Adaptive Neurotechnology for Restoring Neural Function

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The integration of technology with biology makes us more productive in the workplace, makes medical devices more effective, and makes our entertainment systems more engaging. Real-time communication between a nervous system and a device is now possible, but full and reliable integration in biohybrid systems is still far from reality. Biohybrid systems of the future are likely to utilize biomimetic machines with multi-channel, high throughput interfaces not only to integrate with the biological system, but to close the loop in a manner that promotes adaptation in the nervous system. This talk will present some of our work that uses tools and techniques from computational neuroscience and neural engineering to develop biohybrid systems. A neural model of spinal pattern generating circuitry of lower vertebrates was characterized extensively and used to design neuromorphic controllers. These controllers have been interfaced with an active spinal cord, used to adaptively control an orthosis that could allow mobility after lower limb trauma in people and to adaptively control movement using neuromuscular electrical stimulation of paralyzed muscles in a rodent model of movement therapy after incomplete spinal cord injury. In other work, we are developing and deploying neural-enabled prosthetic systems to provide amputees with technology that is highly functional and easy to use. These efforts are directed at developing effective and reliable peripheral neural interfaces that can record motor intent of upper limb amputees and use a fully implantable electrical stimulation system to provide them with sensory feedback thereby closing the loop for seamless integration of the biohybrid system.