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Neuroscience 2013

Presentation Abstract

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Presentation Title: Evolution of the BrainGate real-time Brain-Computer Interface (BCI) platform for individuals with tetraplegia or limb loss

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Abstract: Brain-computer interface (BCI) systems are being developed with the goal of restoring or replacing function for individuals with paralysis, locked-in syndrome or upper limb loss. To this end, BCI research aims to improve understanding of the electrophysiological signals that encode details or goals of movements imagined by individuals unable to move their limbs. Another aim is to advance signal processing and neural decoding algorithms to translate movement-related brain activity into high-fidelity commands for assistive software and devices. Here we report progress on a third aim: to create a powerful but practical computational platform for delivering BCI assistance to those for whom it holds promise. The BrainGate pilot clinical trial offers a productive environment for investigating myriad aspects of intracortical BCI technology and assessing these with individuals in their place of residence. From roots in academia, BrainGate has evolved toward a flexible neural processing system that serves as both a neuroscience research platform and a prototype BCI with a defined roadmap toward a practical, deployable form. This year, we delivered the next-generation investigational BrainGate platform that advances clinical trial research using interchangeable BCI software developed at Brown University, Massachusetts General Hospital, Providence VA Medical Center, Stanford University and Case Western Reserve University. This "Unified Platform" can be configured through an administration interface to command computer cursors (for Windows or custom software), the DEKA prosthetic arm or the DLR assistive robot. The modular architecture provides a clear path to support other devices such as a Functional Electrical Stimulation (FES) controller or other arm/hand systems. The platform incorporates real-time processing that enables simultaneous computation of multiple intracortical neural features for hybrid decoding including spike rates, multi-unit activity (MUA per Humphrey et al. or Stark and Abeles), and local field potentials from any specified frequency bands (typically 96 channels x five simultaneous bands each, including low frequency, beta, gamma and high gamma bands). Although powerful and flexible, this Unified Platform employs commercial personal computers and is therefore relatively large. An important aim for BrainGate2 going forward is to replace those PCs with mobile, low-power components by migrating the current real-time software to an embedded processor configurable through a user-friendly, wireless administration interface to enable practical, safe, and mobile use in both the research domain and, in time, users' homes.

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