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TRAINING THE NEXT GENERATION OF NEUROSURGEONS

The Cleveland Course for Advanced Neuromodulation uses augmented reality technology to bring fundamental concepts to life

In September, a dozen of the country's top neurosurgeons who specialize in deep brain stimulation (DBS) headed to Case Western Reserve University for two days to beta test the new Cleveland Course for Advanced Neuromodulation. The training course is designed to teach neuromodulation clinicians in fellowships the fundamentals of science, electrochemistry, electrical stimulation and neuroresponse. What makes this course different, aside from its focus on the elementals of how electric fields interact with neurons, is that it utilizes augmented reality.

The course toggles between hour-long lectures, followed by demonstrations using the Microsoft HoloLens to reinforce the material and bring it alive. The HoloLens is a self-contained, holographic computer that allows users to interact with digital content and holograms in the environment around them.

"You see holographic objects in the context of the real world as opposed to virtual reality, where you are 100 percent immersed in a digital environment," says Cameron McIntyre, PhD, a professor of biomedical engineering at Case Western Reserve University, an investigator and associate director of industry relations at the Cleveland FES Center and co-creator of the Cleveland Course for Advanced Neuromodulation. "When you are able to still

see the real world, you can see people's faces and communicate with people around you." This makes HoloLens technology an ideal teaching tool, particularly for understanding something as intricate as the human brain and its exquisite network of interconnected neurons.

When McIntyre invited the neurosurgeons to preview the course, he sought confirmation of its value from these key industry leaders. "The big question was 'Is this just a dog-and-pony show, or is this something real?'" says McIntyre, who developed the course in conjunction with Andy Cornwell, Ph.D., director of strategic and industrial collaborations at the Cleveland FES Center. "The resounding answer was that this has gigantic value."

A Convergence of Ideas

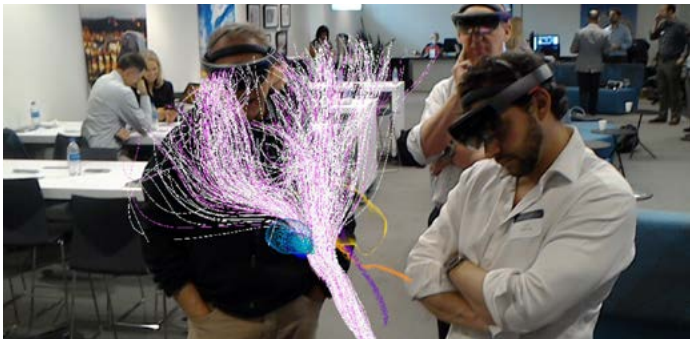
The incorporation of HoloLens technology into the Cleveland Course for Advanced Neuromodulation was serendipitous. Several years ago, McIntyre began envisioning a course for neuromodulation clinicians that would tap into the expertise of neuroengineers at Case Western Reserve University and the Cleveland FES Center. Clinical neuromodulation encompasses DBS, spinal cord stimulation and sacral nerve stimulation to treat a host of conditions, ranging from spinal injury to Parkinson's disease.

"This is probably a $5 billion a year medical device industry," says McIntyre. "Unfortunately, the vast majority of clinical users of those technologies have no real classical training in many of the basic science components related to the devices they use." So McIntyre, Cornwell and Tom Mortimer, emeritus professor at Case Western Reserve University who is credited with inventing the field of neuromodulation, began to develop content for the advanced modulation course for clinicians.

Around the same time, Case Western Reserve University forged a relationship with Microsoft to become one of the first educational content developers of its HoloLens device. Housed in the university's 4,500-square-foot Interactive Commons facility, the HoloLens was originally used to create a HoloAnatomy program to teach medical students about the systems and functions of tissues and organs in the human body. During development of the HoloAnatomy course, McIntyre was invited by the faculty director of the Interactive Commons to participate in a demonstration of the HoloLens.

"I only needed to see if for five seconds, and I knew exactly how we could use it for neurosurgical applications," says McIntyre. "The HoloLens provides a different way to think about connections in the brain. You can see more of a volume-based visualization as opposed to a 2D computer screen. And you can see how things wrap around each other in ways that are hard to do on computer screens."

In particular, McIntyre recognized the benefits for stereotactic and functional neurosurgery, a subspecialty of neurosurgery that uses a stereotactical frame – a device attached the participant's head – and a three-dimensional coordinate system to locate very precise targets within the brain during image-guided and physiologically-



guided surgeries to treat neurological disorders. That's when the advanced modulation course and the HoloLens technology converged.

"We started to think about how we could put everything into this holographic environment and use it to train new neurosurgeons on how to use frame systems, brain anatomy visualization and surgical trajectory planning – all the things neurosurgeons have to take into account when they plan a trajectory through someone's brain," says McIntyre.

Creation of the Course

One of the challenges in creating the advanced neuromodulation course was condensing the material taught in a neural interfacing course for biomedical engineering students at Case Western Reserve University into a two-day class relevant to clinicians. In addition, McIntyre and Cornwell had to divide the material among didactic lectures and interactive applications using the HoloLens.

They created three hour-long lectures, each one immediately followed by a HoloLens demonstration related to the material. For instance, the first lecture covers targeted release of neurotransmitters, sodium channel control and electrochemistry. Afterward, the class breaks into groups of approximately five people to apply the scientific fundamentals they learned in the context of deep brain stimulation on a human patient brain example.

The course is designed for first-year stereotactic and functional fellows, who have already completed medical school and their neurosurgery residency. Before rolling out the class to fellows, McIntyre opted to receive feedback from experienced neurosurgeons – what he calls the industry's "key opinion leaders." The beta test course in September was "a crazy success," says McIntyre. "It reinforced that there is a huge desire and need for the material."

The inclusion of augmented reality was a hit. In fact, it was so well received that the neurosurgeons suggested opening up the course to senior clinicians, too. They would like for tertiary clinics with DBS clinical programs to have the opportunity to send teams including neurologists and neurosurgeons to the course to train together, then those teams could go back to their home institutions and disseminate the knowledge they learned. "That would provide an integrated conceptual understanding of the material among colleagues and allow for seamless transition of information into clinical practice, which would benefit the patient," says McIntyre.

At this point, McIntyre and his collaborators are fine tuning the course based on suggestions from the neurosurgeons and deciding on the best way to proceed with the course, which they would like to offer twice a year to 10 to 12 participants. No matter what the final version of the Cleveland Course for Advanced Neuromodulation looks like, it will capitalize on augmented reality technology and the know-how of local neuroengineers.

"We have the expertise and background on how neuromodulation procedures are done, and we know there's an opportunity to fill an educational niche," says McIntyre. "With the HoloLens, we can offer a completely different way of interfacing with data and a much better way of training clinicians."

For more information about FES research and programs
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About the Cleveland FES Center

The Cleveland FES Center is a consortium of the Louis Stokes Cleveland VA Medical Center, MetroHealth Medical Center, Case Western Reserve University, University Hospitals, and the Cleveland Clinic Neurological Institute. With their support, researchers, engineers and clinicians collaborate together to develop innovative solutions that improve the quality of life of individuals with neurological or other muscular skeletal impairments. Through the use of neurostimulation and neuromodulation research and applications, the Cleveland FES Center leads the translation of this technology into clinical deployment.

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