Success Story

Cleveland Clinic Foundation

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– Dr. Cameron C. McIntyre, Ph.D., Assistant Professor, Department of Biomedical Engineering, Lerner Research Institute, Cleveland Clinic Foundation

Silicon Graphics Prism™ System Assists Deep Brain Stimulation Implant Surgery

To alleviate symptoms of Parkinson's Disease and other nervous system movement disorders, researchers and clinicians at The Cleveland Clinic are implanting an FDA-approved electrical stimulation device into the brain. The deep brain stimulation (DBS) device, very similar to a cardiac pacemaker, is being implanted in approximately 200 people a year at The Cleveland Clinic—one of the largest DBS implant centers in the world.

To provide a theoretical understanding of how electric fields influence the way that neurons in the brain respond to this electrical stimulation, the Department of Biomedical Engineering at The Cleveland Clinic Lerner Research Institute is using a Silicon Graphics Prism visualization system to generate and study computer models of DBS-brain interaction. Once this near-term modeling is completed, researchers will create a new graphical user interface so doctors and clinicians can access these results while interacting with patients.

Interactive Whole Brain Models

One of the most important clinical research aspects of electrical stimulation is the positioning of the DBS device during surgery. One millimeter difference in any direction can significantly affect the outcome.

"We're trying to provide some visual feedback to the clinicians to improve their ability to understand how the stimulation is actually interfacing with the nervous system," said Cameron C. McIntyre, Ph.D., assistant professor, Department of Biomedical Engineering, Lerner Research Institute, The Cleveland Clinic. "These devices need to be implanted within the brain in a very specific location. If you want to start making predictions on the kind of micro scale that we are interested in, you need to have detailed models that accurately represent the properties of the brain tissue and the electric field generated by the stimulation. To do that takes intense computer modeling techniques and, as a result, some very intense computation."

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– Dr. Chris Butson
Research Associate,
Department of Biomedical Engineering,
Lerner Research Institute,
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That is where the Silicon Graphics Prism™ visualization system comes into play. By using the large shared-memory and scalable computing capability of the Silicon Graphics Prism, researchers at the Cleveland Clinic will, for the very first time, be able to interactively visualize DBS simulations anywhere in the brain.

Dr. McIntyre and research associate Chris Butson, Ph.D., recently purchased a Silicon Graphics Prism visualization system running the Linux® Operating environment, with eight Intel® Itanium® 2 processors, 16GB RAM, and four ATI® graphics pipes. The main modeling software used is SCIrun (SCI stands for Scientific Computing and Imaging), originally developed at the SCI Institute at the University of Utah.

The Silicon Graphics Prism provides a shared-memory, multiprocessor environment with integrated visualization capability —which is important from a human interface standpoint.

"The neurologists who are doing these kinds of implants and programming these patients have limited visibility as to what's happening inside the brain," Dr. Butson said. "With Silicon Graphics Prism, we anticipate being able to do whole-brain simulations and run these whole-brain models to create a near real-time visual feedback system for the neurosurgeons and clinicians. The integration of visualization, shared-memory and multiprocessing capability is integral to this process and we can't get that with any other architecture."

Pre-Op and Post-Op Near Real-Time Visual Feedback

One of the Clinic's main goals with the Silicon Graphics Prism system is to implement a "near real-time visual feedback system" as both a pre-operative and a post-operative component of DBS. Drs. McIntyre and Butson want to provide the neurosurgeon with feedback before the doctor implants the electrode and, once it's implanted, help the neurologist customize the stimulation to the individual patient.

As a next step, Drs. McIntyre and Butson are currently developing a graphical user interface and data archiving capability that will allow clinicians to tap into the results generated by the Silicon Graphics Prism system while they are interacting with patients. Since patients might have to return to the Cleveland Clinic several times after surgery to have their DBS implant "tuned", this environment will enable the clinicians to incrementally improve patient outcomes in an orchestrated manner.

"These devices have thousands and thousands of combinations of stimulation parameters that can be adjusted," Dr. McIntyre said. "For example, the technology can be customized based on a patient's particular symptoms and behavioral responses to the stimulation."

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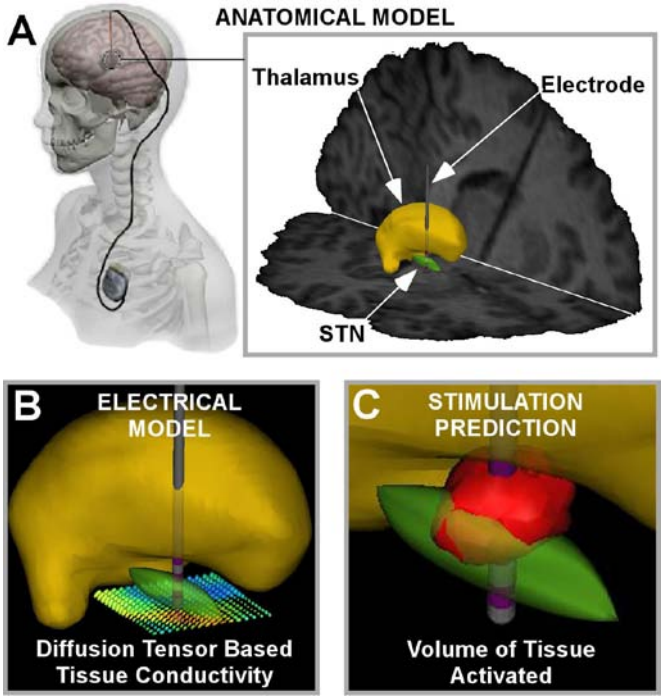

However, it is often difficult for the clinician to know what stimulation parameters are optimal for a given patient and physicians currently have only their personal experiences to guide them in the parameter selection process. The unparalleled visualization and computation capabilities of the Silicon Graphics Prism system will allow clinicians to build patient-specific anatomical and electrical models of DBS and customize device tuning and treatments to each individual.

"Once the device is implanted, we can then provide the theoretical optimum of how the stimulator should be tuned or adjusted to target the stimulation to a specific part of the brain," Dr. McIntyre said.

Expanding the Impact of DBS

Ongoing clinical trials using neurostimulation devices are occurring for a wide range of diseases in many venues. Though not yet approved by the FDA, promising trials of DBS technology include symptom relief of obsessive-compulsive disorder, major depression, and epilepsy.

"We built the infrastructure to analyze individuals on a patient-specific basis and we're actively collecting that data. The next step is starting to analyze this information from a more global perspective," said Dr. McIntyre. "We are integrating data from multiple patients into a database architecture where we can understand trends or generalities that exist across all patients stimulated in particular ways."

The immediate surgical benefits of full-brain visualization provided by the Silicon Graphics Prism system at The Cleveland Clinic will benefit hundreds if not thousands of future recipients of deep brain stimulation technology. Future benefits promise to be just as astonishing as the present.

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