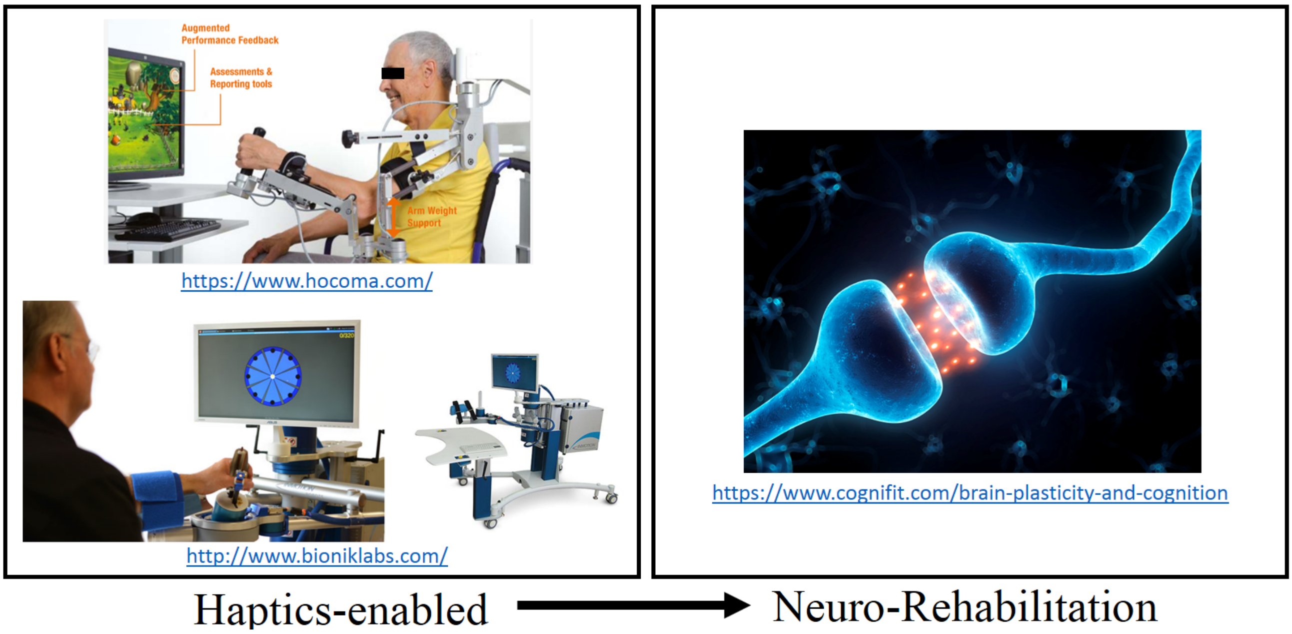
Title: Haptics-enabled Robotic and Telerobotic Neuro-Rehabilitation



Abstract: Current statistics show that the population of seniors and the incidence rate of age-related neuromuscular disorders are rapidly increasing worldwide. Improving medical care is likely to increase the survival rate but will result in even more patients in need of Assistive, Rehabilitation and Assessment (ARA) services for extended periods which will place a significant burden on the world's healthcare systems. In many cases, the only alternative is limited and often delayed outpatient therapy. The situation will be worse for patients in remote areas. One potential solution is to develop mechatronic neuro-rehabilitation technologies that provide efficient and safe means of in-hospital and in-home kinesthetic rehabilitation. In this regard, Haptics-enabled Interactive Robotic Neurorehabilitation (HIRN) systems have been developed and revolutionized the field of motor therapy. Although there are specific advantages with the use of HIRN technologies, there still exist several technical and control challenges, e.g., (a) absence of direct physical interaction between therapists and patients; (b) questionable adaptability and flexibility considering the sensorimotor needs of patients; (c) limited accessibility in remote areas; and (d) guaranteeing patient-robot interaction safety and stability while maximizing system fidelity. The challenges are more concerning when high control effort is needed for severely disabled patients, when the robot is to be used in a patient's home or when the patient experiences involuntary movements. The above-mentioned challenges and possible solutions will be discussed in this talk. Particularly, the design of a haptics-enabled telerobotic rehabilitation framework will be explained. The framework can be used as a new paradigm for delivering motor therapy which gives therapists direct kinesthetic supervision over the robotic rehabilitation procedure. In order to guarantee interaction safety while maximizing the performance of the system, a new theoretical framework for designing stabilizing controllers will be introduced which is initially developed based on small-gain theory and then completed using strong passivity theory. The proposed control framework takes into account knowledge about the variable biomechanical capabilities of the patient's limb(s) in absorbing interaction forces and mechanical energy. Practical and theoretical aspects will be covered in this talk.

Speaker: *Seyed Farokh Atashzar, Ph.D.*

Dr. S. Farokh Atashzar obtained his B.Sc. degree in Electrical Engineering/Control Systems from K. N. Toosi University of Technology, Iran, in 2008 and his M.Sc. degree in Mechatronics from Amirkabir University of Technology, Iran, in 2011. Farokh joined University of Western Ontario (UWO), London, Ontario, Canada, in 2011 to pursue his Ph.D. degree under the supervision of Dr. Rajni V. Patel. In 2012 and 2013, he was a doctoral trainee in the NSERC CREATE program in Computer-Assisted Medical Interventions (CAMI). He serves as a visiting research scholar at the University of Alberta, Canada, in 2014. In 2015 and 2016 he was a doctoral trainee of the Network of Centres of Excellence (NCE) program on "Aging Gracefully across Environments using Technology to Support Wellness, Engagement and Long Life (AGE-WELL)". Farokh received his Ph.D. degree in Electrical and Computer Engineering (ECE) from UWO in 2016. During his Ph.D., Farokh received several awards. He was among the few international students in Ontario awarded an Ontario Graduate Scholarship in 2013. He won two outstanding presentation awards at the Department of ECE (UWO) in two consecutive years (2014 and 2015 competitions). Currently, Farokh is a postdoctoral research associate in the Department of ECE at UWO and Canadian Surgical Technologies and Advanced Robotics (CSTAR), London, Ontario, Canada. Farokh's research interests broadly involve the areas of medical (neurorehabilitation and surgical) robotics, bio-signal processing, physical human-robot and human-telerobot interaction, vision-based robot navigation, and advanced nonlinear control system technologies. His research has been published in more than 20 journal papers and 25 peer-reviewed conference papers, so far. He was a co-organizer of the workshop on "Advanced Intelligent Mechatronics for Neuromuscular Rehabilitation and Recovery Assessment" held in 2016 IEEE/ASME AIM Conference, Banff, AB, Canada. He is a technical co-chair of the "Symposium on Advanced Bio-signal Processing for Rehabilitation & Assistive Systems", which will be held in 2017 IEEE GlobalSIP, Montreal, Canada. He is a co-organizer of the Special Session on "Bio-Signal Processing for Movement Assessment, NeuroRehabilitation and Assistive Technologies", which will be held in 2017 IEEE SMC, Banff, AB, Canada.