NEUROTECH NETWORK

The Current

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Making Sense of Neurosensing

In the past we have featured neurotechnology devices, therapies and treatments that provide function or enhance the abilities of the body. In this issue, we will explore a different segment of the neurotechnology field, Neurosensing. The unique feature of this segment of technology is the ability to monitor or "view" the nervous system. In medical practice, these devices can aid a clinician to a more informed diagnosis, serve as a means to customize treatments or provide the ability to interact with other technology. It is the third smallest segment of neurotechnology but is forecasted to be a $1.2 billion business by 2012. Neurosensing includes a wide variety of applications, including EEG & EMG, brain state analysis and brain-computer interfaces. In this newsletter, we will introduce some systems for monitoring the nervous system, for analyzing movement disorders and for interacting with other technologies.

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Educate: Introduction to Neurosensing

When we think of sensation, the common 5 senses of the human body come to mind: vision, audio, touch, taste and smell. When it comes to neurotechnology, sensing can take a different form. It can be used to monitor, to diagnosis or to provide closed-loop systems with other devices. In layman's terms, neurosensing is technology that monitors or provides a "view" into the human nervous system. Analysis of electrical activity patterns emanated from the central and peripheral nervous systems might lead to a clinical community that is more open to modalities of treatment based on electrical activation of the central nervous system. In this newsletter, we will concentrate on neurosensing used for monitoring the human body and as an interactive tool for people with movement impairments.

Sensing as a Monitor

Through the looking glass of technology, it is possible to view the conductions within the peripheral nervous system. Using stimulating electrodes and biosensors placed on the surface of the skin, this peripheral sensing technology is capable of detecting the peripheral nerve impulses generated in a given muscle. Nerves that are malfunctioning will transmit impulses slower than healthy nerves. Peripheral nerve testing systems are used to diagnosis carpal tunnel syndrome, diabetic neuropathies, leg and lower back pain.

During surgery, anesthesiologists have an aid in the form of consciousness monitoring technology. The monitoring is achieved by applying uniform distribution and compression electrodes to the head surface. Translating information from EEG (electroencephalography), the monitoring system feeds information to the clinician to help make a determination on the optimal anesthesia or sedation.

In the psychiatric world, brain monitoring technology aids the diagnosis and treatment of such conditions as depression, Alzheimer's disease, attention deficit disorder, hyperactivity and dementia. This is not only helpful in diagnosis but also a tool for targeting an effective treatment. Within a few days of application, monitoring systems are able to measure the effectiveness; such as the impact of anti-depressant medications upon the treated person.

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Educate: Introduction to Neurosensing

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Sensing for Movement Disorders

In a medical facility, clinicians attempt to assess the movement of their patients by simulating their home environment. However, the clinician is limited since the patient's home environment may be very different from the simulation. To help overcome this limitation, a new generation of wireless sensing devices have emerged that can be worn by people in their own environments. The device captures the movement activity and transmits it to a clinician who can then use this information to customize a treatment protocol. These neurosensing systems are used to better assess movement disorders such as Parkinson's disease or cerebral palsy. An alternative application of movement sensing devices is the ability to measure pressure and weight-bearing time inside a person's shoe or orthodic device. The information gathered can be used to improve the design of orthoses or prosthetics.

Also in the prosthetics world, sensors are used to aid in the movement of lower extremity amputees. The latest generation of motor-powered prosthetics has sensors that gather and feed information back to the devices. Sensors gather proprioception information also measure gait, pressure and acceleration. It then feeds the information to a module which predicts the next movement. More complex systems include gyroscopes, pressure cells, load cells and angle sensors. With all this information, prostheses can electronically adjust to different walking conditions such as ascending stairs or un-even terrain.

