# AHAD BEHBOODI, MSc, PhD

LinkedIn
Google Scholar

+1 (201) 994-6630
Ahadbeh@udel.edu

**Assistant Professor at UNO Biomechanics, Founder of Elasthetics LLC**

## Research Interest:

As a researcher and entrepreneur, my focus lies in translational research dedicated to advancing pediatric rehabilitation technologies that foster motor learning. My research comprises three fundamental components: 1) design and implementation of rehabilitation systems to improve gait; 2) investigate the effects of such systems at the functional, biomechanical, and cortical levels; and 3) timely market translation of effective systems. My main research projects include:

- **BCI-mediated neurofeedback:** Employing deep learning to create EEG-based brain-computer interface (BCI) systems, for motor rehabilitation.
- **Artificial muscle:** Designing and implementing comfortable exoskeletons based on soft actuators; this initiative led to the establishment of Elasthetics LLC, a spinoff stemming from this project.
- **Task-specific NMES:** Developing rehabilitation protocols based on neuromuscular electrical stimulation (NMES)-assisted gait training, BCI-driven NMES for improving , and motor coordination and NMES-assisted cycling exercise.

## Education:

2013 – 2019 University of Delaware (UDel), Newark, USA

**Department of Physical Therapy (#1 nationally, U.S. News and World Report)**

**PhD:** Biomechanics and Movement Science

Thesis: An Artificial Skeletal Muscle for Use in Pediatric Rehabilitation Robotics

Advisor: Samuel C.K. Lee

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2008 – 2011 Iran University of Science and Technology, Tehran, Iran

**M.Sc.**: Biomedical Engineering-Bioelectronics

Thesis: Designing and Implementing Microcontroller Based FES Cycling System, with Simultaneous Control of System Power and Crank Velocity, Using TMS320f2812 Microcontroller.

Advisor: Abbas Erfanian-Omidvar

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2003 – 2008 Shahed University, Tehran, Iran

**B.Sc.:** Biomedical Engineering-Clinical

Thesis: A Brain Computer Interface for Classification of left vs right hand motor imagery.

Advisor: Ali Motie Nasrabadi

## Professional Experience

August 2023 University of Nebraska Omaha (UNO), Omaha, NE

*Assistant Professor at Department of Biomechanics*

2023-present National Institutes of Health (NIH), Bethesda, MD
*Special Volunteer at Neurorehabilitation and Biomechanics Research Section (NAB) Lab.*

2020-2023 National Institutes of Health (NIH), Bethesda, MD
*Post-doctoral Fellow at Neurorehabilitation and Biomechanics Research Section (NAB) Lab.*
*Mentor: Diane Damiano PT, PhD.*

2019-Present Elasthetics LLC, Newark, DE
*Founder and CEO*

2019-2020 University of Delaware, Newark, DE
*Post-doctoral Fellow Venture Development Center,*
*Entrepreneurship Mentors: Christina Pelican, Daniel Freeman, Derek Lehane; Technical Mentor: Samuel C.K. Lee, PT, PhD*

2016-2017 GoBabyGo, Newark, DE
*Lead Research Engineer at (GoBabyGlobal)*

2013-2019 University of Delaware, Newark, DE
*Full-Time Graduate Research Assistant in the Pediatric Mobility Lab*

2013-2019 Shriners Hospitals for Children, Philadelphia, PA
*Graduate Student Researcher*

2009-2012 Nad-Co (https://www.nadcosharif.com/ an educational company), Karaj, Iran
*CEO the Karaj branch*

2009-2011 Iran Neural Technology Center, Tehran, Iran
*Graduate Research Assistant*

## COMPLETED RESEARCH

**A Soft Smart Ankle Foot Orthosis Powered by Artificial Muscle for Children with CP.**

PI: Ahad Behboodi

This project, born from my dissertation on artificial muscle technology, is led by a team of 3-5 undergraduates and various collaborators. Alongside technical development, My role involved fundraising, regulatory activities, and establishing critical partnerships. At the heart of Elasthetics LLC lies the DE-AFO, a compact, noiseless, and smart ankle-foot orthosis created to aid children with ankle control deficiencies, enabling easier and extended walking. Using dielectric elastomer-based artificial muscles, this orthosis corrects pathological gait, potentially improving mobility and social integration by enhancing ankle motion and increasing walking efficiency for its users.

