University of Minnesota named a Udall Center of Excellence in Parkinson’s Disease Research

BME faculty to lead project exploring novel brain stimulation approaches Disease Research

Increasing the number of electrodes along and around deep brain stimulation leads (left) is enabling more precise targeting of pathways within the brain (right). Shown is an example of a deep brain stimulation array implanted in the subthalamic nucleus (STN, dashed lines) and the capacity of the deep brain stimulation array to direct axonal activation around the lead. This technology is providing new opportunities to investigate how deep brain stimulation can more effectively manage individual parkinsonian motor symptoms and identify pathways (e.g. internal capsule, green) that can lead to side effects when activated by stimulation (purple volume). Scale bar: 1 mm.

The University of Minnesota was named a Udall Center of Excellence in Parkinson’s Disease Research this year, joining eight top institutions like Harvard, Northwestern, Penn and others. With that distinction, the University was awarded a five-year grant totaling $9 million to improve the lives of patients with Parkinson’s disease.

A team of University researchers and physicians, including BME Professors Matt Johnson and Tay Netoff, seek to better understand the changes in brain circuitry that occur in patients with Parkinson’s disease. The multidisciplinary team, led by Jerrold Vitek, professor and chair of Neurology, is leveraging this understanding to improve deep brain stimulation (DBS) and other therapies to treat Parkinson’s disease. The University of Minnesota’s Udall grant will focus on three main Parkinson’s disease research projects:

- **Project 1 (Neurology)** will study the underlying changes in brain circuitry that affects patients with Parkinson’s disease by using cutting-edge brain imaging and intraoperative techniques that Dr. Vitek pioneered.
- **Project 2 (Neurology)** will develop new stimulation approaches in a region of the brain called the pallidum that is important...
Vikram is currently a Senior in our undergraduate Biomedical Engineering program and is on track to graduate summa cum laude honors with an emphasis in Cell and Tissue Engineering. He has participated in clinical and lab research, interned in the biomedical engineering industry and engages in community service as a hospital volunteer and a member of Engineers Without Borders. Vikram enjoys playing classical piano, playing the flute for the UMN concert band and is working towards receiving his private pilot’s license.

What are some highlights of your research experiences?

My first research experience in college was with Dr. Louis Mansky in the Institute for Molecular Virology. Under his mentorship, I acquired many new lab techniques and completed two UROPs while learning how to properly collect, analyze, present and write about my data. I also explored the world of clinical research at the Hennepin County Medical Center where I enjoyed shadowing in the Emergency Department and witnessing how simple clinical questions get translated into research studies. Lastly, my current clinical research internship at the Minneapolis Heart Institute has allowed me to learn about translational research and the clinical trials behind various drugs and medical devices.

What led you to being President of the UMN BMES Student Chapter?

I love the field of biomedical engineering, our BME major, the faculty, the student body and just wanted to give back to the program that has supported and trained me so well over the past few years. I enjoy increasing awareness of biomedical engineering within and outside of campus, engaging in outreach events, learning about how the University works, and working with a great team of officers. I also took on the role because I hope to inspire the vision of the organization and see value in providing academic, professional and social opportunities that help students achieve their goals.

What is your advice for our current BME majors?

My primary advice for BME students is to keep an open mind regarding future interests. Whether industry, graduate school, or medical school, don’t limit yourself. Go with your gut and pursue what you think would be the best fit for you. Also, never sell yourself short! Even if you don’t feel experienced enough for a certain opportunity, don’t be afraid to apply. While keeping your schoolwork as the number one priority, I would also encourage you to get involved in a student group or extracurricular activity so that you can do something you are passionate about, explore new things, form relationships with friends and faculty and strike a balance in your college career.
Dr. Santhi (Elayaperumal) Analytis

After finishing her B.BM.E. degree and minor in Latin American Studies, Santhi spent a summer conducting computational research in Germany (Karlsruhe Institute of Technology), then moved to California to work as an R&D Engineer at Sadra Medical (acquired by Boston Scientific). Then, she went to graduate school at Stanford University and completed her MS and PhD in Mechanical Engineering as an NSF Graduate Research Program Fellow. Her PhD thesis, “Technologies for Needle Manipulation in MRI-Guided Interventions,” involved developing devices including fiber optic strain and force sensing tools, haptic manipulators, and surgical navigation systems. Santhi is currently CTO and co-founder of Moxxly, a San Francisco based consumer tech startup designing products for women. Moxxly’s first product is a smart breast pump system for today’s mobile moms.