Interacting with Other Technology

Neurosensing plays a key role in devices that allow people to interact with other technology where they normally would not have that capability. Much media attention has been given to the emerging technology of brain computer interface (BCI). This break-through technology is being tested to allow people with locked-in syndrome the ability to communicate using thought. Some versions of this use an implanted electrode array placed on the motor cortex, the part of the brain that controls movement. Here thousands of neurons fire together as the brain attempts to generate body movement. This massive activity of neurons occurs in the brain for simple movements, such as lifting a finger, and for more complex movements, such as knitting. In the research surrounding BCI, sensing electrodes are placed on the brain to capture the firing patterns of the neurons. These electrodes are attached is an external computer which "decodes" the patterns to generate movement of a robotic arm, the use of a computer or speech prosthesis.

While much of this technology is still being tested in the laboratory, less complex devices are currently available on the market. Instead of using implanted electrodes, these systems use sensing electrodes placed on the surface of the skin. They come in many different forms, such as a cap placed on the head, a small wireless sensor the size of an automobile remote or a surface electrode pad the size of a quarter. Regardless of what form this sensing technology takes, they all use EMG or electromyography to gather information. The sensors typically interact with a computer to decode the messages. For instance, EMG signals may interact with a computer to allow a severely impaired person the ability to communicate with a voice synthesizer.

Summary

This brief introduction to neurosensing is only the tip of the iceberg. Here we focused on neurosensing to monitor activity, analyze or aid movement and to interact with other technology. New applications for this rapidly changing technology are being tested in laboratories, such as providing the sensation of touch for prosthetics limbs or allowing a completely immobile person the ability to control a wheelchair. Stay updated on these advancements by visiting our website, www.NeurotechNetwork.org

Personal Experiences: Meet Erik Ramsey

At age sixteen, Erik was an average teenager. He worked a part-time job, loved hard rock music and enjoyed hanging out with his friends. One car accident changed Erik and the Ramsey family. While driving home from a movie, Erik and his friend where struck by a minivan. Firefighters on the scene had to use the Jaws of Life to get Erik out of the car. Rushed to the hospital, Erik lay in the intensive-care unit. He was awake but unresponsive; a blood clot formed in a part of his brain stem, causing a stroke. As a result of this brain stem stroke, Erick has a rare but permanent condition known as locked-in syndrome. Survival rates are low, but Erick endures. Erik's brain systems are functioning. He can see, hear and feel but he has no control over any of his muscles, with one exception. Although he cannot blink, Erik still has voluntary command of the up-and-down movement of his eyes. This simple movement is how he communicates with the world until Eddie, Erik's father, discovered Dr. Phil Kennedy and the new speech prosthesis.

"After we had gone through all the conventional means of trying to get rehabilitation and find a cure for Erik's condition," Eddie reflects, "we were referred to Dr. Kennedy by a member of a support group and also one of his special education teachers at high school." Dr. Kennedy and his elaborate team to scientists are helping Erik become the first human being to have his thoughts translated directly into speech. Neurosurgeons involved with this project implanted a tiny electrode onto Erik's brain. The targeted region is the premotor cortex which controls movement of the mouth, lips, tongue and jaw. This sensing electrode communicates with a decoding program on a computer.

While interacting with the system, Erik uses deep concentration and thinks of a word. The brainwave signals are captured by the sensing electrodes; they are recorded. This recording is interpreted, decoded then sent through a voice synthesizer to vocalize that word. The project is in such early stages that it can only interpret one word at a time and it is only available in the laboratory. Eddie describes the system as "trying to find the Rosetta Stone. You know that the answer is there, but it is not just recognizing the brainwaves Erik is thinking, it is also discerning it from similar waves and filtering out such artifacts as yawing, stretching, and spasms that naturally occur when Erik is concentrating."

Looking into the future, the Ramsey's hope Erik will some day be able to communicate to control his own daily living activities. Perhaps he can even drive his own wheelchair. Giving him more interaction with his immediate environment, Erik will "not be an outsider" but be more involved with his surroundings.

Over a decade after that tragic accident, the impact of this technology for Erik has been dramatic. "It gives him a purpose in life and allows him to do something constructive and interesting, says Eddie. "The implant has given Erik hope that someday he will be able to communicate, again." In one word, HOPE.

Neurotechnology Education Series

The Neurotechnology Education Series is designed to build awareness and understanding of neurotechnology among the disability, caregiver and medical professional communities. The series features presentations at disability and medical professional conferences, building strategic alliances within the disability community, public relations efforts with the disability-focused media and enhancing information disseminated through our website.

