FROM SINGLE NEURON TO POPULATION ACTIVITY: DEVELOPING A CLINICALLY VIABLE BRAIN-COMPUTER INTERFACE DEVICE

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Abstract

For people with severe disabilities cause by various neurological disorders, such as spinal cord injury, cerebral palsy, and myodystrophy, they have a limited means to communicate and rely mainly on simple switch-activated devices to interact with their environment. Brain-computer interface (BCI) technology aims to establish a direct link between the brain and external devices, enabling faster and more intuitive communication and control. One of the major challenges in translating this technology from laboratory research into clinical practice is to develop a minimally invasive technique for obtaining reliable long-term neural recording with high spatial and temporal resolution. Recent research has shown that electrocorticography (ECoG) is a promising modality that can potentially meet this requirement. ECoG is a technique similar to electroencephalography (EEG); however, it records brain activity with intracranial electrodes directly placed on top of the brain. ECoG has a much better signal-to-noise ratio and higher resolution than traditional EEG recorded with scalp electrodes, and it is less invasive compared to single-neuron recording technique, where arrays of microelectrodes are inserted into the cortex. Our goal is to translate knowledge and experience gained from previous basic animal and human BCI research into a clinical BCI device with micro-ECoG technology. A micro-ECoG electrode array is composed of miniature electrodes embedded in a silicon disc. It can be implanted with minimally invasive procedure that involves making a small burr hole in the skull. Another potential advantage of this approach is that it may be possible to place electrodes on the surface of the dura mater, leaving the brain's protective sheath intact, which significantly reduces the risk of infection. This BCI system will be even simpler and safer than deep brain stimulator, since its electrodes will not penetrate any brain structures and our device only records electrical activity and does not stimulate. With its simplicity, low clinical risk, and high performance, this system can benefit a large user population (both pediatric and adult) with various degrees of motor disabilities, including those with spinal cord injury and cerebral palsy.

Speaker's Biographical Sketch

Wei Wang is currently an assistant professor in the Department of Physical Medicine and Rehabilitation with a secondary appointment in the Department of Bioengineering. He is also a project leader in the National Science Foundation Quality of Life Technology Engineering Research Center, a joint entity between Pitt-CMU. Wei Wang received a medical doctorate from Peking University Health Science Center in 1999 and a Ph.D. in Biomedical Engineering from Washington University in St. Louis in 2006. After finishing the medical school in 1999, Dr. Wang first completed a master degree in Biomedical Engineering at University of Tennessee Health Science Center. His research there involved developing computer tools for people with severe motor disabilities and providing assistive technology augmenting human-computer interaction in the workspace. His Ph.D. research at Washington University in St. Louis focused on brain-computer interface and motor cortex neurophysiology using microelectrode recording in non-human primates. After completing his Ph.D. study, Dr Wang joined the second largest implantable medical device company, St. Jude Medical, Inc. at Sylmar, California. As a senior scientist there, he developed new signal processing algorithms for real-time embedded systems used in implantable medical devices, and his work had lead to two pending U.S. patents. Dr. Wang joined the University of Pittsburgh in July 2007 and started the human neuroprosthetic research group along with Dr. Doug Weber. Dr. Wang's current research focused on human brain-computer interface research using various invasive and non-invasive techniques, such as magnetoencephalography (MEG) and electrocorticography (ECoG). Dr. Wang's research project is supported by the U.S. Army Telemedicine & Advanced Technology Research Center (TATRC), NIH, and NSF. Dr. Wang also received a pilot grant from University of Pittsburgh Clinical Translational Science Institute (CTSI) to develop a clinically viable brain-computer interface system using micro-electrocorticography.

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