



Center for Sensorimotor Neural Engineering (CSNE) an NSF Engineering Research

Participating Laboratories Summer Research Experience Programs for Undergraduates, Veterans, Teachers, and Young Scholars

Laboratory of Dr. Chet Moritz

Research Mission: The Moritz lab is developing methods for bypassing damage to the brain or spinal cord and restoring conscious control of movement to paralyzed limbs. The team's goal is to record neural signals from intact areas of the brain and to use these signals to control stimulation delivered to paralyzed muscles or the spinal cord below the injury. Previous Research Experience for Undergraduate (REU) students demonstrated that stimulation within the cervical spinal cord is capable of evoking hand and arm movements both before and after injury. This intraspinal stimulation evokes functional and synergistic movements that may be the ideal means to awaken paralyzed limbs.

A Good Match for: Those who are interested in discovering new ways to help restore function for people suffering from paralysis. People interested in the intersection between rehabilitation medicine, physiology, biophysics, neurobiology, and electrical engineering.

UW Department: Rehabilitation Medicine
Website: <http://depts.washington.edu/moritlab/>

Laboratory of Dr. Steve Perlmutter

Research Mission: The Perlmutter lab studies the neural computations performed by the spinal cord and cerebral cortex to generate skillful movements of the arm and hand. Researchers in the lab also investigate the capacity of damaged motor systems for neural plasticity and adaptation, and are developing neuroprosthetic strategies to improve recovery after central nervous system damage.

A Good Match for: People interested in motor behaviors of the arm and hand, neural recordings of primate behavior, and improving motor function after injury to the nervous system. People who want to learn neurophysiological, anatomical, behavioral, and computational research techniques.

UW Department: Physiology & Biophysics, Neurobiology & Behavior
Websites: <http://depts.washington.edu/pbiopage/faculty/sperlmutter>
<http://depts.washington.edu/behneuro/people/faculty/perlmutter.shtml>

Laboratory of Dr. Jeffrey Ojemann

Research Mission: The Ojemann lab is interested in using electrocorticography (ECoG) to answer basic neuroscience questions as well as to develop tools for clinical and rehabilitative applications. ECoG, which is used for long-term clinical monitoring of epilepsy patients, provides a unique opportunity to collect data directly from the surface of the brain in awake, active humans. The group represents researchers from a wide range of backgrounds including neurosurgery, neurology, rehabilitative medicine, engineering, neuroscience, and physics. A major focus of the group is brain-computer interfaces; current projects include learning mechanisms, tactile feedback, and recursive stimulation. Ojemann's team is also investigating more fundamental questions about cortical representation of simple and complex hand movements, the dynamics



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of cognition, language, and higher-order nonlinear interactions between brain areas. Other projects include integration of ECoG and fMRI (functional magnetic resonance imaging) and studies of temporal lobe epilepsy

A Good Match for: People interested in neurosurgery, epilepsy surgery, and brain research. People curious about the intersection between cognitive neuroscience, physics, applied math, and computer science.

UW Department: Neurological Surgery

Website: <http://neurosurgery.washington.edu/research/labs/ojemann.asp>

Laboratory of Dr. Jay Rubinstein

Research Mission: Dr. Rubinstein's lab explores cochlear implant signal processing to develop and improve implantable devices that combat the effects of hearing loss and disequilibrium. The Rubinstein Lab uses novel signal processing strategies to enhance function of current cochlear implant technology, and to understand the processing of auditory information in the brain. In addition, the group is developing novel instruments to evaluate auditory processing in patients.

A Good Match for: People concerned with or interested in the treatment of deafness and other communication disorders. People interested in the intersection of neurophysiology, otolaryngology, audiology, computer science, and neural engineering.

UW Department: Otolaryngology

Website: <http://depts.washington.edu/coursejo/ESVN/rubinstein.html>

Laboratory of Dr. Brian Hafner/Dr. Valerie Kelly

Research Mission: Research in this lab centers on the development of clinically useful and meaningful outcome measures such as the assessment of performance, function, and quality-of-life in people with limb loss and difference. The lab is also involved with the development of tools and instruments suited to measuring orthotic and prosthetic interventions and the impact on the lives of end users. Current projects include a longitudinal study of mechanical, magnetorheological, and powered prosthetic knee technologies and an evaluation of the cognitive demands associated with mobility in people with transfemoral loss.

A Good Match for: People who are excited by the design of “smarter” prosthetic limbs and improving quality of life for people with amputations. People interested in the intersection between rehabilitation medicine, bioengineering, and neural engineering.

