EMBODIMENT OF BI-DIRECTIONALLY INTEGRATED PROSTHETIC LIMBS

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ABSTRACT

The sense that a prosthetic hand is something other than the body, that it is a tool, prevents instinctive engagement with the device by amputees. We have built myoelectrically-controlled, battery-powered prosthetic limb systems with robotic sensation for home use that provide tactile feedback when the prosthetic fingers contact objects. These systems are currently employed in a take-home trial with amputee participants that have a biological neural machine interface (targeted reinnervation). We identified locations on the reinnervated skin of three participants that correspond to a feeling of touch on their missing fingers and matched them to sensors integrated with the terminal device digits (strain gages in D1-D3 and force sensitive resistors on D4 and D5). When sensors on the prosthesis detect contact, touch robots mounted above these locations press on the reinnervated skin to generate a feeling of proportional pressure that is projected to the appropriate missing fingertip. During baseline testing at the start of the ten month study period, we investigated whether tactile feedback during a series of psychophysical tests would induce a sense of ownership (i.e., embodiment) of the robotic prosthetic hand. Subjects completed questionnaires indicating the degree to which they agreed with nine different statements (three embodiment-related and six control). Two users showed greater embodiment of the prosthetic hand when tactile feedback was provided. The third user showed a slight trend toward embodiment when using his prosthesis both with and without tactile feedback provided by the touch robots. Providing a sense of touch to prosthesis users through a bi-directionally integrated limb encourages embodiment of the prosthetic hand so that it is interpreted as being part of the amputee's body.