Electrical & Computer Engineering

S E M I N A R

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A Regenerative Peripheral Nerve Interface System for Bidirectional Robotic Limbs

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Abstract—Thought-controlled prosthetic limbs have been tested on human subjects. However, the invasive nature of the brain-machine interface is an impediment, even though it has allowed quadriplegic people to move wheelchairs and prosthetic arms. DARPAs prosthetics program has made enormous progress in upper-limb prosthetics. However, the neural interface was rerouted through limited number of chest muscles to transform the electroneurographic (ENG) peripheral neural signals into detectable electromyographic (EMG) muscle signals losing many degrees of freedom (DoF) and requiring training of uncomfortable chest muscle movement to control prostheses. The obstacles of both non-invasive approach and direct communication with nerves have inspired me to bring a noble neural interface using regenerated peripheral nerve systems (PNS). The peripheral nerve system has a natural regenerative capability. When it gets damaged or even cut, the natural healing system and regenerative function is initiated. Although the damaged nerves on the distal side degenerate and lose the function of delivering neural signals, if the nerves on the proximal side are supported properly and reconnected to the distal side nerve stump, the proximal nerves can grow back and even reinnervate muscles. I have developed bio-compatible microconduits and individually accessible microelectrodes. The microconduits serve as a nerve regeneration scaffold and microelectrodes build an electrical communication pathway between regenerated peripheral nerves inside scaffolds and data acquisition systems outside the amputated bodies. The electrical interface of sensory and motor axons separated by microconduits will make it possible to implement bidirectional communication between prosthetic limbs and amputated bodies. Individually addressable motor axons will be able to control the natural 22 DoF prosthetic arms through over 100 microelectrodes. The regenerated sensory axons in the microconduits will be stimulated by microsensors in the prostheses and the patient will be able to feel sensations.

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