application is in preparation for this invention.

A non-cost extension was filed and granted.

Conclusion

We have developed a new prototype sensory feedback device. Data collection is pending.

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