Over the past few months, Neurotech Network has addressed audiences at the United Cerebral Palsy Annual Conference in San Francisco, CA, the Abilities Expo Midwest in Chicago, IL and the United Spinal Association's Independence Expo in Orlando, FL. Not only have we addressed these audiences, but there has been an exponential increase in visits to the resources offered on our website.

If you missed us at these events, then join us at these upcoming events:

- Southwest Conference on Disability, Albuquerque Convention Center, Albuquerque, MN—October 2, 2009
- National Caregivers Conference, Woodbridge Conference Center, Iselin, NJ—October 29, 2009
- Abilities Expo Southeast and featuring the Technology Showcase, Cobb Galleria Convention Center, Atlanta, GA—November 6 & 7, 2009

More presentations are being scheduled. Check out our website for the most updated lisitng.

Sponsorship for one or more of the events are available. Members of the Neurotech Awareness Coalition have priority status. Join us in this important effort to build awareness about neurotechnology. Contact Jennifer French for details, jfrench@neurotechnetwork.org or call 727.321.0150.

Resources For Neurosensing

There are many resources available to learn more about Neurosensing. The following is a listing of neurotechnology organizations offering technology for monitoring activity, analysis of movement and interacting with other technology. There are many more applications of neurosensing such as brain state analysis and sleep or alertness monitoring. These additional solutions may be found in the Neurotechnology Database available for free from the Educate Page.

- Ablenet
- Applied NeuroSolutions
- Aspect Medical Systems
- BrainScope
- CareFusion
- CleveMed
- Control Bionics
- EGI, Electrical Geodesics
- Infinite Biomedical Technologies
- Lexicor, NEBA
- Natus Medical
- Neural Signals
- Neurolutions
- Neurometrix
- Neurowave
- Nexstim
- Ossur Bionic Technology
- Victhom Human Bionics
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Prior to considering any new therapy, treatment or device, a proper evaluation must be conducted with a knowledgeable medical professional. There are health, medical and financial risks. Out of pocket costs and available insurance coverage for any treatment must be considered prior to starting a protocol. Finally, this is an evolving field of science and technology development. Updated information regarding these devices and organizations is available in the Educate section of our website at www.NeurotechNetwork.org

***Neurotech Network, The Society to Increase Mobility and its representatives do not rate, endorse, recommend or prescribe any products, procedures or services. This fact sheet is for informational purposes only.*

On the Horizon: Updates in the World of Neurotech

- Spaulding Rehabilitation Hospital, Boston, MA is conducting human clinical trials using FES rowing for spinal cord injury. This study was featured in the Boston Globe.
- Scientists at the Massachusetts General Hospital have initiated the BrainGate2 pilot clinical trial to expand restorative neurotechnology research to evaluate how people with spinal cord injury, brain stem stroke, muscular dystrophy, amyotrophic lateral sclerosis (ALS), or limb loss may be able to use brain signals to control assistive devices.
- Helen Hayes Hospital in West Haverstraw, NY and the Wadsworth Center in Albany, NY are recruiting volunteers who have had a spinal cord injury to participate in a study of spinal reflex training. The results of this study will help develop a new therapeutic treatment for better functional recovery after spinal cord injury or other damage to the nervous system. Inquiries should contact Dr. Thompson at thompsona@helenhayeshosp.org
- CPT codes are critical for insurance reimbursement. The American Medical Association recently released a Category III CPT code for physiologic recording devices for tremor. The Kinesia system, from CleveMed, is a wireless patient worn device for monitoring the severity of movement disorders such as tremor.
- Uroplasty received a patent for thr overactive bladder device. The system uses stimulation methods for treatment of the overactive bladder symptoms including urinary urgency, urge incontinence, and frequency of urinary voids. The Urgent PC Neuromodulation System is a minimally invasive, office-based, nonsurgical system designed to deliver retrograde access to the sacral plexus through percutaneous electrical stimulation of the posterior tibial nerve.
- Medtronic, Inc., the Minneapolis, MN manufacturer of neuromodulation systems, announced it has submitted a Pre-Market Approval application with the U.S. Food and Drug Administration for Medtronic deep brain stimulation for patients with medically refractory epilepsy with partial-onset seizures. These are patients who have uncontrollable seizures with little or no response to currently available anti-epileptic medications.
- Neurotech Network, will sponsor a forum devoted to clinician and consumer perspective at the 2009 Neurotech Leaders Forum Oct. 26-27 in Newport Beach, CA. The panel will bring together practicing clinicians and representatives from the disability community with leaders in the neurotechnology industry. Discussion topics will be directed at the gaps in treatment and consumer priorities. For more information on the Neurotech Leaders Forum, contact Neurotech Reports at 415.546.1259
- The Cleveland FES Center will be offering a webcast series titled the Neural Prosthesis Seminar Series. Targeted toward clinicians and research professionals, these webcasts are available free of charge and each topic will be available after the scheduled date.