**Design and Evaluation of a Neurofeedback System for Training the Lower Limb Motor Coordination in Children with Cerebral Palsy (CP).**

Role: Lead Researcher PI: Diane Damiano

NIH internal funding; protocol #13-CC-0110

I led a team comprising three post-bachelor's biomedical and mechanical engineers to design and implement a real-time brain-computer interface (BCI)-mediated neurofeedback training system for motor rehabilitation using the associative learning paradigm. We evaluated the system's efficacy on children with CP. The system recorded cortical activities through EEG measurements and predicted movement intention using deep learning models. Subsequently, we provided assistance and proprioceptive feedback via functional electrical stimulation, aiming to aid in the motor rehabilitation of the children involved.

**Analyzing Cycling Performance of Children with CP**

PI: Samuel C.K. Lee

NIH's Eunice Kennedy Shriver National Institute of Child Health and Human Development
(grant # R01HD062588-01A1)

The aim was to analyze EMG and crank angle data obtained from 40 children with CP while they cycled on a recumbent tricycle. I collaborated with a mechanical engineer and a physical therapist to develop the signal processing pipeline. We introduced and explored novel processing techniques aimed at quantifying cycling performance aspects such as smoothness, co-activation, and muscle activation timing, addressing the specific anomalies observed in this population.

**Artificial Muscles for Mechanizing a Unilateral Pediatric Shoulder/Elbow Orthosis**

Role: Lead Researcher PI: Samuel C.K. Lee

Funded by Shriners Hospitals for Children (Grant #87500-PHI17)
NIH DE-CTR ACCEL (Grant # U54-GM104941)

Under Dr. Lee's guidance, I conceived the notion of employing dielectric elastomer artificial muscles in pediatric rehabilitation. I facilitated the introduction of artificial muscle technology into Dr. Lee's Lab by forging collaborations with pioneers in the field, including Dr. Federico Carpi and Dr. Gabor Kovacs. As the Principal Investigator, mentored by Dr. Lee, I authored multiple successful grant applications, securing approximately $200k in funding for the project. The primary objective focused on developing and implementing a unilateral exoskeleton utilizing DE-based artificial skeletal muscles. These muscles, characterized by their low weight, acoustic silence, and compliance, aimed to enhance the organic sensation of rehabilitation robots, potentially increasing their acceptance within the field.

**FES Assisted Walking System to Improve Fitness and Strength in Children with CP**

PI: Samuel C.K. Lee

Funded by Shriners Hospitals for Children (grant #71011).

I led the engineering endeavor in this project, centered on developing and assessing an FES system and training regimen intended for clinical deployment to address crouch gait. We evaluated the immediate and training effects of this system on children with CP. My primary focus involved designing and implementing the system in LabVIEW. This system could detect seven phases of gait within the CP population using two shank-attached inertial measurement units (IMUs) and perform real-time stimulation of up to five lower extremity muscles on each side.

**FES Assisted Cycling to Improve Fitness and Strength in Adults with Spinal Cord Injury**

PI: Abbas Erfanian-Omidvar

In this project, I modified a stationary recumbent cycling device to incorporate functional electrical stimulation, aiming to improve cardiovascular activities and muscle strength among individuals with spinal cord injuries. Using C++ and a Texas Instruments microcontroller, I developed a system capable of simultaneously controlling motor velocity and cycling power. This system utilized the Super Twisting Sliding Mode control algorithm.

## LEADERSHIP

2020-Present Neurofeedback Project at NIH

Lead a team of two biomedical (one male, one female) and one mechanical engineers (male) at **National Institutes of Health** (NIH) Rehabilitation Medicine Department. Implementing a real-time brain computer interface (BCI) system for rehabilitation application based on neurofeedback motor learning paradigms.

2019-Present DE-AFO project at UDel

Conceptualizing the idea of a comfortable and smart ankle-foot orthosis for children with cerebral palsy (DE-AFO) using dielectric elastomer actuators. Securing ~$350K of funding for the project. Established a startup called **Elasthetics LLC**. Led a team of two undergraduate mechanical engineers, one undergraduate electrical engineer, two scientific consultants (two females), a physical therapist, and two business advisors (one female).

