Department of Biomedical Engineering
Graduate Seminar

Postdoctoral Research Showcase Seminars

Subject: How Molecular Structure Influences Biomaterial Function

Dr. Amanda Acevedo-Jake, Ph.D.
Post-Doctoral Research Associate, BME, NJIT

Abstract:

Found in all domains of life, and the most abundant protein in mammals, the collagen triple helix provides structural integrity to tissues, plays crucial roles in immunity and infection, and regulates many ubiquitous biological processes. Disruptions to its canonical primary (Xaa-Yaa-Gly) n sequence repeat cause distinct structural alterations to the triple helix and result in lethal phenotypes in the disease Osteogenesis Imperfecta. Using a series of NMR experiments, we correlate specific single amino acid substitutions to observed clinical phenotypes; from our work we show that the most severe Osteogenesis Imperfecta phenotypes arise from the largest deviations away from expected molecular structure of collagen, and generate NMR-guided Rosetta-based models to visualize these specific disruptions.

In a second project, a mechanical bond is introduced along the backbone of an oligonucleotide mimic, generating the first synthetic DNA-rotaxanes. For over 50 years, the mechanical bond has been observed to alter the behavior and physical properties of naturally occurring biomolecules such as microcin J25 and catenanted DNA, where its incorporation can both stabilize the biopolymer against degradation and prevent its biological activity. Here, we combine biocompatible 'click' DNA with a small macrocycle AT-CuAAC approach to selectively prepare new DNA-rotaxanes, in which the macrocycle encircles a biocompatible triazole-linked axle analogue of the E. coli T7 promoter sequence. While the non-interlocked axle forms a stable duplex with T7 reverse and is biologically functional, the mechanically interlocked rotaxane-DNA does not, suggesting macrocycles can be used long-term to 'silence' the activity of oligonucleotides.

Bio:

Dr. Amanda Acevedo-Jake is beginning her second postdoctoral research associate role in the lab of Prof. Vivek Kumar in the Department of Biomedical Engineering at NJIT. Her research interests focus on designing functional mimetic biomaterials, characterization of their inherent physical and structural properties, and their use for specific targeted biological applications. She obtained dual B.Sc. degrees in Chemistry in Biochemistry (College of Charleston 2010), and as an undergraduate gained experience in strong base synthetic methodology of bioactive compounds as well as in the functionalization of fullerene-based materials for energy storage and Electronic applications. She received her PhD under the supervision of Prof. Jeff Hartgerink (Rice University 2017) working on the design and self-assembly of collagen-mimetic peptides. After this she moved to the labs of Profs. Ali Tavassoli and Steve Goldup (University of Southampton, England) where she completed her first PDRA role in the development of DNA-rotaxanes. Her current research focuses on using peptide-based hydrogels as a platform for biomedical applications such as wound healing, tissue regeneration, drug delivery and modulating infection and inflammation.

Department of Biomedical Engineering
Graduate Postdoc Seminar

Subject: Learning Balanced Motion Controller for a Novel Rehabilitation Exoskeleton

Dr. Shuzhen Luo, Ph.D.
Post-Doctoral Research Associate, BME, NJIT

Abstract:

A significant challenge for the design and control of a robotic lower extremity rehabilitation exoskeleton is to maintain the balance during programmed tasks or motions, which is crucial for the safety of the mobility-impaired human operator. Due to the differences in the degree of mobility impairment, the human-exoskeleton interaction forces are unpredictable and could vary substantially and cause conventional motion controllers to behave unreliably or robot to fall down. In this work, we propose a new, reinforcement learning-based, motion controller for a novel rehabilitation exoskeleton, aiming to produce well balanced motion with efficiency and robustness. Unlike most existing rehabilitation exoskeletons, our exoskeleton has actuated ankles and is equipped with multiple foot force sensors to measure ground reaction forces (GRFs) and compute the foot center of pressure (CoP), an important indicator of balance. This proposed balanced motion controller takes advantage of the CoP information by incorporating it in the state input of the policy network and adding it to the reward during the learning. In addition, we use dynamics randomization and adversary force perturbations during the training to further improve control robustness. To evaluate the effectiveness of our learning controller, we conduct numerical experiments with different settings to demonstrate the remarkable ability of the controlled exoskeleton to repetitively perform well balanced squatting motions under strong perturbation or human interaction forces.

Bio:

Shuzhen Luo is currently a postdoctoral research associate in the lab of Prof. Alex Zhou in the Department of Biomedical Engineering at NJIT. She graduated from Nankai University, with a Ph.D. degree in control science and engineering. Her Ph.D. work was in the area of dynamic modeling and disturbance rejection control for the powered parafoil robot. For one year following her graduation she was at the Robotics, Automation and Mechatronics (RAM) Lab in Rutgers and worked in the Non-uniform rational basis spline (NURBS)-based modeling and model predictive control of soft robots. Her research interests include dynamic robotic control, reinforcement learning and active disturbance rejection control. She is currently working on the reinforcement learning-based balance control for rehabilitation exoskeleton robots.

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