Did your UMN BBmE degree prepare you for your PhD at Stanford?

Definitely! At the U, I had a couple undergraduate research stints, in Prof. Tranquillo and Prof. Timm’s labs, and got a taste for building, testing, and modeling things. These experiences, in addition to my B.BM.E. coursework, helped me realize my passion for engineering and applied problem solving.

What led you to launch Moxxly so soon after your PhD?

One of the reasons I moved to Silicon Valley was to learn what it was like to work at a medical device startup, always keeping in mind that I wanted to someday start my own company. Many students at Stanford have an entrepreneurial mindset, including my fellow co-founders. The right idea and right team came along and the timing was perfect. Despite the design and business classes I took, I felt the best way to learn entrepreneurship was to dive right in and start!

What has been the best part of launching Moxxly?

Building Moxxly has been rewarding because of the users. We take a women-centered, consumer tech, style-savvy approach to the brand, which makes it different from other medical devices I have worked on. This allows us to get closer to the customers, and be directly in contact with the lives we are trying to make easier. It’s very motivating to see users excited about our product, and grateful to have alternates to a problem that is a big pain point in early motherhood.

University of Minnesota named a Udall Center of Excellence in Parkinson’s, cont.

BME Professors Johnson and Netoff are leading project 3. This project seeks to better understand the neurophysiological basis for why DBS therapy for Parkinson’s disease works better for some parkinsonian symptoms than others. Particularly, gait and postural instability can often be challenging to manage with current therapies. The ultimate goal of this research is to identify optimal stimulation parameters to target each parkinsonian motor symptom. The Johnson and Netoff labs are utilizing engineering principles to develop new technology for quantitative assessment of motor signs and optimization algorithms to personalize DBS therapy to patients and their individual symptoms.

“At the University of Minnesota, we have a world-class multidisciplinary team to treat patients with Parkinson’s disease,” said Vitek. “And because of our significant experience and expertise, we are able to take on this complex and often debilitating movement disorder with a goal of improving patient’s lives.” “The Udall grant is a testament to the world-class team Dr. Vitek has assembled,” said Brooks Jackson, dean of the Medical School. “By bringing a multidisciplinary approach to this research, Dr. Vitek and his team have put the University of Minnesota in a position to be a leader in advancing science and hopefully developing new treatments and cures for Parkinson's disease.”
Our brain works using electricity. Information between neurons is passed by action potentials in the form of electrical currents along their membranes. Intact electric signalling is very important for the functioning of the brain. Various neurological and psychiatric disorders are thought to occur from pathological processes with regards to electric signal propagation between neurons. Devices to non-invasively modulate electric activity in the brain show promise as treatment option in diseases ranging from depression to stroke.

Prof. Alexander Opitz's lab works on improving non-invasive brain stimulation (NIBS) technologies based on electromagnetic fields. Computational models to estimate the electric field distribution during transcranial magnetic (TMS), transcranial electric (TES) stimulation are integrated with neuronavigation systems to improve targeting approaches of specific brain circuits. This is combined with studies of the biophysical and physiological foundations of NIBS with the hope that a better understanding can be translated into improved stimulation protocols for clinical applications.

Currently, the response to NIBS protocols can vary strongly across individuals making personalized interventions a promising venue. Prof. Opitz's lab is working to identify individual anatomical and functional predictors for the response to NIBS. Biomedical imaging technologies like MRI and EEG can provide insights into brain processes of individuals that can help tailor stimulation approaches. Prof. Opitz envisions that improved technology and better understanding of brain physiology will lead to personalized NIBS therapies to tackle brain disorders, such as depression, which currently put a large strain on individuals and society.