2016-2019 Artificial Skeletal Muscle Project at UDel

Conceptualizing the idea of using soft actuator (Dielectric Elastomer) for pediatric rehabilitation robotics. translating the knowledge to the lab by establishing collaboration with a pioneer research group in Europe led by Dr Federico Carpi. Securing ~$200K funding for the project. Led a team of two under graduate mechanical engineering students.

2017-2018 GoBabyGo

Led a team of three undergraduate engineering students (one female) to design an electrical circuit for modifying ride on cars for children with movement disabilities. The modification was used in multiple GobabyGo events including an event sponsored by Philadelphia Eagles and Children's Hospital of Philadelphia in Lincoln Financial Field.

2011-2013 NadCo

CEO of a robotic education company in Karaj, Iran. Led a team of seven staff members 20 teachers which provided the required hardware, software, curriculum and instructors for teaching robotics to more than 1500 students in 30 high, middle and elementary schools.

## HONORS AND AWARDS

2020 The Center for Translation of Rehabilitation Engineering Advances and Technology (TREAT) Commercialization Assistance Program. NIH P2CHD086841.

2019 American Congress of Rehabilitation Medicine's (ACRM's) LaunchPad Most Innovative award, for "Soft Ankle Foot Orthosis Powered by Artificial Muscle, DE-AFO."

2019 University Science Center's QED program Awardee. QED is a competitive $200K proof of concept funding for 20 institutes in Pennsylvania, Delaware, and New Jersey.

2017 Head of the engineering team (Six biomedical and mechanical engineers, 2 females) for one of the biggest charitable GoBabyGo events, FlyBabyFly event for the Philadelphia Eagles' roster in Lincoln Financial Field, with more than 15 participating teams from major organizations including American Airlines and Toyota. The goal of this event was to modify ride-on cars for children with disabilities.

2015 Chosen student participant for the IEEE Signal processing summer school in Pavia, Italy.

## PATENT

Behboodi A, Lee SC, Binder-Macleod SA, Wright H, inventors; University of Delaware, assignee. *"Modular Artificial Skeletal Muscle Actuators and Exoskeletons Powered Thereby."* United States patent application US 17/117,904. 2021 Apr 29.

## GRANTS

2020 Pennsylvania Pediatric Device Consortium, funded by FDA, through Children's Hospital of Philadelphia (CHOP). "Soft Ankle Foot Orthosis Powered by Artificial Muscle, DE-AFO." PI: **Behboodi**. $50k.

2019 Philadelphia University City Science Center QED award. "Soft Ankle Foot Orthosis Using Artificial Muscle, DEAFO". PI: **Behboodi**. $185K

2019 The University of Delaware's Horn Entrepreneurship Program **Post-Doctoral Innovation Fellowship, $75k**.

2018 NSF I-Corps Team, project # 1906128. "Soft Ankle Foot Orthosis Using Artificial Muscle, DEAFO". PI: **Behboodi**. $50K

2017-2018 NIH DE CTR ACCEL, Grant # U54-GM104941. "Artificial Muscles for Mechanizing a Unilateral Pediatric Shoulder/Elbow Orthosis" No-Cost Extension. PI: Lee. (Behboodi, %50 effort). $40K

Role: Conceptualization. Lead on writing the research plan. Execution.

2016-2017 NIH DE-CTR ACCEL, Grant # U54-GM104941. "Artificial Muscles for Mechanizing a Unilateral Pediatric Shoulder/Elbow Orthosis". PI: Lee. (Behboodi, %50 effort). $80K

Role: Conceptualization. Lead on writing the research plan. Execution.

2016-2018 Shriners Hospital for Children, Grant #87500-PHI17. "Artificial Muscle Actuators for Mechanizing an Upper Extremity Exoskeleton Orthosis". PI: Lee. (Behboodi, %50 effort) $120K

***Role***: Conceptualization. Lead on writing the research plan. Execution.

2018 NSF I-Corps Site, Grant # 1347329. *"Soft Ankle Foot Orthosis Using Dielectric Elastomer, DEAFO"*. $3K

***Role***: Conceptualization. Lead on writing the research plan. Execution.

## MEDA COVERAGE

2021 *UD Research:* ***FRONT END OF DISCOVERY: HELPING CHILDREN MOVE***

2020 *CHOP:* ***SEED FUNDS AWARDED TO FOUR PROPOSALS TO DEVELOP MEDICAL DEVICES FOR CHILDREN***

The Venture Development Center and Physical Therapy Department at the University of Delaware are collaborating to develop the DE-AFO