Updates are available on our website. Stay updated by signing up for email notifications too. Visit our website at www.NeurotechNetwork.org.

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Advances Improve Outlook for Peripheral Nerve Repair

A number of research institutions and commercial firms are pursuing new technology for peripheral nerve repair. The new findings may have an impact on the nerve repair market and lead to new treatments for neurodegenerative diseases such as multiple sclerosis.

After an injury that severs a peripheral nerve, such as one in a finger, nerve endings continue to grow. But to regain control of the nerve surgeons must join the two fragments. For large gaps surgeons used to attempt a more difficult nerve graft. Current surgical practice is to attach tiny tubes, called nerve guides, that channel the two fragments toward each other.

Today's commercial nerve guides are made from collagen, a structural protein derived from animal cells. But collagen is expensive, the protein tends to trigger an immune response and the material is weak in wet environments, such as those inside the body.

Miqin Zhang, a University of Washington professor, recently authored a paper in Advanced Materials describing a new mixed-fiber material for nerve repair. The first component of their material, polycaprolactone, is a strong, flexible, biodegradable polyester commonly used in sutures. The second component, chitosan, is found in the shells of crustaceans. UW researchers combined the fibers by first using a technique called electrospinning to draw the materials into nanometer-scale fibers, and then weaving the fibers together. The resulting material has a texture similar to that of the nanosized fibers of the connective tissue that surrounds human cells.

Researchers at the University of Pittsburgh recently used biodegradable nerve guides to transplant adipose precursor cells into the injured peripheral nerves of laboratory rats to determine if the guided fat cells could improve nerve regeneration and functional recovery. APCs have demonstrated an ability to differentiate in vitro into cartilage (chondrogenic), bone (osteogenic), fat (adipogenic), and muscle (myogenic) cell types.

Control groups for this study included those with no treatment, those receiving an autograft but no nerve guide tube, and those receiving an autograft and nerve guide tube but no APC transplant in the guide tube. Their results also showed that transplanted human-derived APCs survived for up to 12 weeks in the injured peripheral nerve and formed a more robust nerve with nerve cells more than double the size of those formed using the conduit alone.

Several commercial firms offer products for the peripheral nerve repair market. Stryker Corp. offers a range of treatment options for peripheral nerve injuries, including NeuroMatrix, a resorbable, semi-permeable, collagen tubular matrix designed to create a protective environment for axonal growth across a nerve gap, and Neuroflex, a flexible conduit. Integra Neurosciences offers the NeuraGen nerve guide.

AxoGen's Avance product is decellularized and cleansed extracellular matrix from donated human peripheral nerve. The cleaning process preserves the structural characteristics of the extracellular matrix needed to provide a bridge for nerve discontinuities while cleansing out the tissue's irrelevant characteristics.

Commentary provided by Jim Cavuoto, Neurotech Reports

New Website is Launched

Have you visited the Neurotech Network website lately? It recently had a make over. Making it easier for you to navigate, the new website offers a section dedicated to Education Resources, Media Center, and Conference Appearances.
Visit our website to learn more about neurotechnology in layman's terms, to meet other neurotechnology users and to find out where we will be next.