Live Demonstration: Upper Limb Prosthetic Control Using Toe Gesture Sensors and Various Touch Interfaces

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I. Introduction

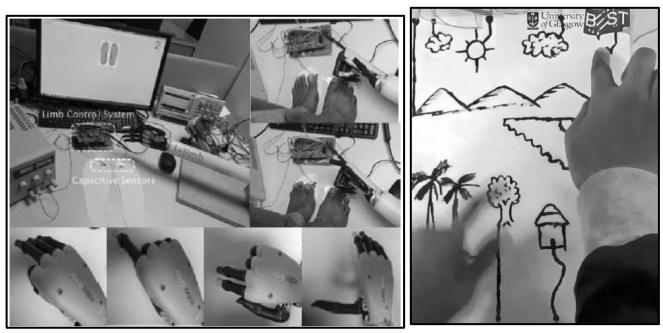
Orienting technology, through new techniques, to rehabilitate the disabled and physically challenged and to help elderly is a noble cause, which will improve the quality of life of millions. Prosthetics is one of the important research area where robotic technology serves its best for medical sciences. Conventionally various prosthetic control techniques exists and each has their own advantages and disadvantages. These control techniques ranges from simply implementable, cable-controlled, body-powered prosthetics to technologically challenging Targeted Muscle Reinnervation (TMR) based prosthetics control system. The effectiveness of a upper-limb prosthetic control method for wide-spread application depends on various factors such as cost-effectiveness, ability for easy fabrication, ruggedness, repeatability on daily use, easily installable, usability, ability to bring dexterity and accuracy to perform various gestures/associated activities etc. The current techniques have major drawbacks, namely: with EMG there is a need of relatively complex electronics/sensor electrodes and classification algorithms for implementing large gesture range; EEG suffers from reliability issue and cost; sweating and placement positions of electrodes may interfere with reliable working in case of both EEG and EMG techniques; need of invasive surgery and associated high cost in case of TMR or implanted myo/neural interface etc. We will present demo of a robust, non-invasive, simple, touch-based toe gesture sensor system for upper limb prosthetic control.

The second part of the demo will focus on touch interface. Touch interface is increasingly becoming a major way through which we interact with electronic gadgets/systems especially with mobile phones and tablets. In future the use of touch and gestures to interact with electronics or in-turn everyday objects will further increase. With this in view, the engineering/technology behind the touch screen is of interest to many. Also further advancement of touch screen towards electronic skin is a futuristic concept which will enable amputees to feel through their prosthetics and robots to become touchy and feely.

II. Demonstration Setup

A toe gesture sensing interface system has been developed. The scheme takes advantage of the user making various gestures with their left and right hallux digits in the form of a Morse code on a footwear. The touch results in change in capacitance of the sensors, which is readout by an interface circuitry. This is transmitted wirelessly to a computing system attached to iLimb prosthetic hand, which controls it resulting in various upper-limb prosthetic gestures or grasping pattern depending on the corresponding mapped Morse code. The demo will comprise of a pair of smart footwear with toe gesture sensing electronics implemented in it and iLimb prosthetic hand. Figure 1a uses an insole like arrangement to demonstrate the idea. During the actual demo the entire electronics and the battery for powering it will be embedded in a footwear.

Demonstrating prototypes of various touch technology namely: Resistive, Capacitive, Optical, Ultrasonic technologies will be demonstrated. A smart wireless portrait frame will be demonstrated where any portrait on paper sketched by conductive ink interfaced with the flexible smart frame can be used as a touch panel to control objects [Fig 1b].



a b

Figure 1: (a) Implemented toe gesture sensing system and various gestures of i-Limb™ (b) touch interface on paper

III. Visitor Experience

The visitor will wear the smart toe gesture sensing footwear. They will make various gestures with their toe. Wireless receiving interface circuit connected to i-Limb prosthetic hand will receive the input from the smart footwear and control the prosthetic hand resulting in various mapped hand gestures or grasp patterns. They will also get hands-on experience on various kinds of touch interfaces.

IV. Conference Paper

Paper ID:1916, Upper Limb Prosthetic Control Using Toe Gesture Sensors*, William R Taube, Hadi Heidari, Anton Polishchuk, Dhayalan Shakthivel, Dinesh Bhatia, and Ravinder Dahiya, IEEE Sensors 2015, South Korea.*

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