2019 *UDaily:* ***ARTIFICIAL MUSCLE POWER***

UD research team funded to develop medical device for children with cerebral palsy

2019 *O&P EDGE:* ***UNIVERSITY RESEARCHER AWARDED FOR ORTHOSIS DEVELOPMENT***

2019 *EurekAlert (a service of the American Association for the Advancement of Science (AAAS)):****ARTIFICIAL MUSCLES' TO HELP CHILDREN WITH CEREBRAL PALSY***

## PUBLICATIONS

**Under Review:**

- Bulea T, **Behboodi** A, Lee W, Damiano D. *"Online application of independent component analysis to isolate cortical sources for EEG-based brain machine interfacing applications: toward real-time control and feedback"* IEEE Transactions on Neural Systems and Rehabilitation Engineering information.

**Peer Reviewed Journal Papers:**

- **Behboodi** A, Hinchbereger T, Lee W, Damiano D. "*Determining Optimal Mobile Neurofeedback Methods for Motor Neurorehabilitation in Children and Adults with Non-progressive Neurological Disorders: a Scoping Review."* Journal of NeuroEngineering and Rehabilitation.
- Kahlon SA, Verma K, Sage A, Lee SCK, **Behboodi** A**.** *"Enhancing wearable gait monitoring systems: identifying optimal kinematic inputs in typical adolescents."* Sensors.
- **Behboodi** A, Sansare A, Zahradka N, Lee SCK. *"Case Report: The Gait Deviation Index may predict the neurotherapeutic effects of FES-assisted gait training in children with cerebral palsy"* Frontiers in Rehabilitation Sciences.
- Kahlon, A, Sansare A, **Behbood** A, (2022) *"Remote Gait Analysis as a Proxy for Traditional Gait Laboratories: Utilizing Smartphones for Subject-Driven Gait Assessment across Differing Terrains."* Biomechanics.
- Sansare A, **Behboodi** A, Johnston TE, Bodt B, Lee SCK. (2021) *"Characterizing Cycling Smoothness and Rhythm in Children with and without Cerebral Palsy"*. Frontiers in Rehabilitation Sciences.
- Zahradka N, **Behboodi** A, Sansare A, Lee SCK. (2021) *"Evaluation of Individualized Functional Electrical Stimulation-Induced Acute Changes during Walking: A Case Series in Children with Cerebral Palsy."* Sensors.
- Zahradka N, Verma K, **Behboodi** A, Bodt B, Wright H, Lee SCK. (2020) *"An Evaluation of Three Kinematic Methods for Gait Event Detection Compared to the Kinetic-Based 'Gold Standard."* Sensors.

- Zahradka N, **Behboodi** A, Wright, H., Bodt, B, Lee SCK. (2019) *"Evaluation of Gait Phase Detection Delay Compensation Strategies to Control a Gyroscope-Controlled Functional Electrical Stimulation System During Walking*." Sensors.
- **Behboodi** A, Zahradka N, Wright H, Alesi JF, and Lee SCK. (2019). *"Real-Time Detection of Seven Phases of Gait in Children with Cerebral Palsy Using Two Gyroscopes."* Sensors.
- **Behboodi** A, Zahradka N, Alesi JF, Wright H, Lee SCK. (2019) *"Use of a novel functional electrical stimulation gait training system in 2 adolescents with cerebral palsy: a case series exploring neurotherapeutic changes"* In Physical therapy.