UW Department: Rehabilitation Medicine

Websites: <http://www.rehab.washington.edu/education/faculty/nonproviderbios/hafner.asp?view=>



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Laboratory of Dr. Kat Steele

Research Mission: The Ability Lab, led by Dr. Kat Steele, is focused on using engineering and design to improve mobility for individuals with neurological disorders such as cerebral palsy and stroke. The team uses a variety of tools including musculoskeletal simulation (<https://opensim.stanford.edu>), motion analysis, 3D-printing, and electromyography to determine new ways to improve human movement. Previous Research Experience for Undergraduate (REU) students have worked on projects to use 3D-printing to improve the design of orthoses for individuals with impaired hand movement and to develop new systems to measure muscle activity during daily life with electromyography.

UW Department: Mechanical Engineering

Websites: <http://faculty.washington.edu/kmsteele/>

Laboratory of Dr. Adrian KC Lee

Research Mission: The Lee Lab uses advanced brain imaging techniques such as magnetoencephalography (MEG), electroencephalography (EEG) and magnetic resonance imaging (MRI) to investigate high-level cognitive processes like attention and decision-making. The lab seeks to discover unique patterns of brain activity, or neural signatures, that can be used to identify different brain states. The ultimate goal of this research is to combine this information with modern engineering approaches to improve brain-computer interface technologies; this method could enable neuroprosthetic users to dynamically tune their devices using only their minds.

A Good Match for: People interested in speech and hearing sciences and auditory brain sciences. A good match for people curious about how the human brain processes the sounds we hear and how to develop brain-computer interface devices to help people with disabilities better communicate.

UW Department: Speech and Hearing Sciences

Website: <http://depts.washington.edu/labsn/>

Laboratory of Dr. William Shain

Research Mission: The Shain lab uses multidisciplinary approaches to study interactions between implanted neuroprosthetic devices and the brain. The Shain lab is involved in designing, fabricating, implanting, and testing new devices. Their research efforts are aimed at developing devices that last the lifetime of the user.

A Good Match for: People who want to research implanted devices, deep brain stimulation, and tissue response. People interested in the intersection between neurosurgery, electrical engineering, and computer science.

UW Department: Neurological Surgery

Website: <http://neurosurgery.washington.edu/education/faculty/researchbios/shain.asp>

Laboratory of Dr. Fred Rieke

Research Mission: The research in the Rieke lab focuses on sensory signal processing, particularly in cases where sensory systems perform at or near the limits imposed by physics. The central goal of the work in the Rieke lab is to relate biophysical mechanisms operating in the retina to defined roles in computation and



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ultimately behavior. The experimental basis for this work comes from several physiological preparations that allow researchers to track responses generated by the rod and cone photoreceptors across the retinal circuitry, and recently also from human behavioral work.

A Good Match for: People who want to research vision and visual processing. People interested in studying physiology and biophysics.

UW Department: Physiology and Biophysics

Website: <http://rieke-server.physiol.washington.edu/index.html>

Laboratory of Dr. Adrienne Fairhall

Research Mission: The Fairhall group develops theoretical approaches to understand processing in nervous systems. The lab collaborates closely with experimental labs investigating a range of different systems, from single neurons to behaving animals. Their work aims to uncover neural algorithms of information processing. They are particularly interested in the way in which neural coding and representation is affected or shaped by the complex statistics of the natural world.

A Good Match for: People who want to apply a love for mathematics and data analysis to uncovering algorithms of information processing in a range of systems.

UW Department: Biophysiology & Biophysics

Website: <http://fairhalllab.com/>

Laboratory of Dr. William Moody

Research Mission: Research in the Moody lab concerns the roles of spontaneous electrical activity in the development of the nervous system. Ongoing experiments ask how such activity is controlled and what roles it plays in nervous system development. Patch clamp and calcium imaging methods on living slices of developing mouse brain are some of the techniques being used to study these questions. The laboratory is small, with people at all levels (faculty from other universities on sabbatical visits, technicians, postdoctoral fellows, graduate students, and undergraduates; not all necessarily at the same time) working closely together.

A Good Match for: People who want to learn about electrical activity in the brain and how the brain develops. People interested in neurobiology and behavior.

UW Department: Biology

Website: <http://faculty.washington.edu/profbill/>



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Laboratory of Dr. Thomas Daniel

Research Mission: The Daniel lab is interested in sensorimotor control of animal locomotion. Projects in the lab include the study of flight control, implantable microelectronics to control behavior, and the dynamics of muscle contraction. The goals of these projects are to learn about neuronal dynamics and networks, synaptic interactions between neurons, and how neuronal signaling, behavior, and environmental stimuli are linked.

A Good Match for: People who want to work with insects, are fascinated by flight, or interested in building mathematical models and algorithms. People interested in the intersection between neurobiology, neural engineering, bioengineering, mechanical engineering, electrical engineering, and mathematics.

