I am applying for a Fulbright Award seeking a research grant in Switzerland to fund a 12-month project at the Swiss Federal Institute of Technology in Lausanne (EPFL). At the Translational Neural Engineering Laboratory, I would work with the support Prof. Silvestro Micera developing a novel robotic rehabilitation technique for stroke recovery. Switzerland is the ideal place to do neuroscientific research that translates into meaningful treatment methods, especially with the recent formation of Campus Biotech in 2012. This muti-development facility, located in Geneva, houses research groups from the University of Geneva, EPFL, and the Wyss Center for Bio- and Neuro-Engineering resulting in a dynamic environment which fosters collaboration, innovation, and the translation of technology. A Fulbright research grant for Switzerland would give me the opportunity to demonstrate the excellence of United States research through my collaboration with an international community on the development of a novel rehabilitation framework at a world-class research facility.

The primary cause of disability in adults in western countries is stroke, which often results in motor function damage. More often than not, stroke victims suffer upper-limb dysfunction making reaching and grasping tasks very difficult or even impossible. Robot-aided motor rehabilitation methods help stroke victims recover their muscular coordination through the use of a robotic exoskeleton that guides the arm of the patient through reaching motions. Robotic-aided rehabilitation is becoming increasingly popular because it provides intensive and highly repeatable therapy which has been proven to improve the coordination of neuromuscular system [?]. Traditionally, the rehabilitation strategy and evaluation are done through the analysis of only kinematic and muscle activation data. My project will be the development of personalized rehabilitation strategies that incorporate analysis of cortical activity patterns recorded using noninvasive electroencephalography (EEG) recordings.

This project will be an extension of the research I have already done at the Translational Neural Engineering Laboratory in the summer of 2015. Using EEG recordings of cortical activity and electromyographic (EMG) recordings of arm muscle activity from healthy subjects, the objective of my research project was to find links between brain activity and the activation of coordinated muscle groups, or muscle synergies. We successfully developed a strategy for analyzing cortico-muscular activity in stroke patients relative to healthy patients, which uses the extraction of EEG microstates and a multiple block partial least squares analysis framework (this may change)[?]. We propose that motor rehabilitation treatment for stroke patients can be improved by leveraging this analysis of cortical dynamics to determine personalized rehabilitation strategies which are more effective. Rather than simply working to restore particular muscle activation patterns, we can develop strategies for restoring proper cortical patterns for neuromuscular control. A year-long Fulbright Award would fund my contribution to the development, implementation, and evaluation of a personalized robot-aided rehabilitation strategy that uses the analysis framework developed by my previous research project at the TNE.  
An exciting aspect of this project is the opportunity to collaborate in an academically diverse environment with two specialists at the cutting-edge of their field. The Translational Neural Engineering Laboratory, previously located on EPFL’s campus in Lausanne, has just moved to Campus Biotech in the fall of 2015. There I will be supervised by the head of the laboratory Prof. Silvestro Micera, who is the Bertarellie Foundation Chair in Translational Neuroengineering at EPFL. The rehabilitation strategy development, experimental design, and clinical trial execution will all happen within the operations of the TNE. I will also continue working with Prof. Dimitri Van de Ville, head of the Medical Image Processing Laboratory, to develop novel signal processing and machine learning techniques for effective cortico-muscular analysis. Before the clinical trial at the University of Geneva Hospital begins, I will continue developing cortico-muscular analysis techniques using the healthy subject data I used in the summer of 2015. The clinical trial will take nine weeks, where stroke victims will have 3 rehabilitation sessions of 45 minutes each week. The recovery of stroke victims using the novel rehabilitation strategy which leverages neural recordings will then be compared with the recovery of patients using the traditional strategy. By the end of my research project, we will look to present our results at a neuro-rehabilitation conference.

My education and diverse research projects give me the skills and experience necessary to carry out this proposed project successfully. This spring, I will graduate from Carnegie Mellon University with my bachelor’s degree in Electrical and Computer Engineering. I have taken rigorous courses in discrete signal processing, cognitive neuroscience, robotics, and a graduate course in neural signal processing which give me the academic training necessary for this project. I have a wide variety of research experiences ranging from humanoid robot development to neural network reconstruction algorithm design. Working for CMU’s Darpa Robotics Challenge team, I learned so much about systems engineering, validation testing and how to develop software in a team-oriented environment. My undergraduate research project with Prof. Jelena Kovacevic resulted in the publication of a faster, more accurate algorithm for determining functional connectivity in cortical networks. From this experience, I learned how to work independently and get through research roadblocks. Sponsored by an undergraduate fellowship from the Center for the Neural Basis of Cognition, a joint program between Carnegie Mellon and the University of Pittsburgh, I work with Prof. Byron Yu on the development of a dimensionality reduction framework for analyzing membrane potential population recordings. By working with Prof. Yu on this untouched area of neuroscientific research, I have really grown in my ability to think creatively and design experiments. And lastly, my summer at EPFL under Prof. Micera sponsored by a ThinkSwiss scholarship gives me a lot of momentum going into a full-year research project with the same group. I am already familiar with the lab resources, and I will be able to use the large code base I have written for this analysis. These experiences have shown me a lot about what it takes to be a successful scientist, and I am confident in my ability to do meaningful research in my area of expertise.

[I need to add some stuff about getting involved in Swtizerland and a summary, but this part is what I need you to review the most.]