**Peer Reviewed Conference Papers**

- **Behboodi** A, Lee W, Damiano D. (2022) *"Evaluation of Multi-Layer Perceptron Neural Networks in Predicting Ankle Dorsiflexion in Healthy Adults Using Movement-Related Cortical Potentials for BCI-Neurofeedback Applications."* In 18th IEEE International Conference on Rehabilitation Robotics (ICORR).
- **Behboodi** A, and Salehi S. (2017) *"SDRE controller for motion design of cable-suspended robot with uncertainties and moving obstacles."* In IOP Conference Series: Materials Science and Engineering.
- **Behboodi** A, Wright H, Zahradka N, and Lee SCK. (2015) *"Seven phases of gait detected in real-time using shank attached gyroscopes."* In 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC).
- **Behboodi** A, Alesi J, Lee SCK. (2021*) "An Artificial Skeletal Muscle for Use in Pediatric Rehabilitation Robots"* In Amir Jafari and Nafiseh Ebrahimi (Eds), Soft Robotics in Rehabilitation. Amsterdam, Netherland: Elsevier.
- Lee SCK, **Behboodi** A, Alesi J, Wright H. (2020) *"Functional Electrical Stimulation Interventions for Children and Youth with Cerebral Palsy"* In: Miller F., Bachrach S., Lennon N., O'Neil M. (Eds) Cerebral Palsy. Berlin, Germany: Springer.

**Book Chapters**

- **Behboodi** A, DeSantis C, Lubsen J, Lee SCK. (2020) "*A Mechanized Pediatric Elbow Joint Powered by a De-Based Artificial Skeletal Muscle."* In 42nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC).
- **Behboodi** A, Lee SCK, (2019) *"Benchmarking of a Commercially Available Stacked Dielectric Elastomer as an Alternative Actuator for Rehabilitation Robotic Exoskeletons."* In 16th IEEE International Conference on Rehabilitation Robotics (ICORR).

## PRESENTATIONS

**Podium Presentations (Abstract)**

- RehabWeek-IEEE International Conference on Rehabilitation Robotics (ICORR), 2022 "Evaluation of Multi-Layer Perceptron Neural Networks in Predicting Ankle Dorsiflexion in Healthy Adults Using Movement-Related Cortical Potentials for BCI-Neurofeedback Applications." **Behboodi** A, Lee W, Bulea T, Damiano D.
- Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2020 "A Mechanized Pediatric Elbow Joint Powered by a De-Based Artificial Skeletal Muscle." **Behboodi** A, DeSantis C, Lubsen J, Lee SCK.

- IEEE Engineering in Medicine and Biology Society (EMBC), 2015 "Seven phases of gait detected in real-time using shank attached gyroscopes." **Behboodi** A, Wright H, Zahradka N, Lee SCK.

- Iranian Conference on Electrical Engineering, 2012. "Implementation of DSP Based FES-Cycling System with Control of Crank velocity." **Behboodi** A, Erfanian A.

**Poster Presentations (Abstract)**

- International Conference on Mobile Brain/Body Imaging (MoBI), 2022. "*Motor Attempt or Motor Imagery? The Effect of Brain-State on Functional Outcomes of Brain Computer Interface (BCI)-Mediated Neurofeedback Training for Stroke: A Scoping Review."* **Behboodi** A, Lee W, Hinchberger T, Damiano D.
- International Conference on Mobile Brain/Body Imaging (MoBI), 2022. *"BCI-Neurofeedback Training for Neurorehabilitation: a scoping review to identify optimal strategies for promotion or recovery of motor function."* **Behboodi** A, Lee W, Hinchberger T, Damiano DL.
- IEEE International Conference on Rehabilitation Robotics (ICORR), 2019. *"Benchmarking of a Commercially Available Stacked Dielectric Elastomer as an Alternative Actuator for Rehabilitation Robotic Exoskeletons."* **Behboodi** A, Lee SCK.

- International Cerebral Palsy Conference, 2016. *"Real-time Detection of 7 Phases of Gait in Children with CP Using Minimized Sensor Setup."* **Behboodi** A, Wright H, Zahradka N, Lee SCK.

- Gait and Clinical Movement Analysis Society Annual Conference (GCMAS), 2014. *"A Combined IMU and FSR System for Detecting 7 Phases of Gait in Real-Time."* **Behboodi** A, Zahradka N, Lenoir K, Marion MS, Wright H, Zarkou A, Torres M, Sazonov E, Lee SCK.

**Other Abstracts:**

- International Mobile Brain/Body Interaction Conference (MoBI), 2022. *"Investigation of Independent Component Analysis for use in Brain-Computer Interface Neurofeedback Paradigms for Motor Rehabilitation."* Lee W, **Behboodi** A, Bulea T, Damiano D.

- European Academy if Childhood Disabilty (EACD), 2022. *"Scoping review on neurofeedback training strategies most strongly associated with improved motor function for pediatric neurorehabilitation applications"* **Behboodi** A, Lee W, Hinchberger T, Damiano D.

