Development of a Myoelectric Training Tool for Above Elbow Amputees

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Introduction

Above-elbow myoprostheses aim to restore the functionality of amputated limbs and improve the quality of life for amputees. By using electromyography (EMG) electrodes attached to the surface of the skin, amputees are able to control motors in myoprostheses by voluntarily contracting the muscles of their residual limb. An advance in myoelectric control called targeted muscle reinnervation (TMR) reinnervates severed nerves into healthy muscle tissue and increases the number of muscle sites available for use in control purposes. In order to improve rehabilitation after TMR surgery, an inexpensive myoelectric training tool is being developed for the Glenrose Rehabilitation Hospital that can be taken home by the TMR patients and used for biofeedback tasks.

Relevance

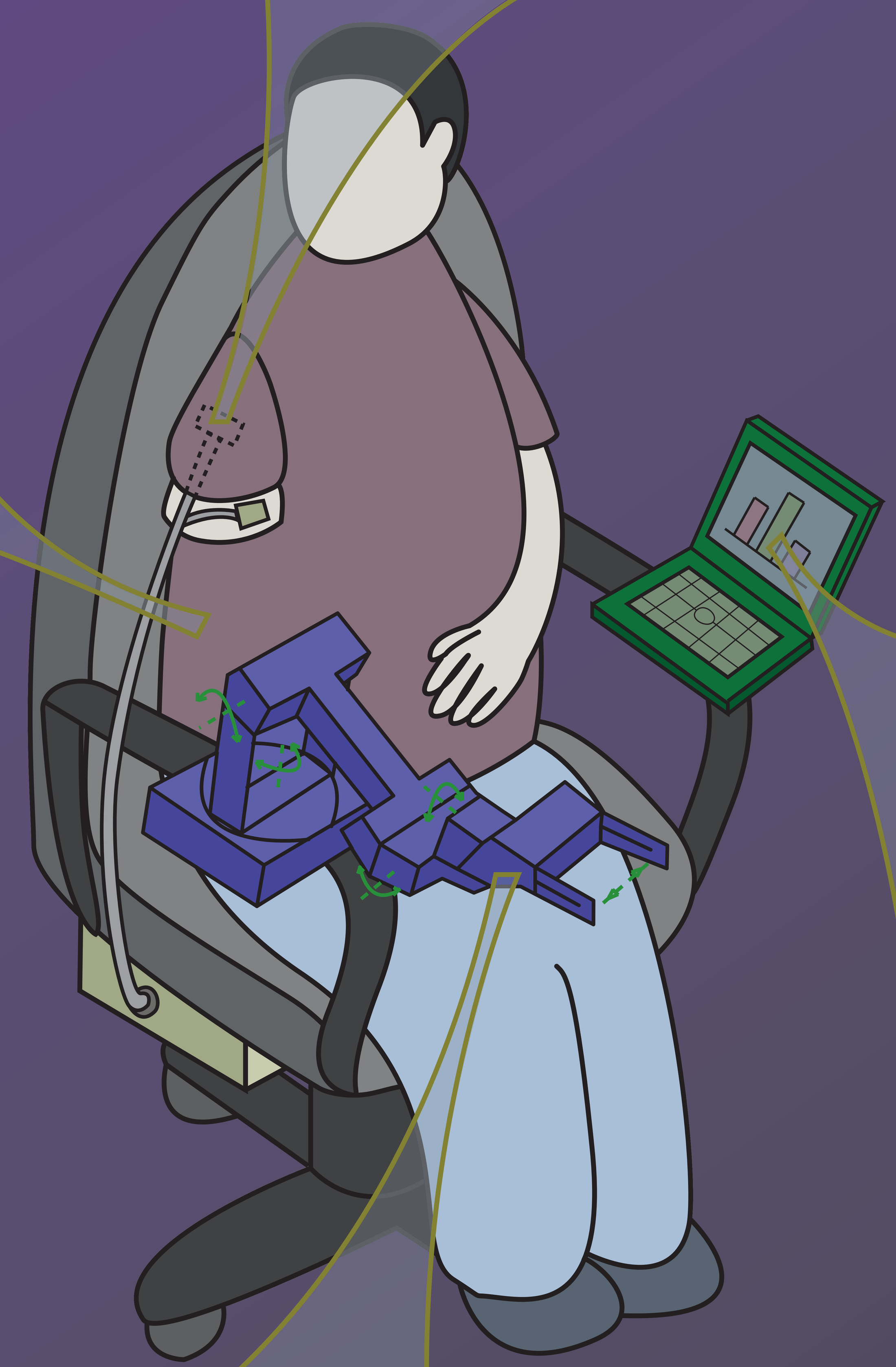
Currently for rehabilitation TMR patients are asked to imagine moving their missing limb. The proposed tool will decrease rehabilitation time and improve function earlier by allowing the patient to practise using visual feedback and creating EMG signals as soon as their nerves begin generating EMG signals. The tool can also be used for training and evaluation of non TMR upper limb amputee patients.

Patient

The patient generates EMG signals through voluntary contraction of their muscles and closes the control loop by providing visual feedback of the robotic arm.

Signal Acquisition

Electrodes on the patient's residual limb amplify the signals before passing them onto a conditioning board housed on the underside of the chair. A data acquisition card converts the signal from analog to digital and passes it onto the control software.



Robotic Arm

An AX 12 Smart Arm provides 5 degrees of freedom (shown in green). The actuators in the arm provide position and velocity feedback to the control software.

Control Software

The control software maps the EMG signals to the degrees of freedom of the robotic arm. A graphical user interface provides feedback and allows the patient to modify and save user settings.

Progress

The robotic arm has been assembled and tested. The conditioning board has been designed by a 4th year capstone team in Electrical Engineering to acquire the EMG signals. Processing software has been developed to convert the EMG signals to a form useable by the controller software. The controller software has been designed to accommodate both conventional control schemes used by current commercial prostheses and a novel control scheme implemented by the author in collaboration with the Reinforcement Learning and Artificial Intelligence group in Computing Science. The graphical user interface (GUI) has been created. A 3D simulator of the robotic arm has been developed by a 4th year design team in computing science.

Future Work

A preliminary prototype that controls up to two robotic joints simultaneously using muscle signals has been designed and tested. Future work will involve completing the design, fabrication, and testing of all remaining systems and ensuring that all applicable safety standards are met. Following the completion of the training tool clinical studies will be performed to test the novel and conventional control methods on TMR patients.

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