UW Department: Biology

Website: <http://faculty.washington.edu/danielt/>

Laboratory of Dr. Rajesh Rao

Research Mission: The Rao lab studies the computational principles underlying the brain's remarkable ability to learn, process, and store information. Using a combination of probabilistic techniques, computer simulations, and collaborative neurobiological experiments, researchers are investigating how the brain learns efficient representations of objects and events occurring in the natural environment, the algorithms that allow useful sensorimotor behaviors to be learned, and how the knowledge gained through computational studies of the brain may be used in biomedical applications such as brain-computer interfaces.

A Good Match for: People fascinated by brain-computer interfaces. People interested in the intersection between computer science, mathematics, and neural engineering.

UW Department: Computer Science & Engineering

Website: <http://homes.cs.washington.edu/~rao/>

BioRobotics Laboratory (Dr. Blake Hannaford and Dr. Howard Chizeck)

Research Mission: The University of Washington's BioRobotics Lab is home to a number of students and faculty dedicated to improving the lives of people through cyberphysical systems. The lab's mission is to develop science, technology, and human resources at the interface between robotics, control theory and the biological sciences. Their goal is to produce useful, innovative research and technology as well as trained researchers capable of driving technological advancement in medical and biological systems. The lab has ongoing projects investigating privacy and security in brain-computer interfaces, brain-computer interface optimization, closed-loop deep brain stimulation, and lower-limb targeted muscle reinnervation.

A Good Match for: People interested in the intersection between electrical engineering, robotics, and electromechanical design.

UW Department: Electrical Engineering

Website: <https://brl.ee.washington.edu/>



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Laboratory of Dr. Kristi Morgansen

Research Mission: The Morgansen lab is interested in control methods for nonlinear and coordinated control systems. Current research topics include bio-inspired agile flight, the use of fish-like propulsive methods for locomotion and active flow control, control of coordinated systems with communication constraints, vision-based sensing for state estimation, and integration of cognition in multi-agent systems.

A Good Match for: People fascinated by the design of autonomous vehicles (underwater, ground, air, and space) and how biology can inspire engineering designs. People interested in the intersection between aeronautics, astronautics, robotics, and neural engineering.

UW Department: Aeronautics and Astronautics

Website: <http://www.aa.washington.edu/faculty/morgansen/> (see “associated labs”)

Laboratory of Dr. Jacque (Chris) Rudell

Research Mission: The Rudell lab studies a broad range of topics related to analog, mixed-signal, RF, and mm-wave circuits. The emphasis of the work is on novel architectures and circuits which overcome the challenges presented by future low cost, advanced silicon technologies, such as ultra-low voltage, low-intrinsic device gain, and poor matching characteristics. Typical projects in the lab focus on applications which are challenging to integrating as a single-chip. Some examples include devices for high-speed communication, imaging, and biological interfaces including neural stimulation. Students in our lab will focus both on system-level design issues as well as nuts and bolts implementation of an integrated circuit.

A Good Match for: People who want to design hardware for neural engineering applications, such as tiny implantable chips that stimulate neurons. People interested in electrical engineering.

UW Department: Electrical Engineering

Website: <http://www.ee.washington.edu/research/fast/FAST.html>

Laboratory of Dr. Joshua Smith

Research Mission: The Smith lab aims to improve the connection of information systems to the physical world. Researchers in the lab work to invent new sensor systems, devise innovative ways to power and communicate with them, and develop algorithms for using them. This research has applications for implanted devices, including those used for recording from and stimulating the nervous system.

A Good Match for: People curious about new sensor system technologies and their use in robotics and medical devices. People interested in the intersection of bioelectronics, robotics, ubiquitous computing, electrical engineering, and neural engineering.

UW Department: Electrical Engineering; Computer Science & Engineering

Websites: <http://sensor.cs.washington.edu/jrs.html>

<http://sensor.cs.washington.edu/index.html>



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Laboratory of Sara Goering

Research Mission: The neuroethics group (Goering “lab”) studies ethical issues arising from emerging neural engineering technologies. Issues include questions of privacy, security, moral and legal responsibility, changes in our understanding of agency, shifts in personal identity, and social justice. We have a commitment to the inclusion of disability perspectives in the design of devices intended to benefit people with disabilities. Our group does both normative theoretical research and writing, and empirical studies such as focus groups with intended end-users.

A good match for: Students interested in neural engineering and particularly drawn to the ethical and policy implications of new technologies. Interest in philosophy, disability studies, and social justice. Engineering, neuroscience, social science and humanities majors welcome.

UW department: Philosophy

Websites: <https://www.phil.washington.edu/users/goering-sara>
<http://csne-erc.org/research/thrust-areas/thrust-4-neuroethics>