- American Physical Therapy Association's Combined Sections Meeting (CSM), 2022. *"Absent Acute Kinematic Improvements of FES-Assisted Walking Are Not Indicative of Training Effects with FES."* Sansare A, **Behboodi** A, Zahradka N, Lee SCK.

- SPIE Photonics West BiOS, 2022 *"Smartphone Sensor Application for Gait Analysis."* Kahlon A, **Behboodi** A, Sansare A.

- Combined Sections Meeting (CSM), 2021. *"Aerobic Response to FES-Assisted and Volitional Cycling in Children with Cerebral Palsy"*. Sansare A, **Behboodi** A, Jain A, Harrington AT, Lee SCK.

- American Academy of Cerebral Palsy and Developmental Medicine (AACPDM), 2020. "A Comparison of Cycling Smoothness, Rhythm And Cadence In Children With And Without Cerebral Palsy" Sansare A, **Behboodi** A, Alesi JF, Lee SCK.

- American Academy of Cerebral Palsy and Developmental Medicine (AACPDM), 2020. "Stochastic Resonance Stimulation Improves Control Of Balance During Walking In Children With Cerebral Palsy: A Pilot Study" . Sansare A, Reimann H, **Behboodi** A, Lee SCK.
- Gait and Clinical Movement Analysis Society (GCAMS) Annual Conference, 2020. "A Comparison Of Kinematic-Based Foot Velocity, Shank Angular Velocity, Coordinate-Based Treadmill Algorithms In Detecting Heel-Strike And Toe-Off Kinetic Force Plate Data Of Children With And Without Cerebral Palsy, And Unimpaired Adults" Verma K, **Behboodi** A, Zahradka N, Bodt B, Lee SCK.
- A Gait and Clinical Movement Analysis Society (GCMAS) Annual Conference, 2019. "Effects of FES-assisted Recumbent Cycling on Children with Cerebral Palsy." Sansare A, **Behboodi** A, Alesi JF, Wright H, Lee SCK.
- Center for Biomechanical Engineering Research Day, 2019. "Effects of FES-assisted Recumbent Cycling on Children with Cerebral Palsy." Sansare A, **Behboodi** A, Alesi JF, Wright H, Lee SCK.
- International Functional Electrical Stimulation Society Workshop, 2015. "A Gyroscope-Based Closed-Loop Feedback System for Delivery of Functional Electrical Stimulation During Walking." Zahradka N, **Behboodi** A, Wright H, Lee SCK.
- World Conference of Biomechanics, 2014. "A First Look at A Closed Loop IMU and FSR Based Feedback System for Delivery of Functional Electrical Stimulation During Walking." Zahradka N, **Behboodi** A, Lenoir K, Marion MS, Wright H, Zarkou A, Torres M, Sazonov E, Lee SCK.

**Invited Presentations**

- National Institutes of Health (NIH) Rehabilitation Medicine Department Grand Rounds, 2021. "Neuroprosthetic and Neurotherapeutic effects of Neuromuscular Electrical Stimulation (NMES) on Children with Cerebral Palsy (CP)."
- University of Delaware Biomechanics and Movement Science Seminar Series, 2021. "The effects of Neuromuscular Electrical Stimulation (NMES) on Children with Cerebral Palsy (CP)."
- University Science Center Annual Investor Meeting, 2019. "Soft Ankle Foot Orthosis Powered by Artificial Muscle; DE-AFO."
- American Congress of Rehabilitation Medicine (ACRM) Annual Conference, 2019. "Soft Ankle Foot Orthosis Powered by Artificial Muscle; DE-AFO."
- American Academy of Cerebral Palsy and Developmental Medicine (AACPDM) Annual Meeting, 2019. "Real-Time Gait Phase Detection and Electrical Stimulation Delivery in Children with CP."
- ACCEL Annual Meeting, Spring, 2018. "Artificial Muscles for Mechanizing a Unilateral Pediatric Shoulder/Elbow Orthosis."
- ACCEL annual; meeting, Spring 2017. "Artificial Muscles for Mechanizing a Unilateral Pediatric Shoulder/Elbow Orthosis.

## PROFESSIONAL SERVICE

**Grant Reviews**

National Science Foundation (NSF), Panel:221605 - Phase I SBIR/STTR: Rehabilitation & General Medical Devices

**Journal Reviews**

- Neurorehabilitation and Neural Repair, SAGE
- IEEE Transactions on Neural Systems and Rehabilitation Engineering
- International Journal of Environmental Research and Public Health (ISSN 1660-4601)
- Sensors, MDPI (ISSN 1424-8220)
- Machines, MDPI (ISSN 2075-1702)
- Symmetry, MDPI (ISSN 2073-8994)

## MENTORSHIP

**Arjan Kahlon:** Arjan conducted a remote gait analysis project, under my mentorship, during his senior years in high school. As the results of this project:

- he published a journal article as the first author at (see the publication section),
- won 3rd place at Delaware Valley Science Fair (DVSF), and Leon Reznik Memorial Award
- won 1st place at BioGENEius statewide competition
- Become BioGENEius International Finalist (1 of 14 worldwide);
- honored as a Regeneron Top 300 Scholar in their Science Talent Search.

Arjan is currently a pre-Med freshman at University of Pennsylvania.

**University of Delaware Senior Design 2021:** Mentored a team of four senior Biomedical Engineering students (three females)**.** Project title: *Detection and Visualization of Gait Events*.

**University of Delaware Senior Design 2020:** Mentored a team of five Biomedical Engineers, senior Biomedical Engineering students, with diverse ethnic background. Project title: *DE-AFO Enhancements*.

## OTHER ACCOMPLISHED PROJECTS and TECHNICAL SKILLS

2022 Investigated the classification accuracy of **Recurrent Neural Network** in prediction of ankle dorsiflexion attempt using **MATLAB Deep Learning toolbox**.

2021 Investigated the classification accuracy of Multi-Layer Perceptron **Neural Network** in predicting ankle dorsiflexion attempt classification and the effect of spatial filtering (e.g., Laplacian and Independent Component Analysis) using **PyTorch** framework.

2021 Investigated the effect of spatial filtering, including independent component analysis (**ICA**), Laplacian and common average referencing (CAR), event related potentials in EEG activation, using **EEGLab** toolbox in **MATLAB**.

2020 Investigated the feasibility and benefits of real-time independent component analysis (ICA) for EEG-based brain computer interface (BCI) applications, in **MATLAB**.

2021 Nonlinear analysis of gait in children with CP using Sample Entropy, Approximate Entropy and Lyapunov Exponent algorithms, in **MATLAB**.

2019 Proposed and evaluated a measure, based on cross correlation, to quantify cycling smoothness in children with CP, in **MATLAB**

2019 Quantified lower extremity muscles' co-contraction in children with, CP, using **EMG**, in **MATLAB**.

2018 Designed a **LabVIEW**-based test-rig, with ability to stream in laser displacement sensor, load cells, and control high voltage amplifiers. I used the test-rig for benchmark testing the mechanical properties of the CTsystems' stacked **dielectric elastomer actuator**, including strain, stress, strain-rate, reliability, electromechanical delay, hysteresis.

2017 Implemented **PID** algorithms in National Instruments (NI) **CompactRIO**-based testing setup, using **LabVIEW** real-time, for a civil engineering project with the capability to control velocity and torque of two stepper motors, simultaneously, while reading pressure, load, and torque sensors in real-time.

2015 Designed and implemented a rule-based real-time gait phase detection system for children with CP using a shank attached inertial measurement unit (**IMU**), in **LabVIEW**.

## WORKSHOP

2021 UC San Diego 2021 virtual EEGLAB workshop

2021 NIH Office of Intramural Training and Education (OITE) Management Boot Camp

2020 Center for Translation of Rehabilitation Engineering Advances and Technology (TREAT) Commercialization Advancement Cohort.

2019 NSF I-Corps Spring Cohort, Boston. "I-Corps enables the transformation of invention to impact. The curriculum integrates scientific inquiry and industrial discovery in an inclusive, data-driven culture driven by rigor, relevance, and evidence. Through I-Corps training, researchers can reduce the time to translate a promising idea from the laboratory to the marketplace."

2015 IEEE Engineering in Medicine and Biology Society (EMBC) Summer School on Advanced Biomedical Signal Processing, University of Pavia, Italy.