APT CENTER
WE BUILD TRANSLATION

First annual

2024 Spring i-Con

Inspire and Connect

Thursday, May 30, 2024; 1:00 p.m. – 6:00 p.m.

Tinkham Veale Ballroom,
Case Western Reserve University

Prizes for Students
1st place - $200 & registration to a future conference
2nd place - $100
3rd place - $50

Agenda

1:15 pm to 2:30 pm - Networking Workshop

Listen to an expert discuss methods of networking both in academia and the business world!

2:45 pm to 3:45 pm - Career Panel

Listen to our panel of industry experts and professors discuss their current careers and what helped them get to where they are today!

4:05 pm to 5:00 pm - Keynote Speaker Dr. Joseph Pancrazio

Joseph Pancrazio has a 30+ year career spanning academia and federal government working at the interface of bioscience and engineering. He currently serves as Vice President for Research and Innovation (VPRI) and Professor of Bioengineering at UT Dallas. In his role as VPRI, he oversees research funding, grants and contracts; campus research facilities and information systems; technology commercialization and licensing; venture development “incubator” facilities; and laboratory compliance and safety.

5:05 pm to 6:00 pm - Trainee Poster Session

i-Con Inspire and Connect

Poster 1 - Input/Output Properties of FES Reaching and Grasping for Control by a Brain Machine Interface

Benjamin Alexander

BJ Alexander[1,3], JT Krall[1,3], WD Memberg[1,3], AB Ketting-Olivier[1,3], JP Miller[2,3,4], RF Kirsch[1,2,3], AB Ajiboye[1,2,3]

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Often, brain machine interfaces are used to control synthetic end-effectors that have consistent mappings of inputs to outputs. Control of a participant's arm using functional electrical stimulation (FES) introduces novel challenges related to uncharacterized dynamics of the biological system and the interface with the stimulating electrodes.
Pulse width modulated kinematic recruitment curves (RCs) were acquired to quantify the resolution of the joint angles produced using different pulse amplitudes (PA) and different levels of cocontraction. Surprisingly, we found that increased PA, while corresponding to an increase in RC steepness, did not correspond to increased joint angle resolution. Similarly, incorporating linear cocontraction of the biceps and triceps, rather than increasing resolution through increased stiffness, showed no increase in resolution compared to the no cocontraction condition. Overall, these results indicate that different methods such as feedback control or force-balanced cocontraction are necessary to more accurately map stimulation parameters to joint angles.

Poster 2 - Predictive Simulation of Caregiver-Assisted Patient Sit-to-Stand Transfers

Md Asif Arefeen

MA Arefeen[1], RJ Triolo[1,2], ML Audu[1,2]

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Healthcare workers, especially caregivers who often engage in manual patient transfer duties, face the risk of developing musculoskeletal disorders due to their work. The purpose of this study is to develop a framework for predictive simulation of caregiver-assisted patient sit-to-stand during the transfer tasks. We propose a two-dimensional 8 degrees of freedom skeletal model for both the caregiver and the participant. The main aim is to use the model to predict the loads on the caregivers' shoulders and lower back with a realistic simulation of a typical assistive transfer. OpenSim Moco is utilized to solve this optimal control problem by minimizing the caregiver's control efforts. The predicted joint angles, joint torques, ground reaction force and joint reaction forces are presented. Future work involves conducting predictive simulations to explore the potential of stimulating specific paralyzed muscles in participants and assessing their impact on transfer effort.

Poster 3 - Effects of Curing Parameters on Electrical Resistivity of Aerosol-Printed Silver Circuits

Winifred Asante

W Asante[1], C Kromalic[2,3], E Blythe[1,3], JL Gbur[1,2,3]

[1]Biomedical Engineering, Case Western Reserve University; [2]Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center; [3]Materials Science and Engineering, Case Western Reserve University

Flexible electronics may provide a minimally-invasive alternative for biomedical sensors or leads. Traditionally, wire-based leads connect micro-fabricated electronics and other modules in the system for nerve stimulation. In this work, aerosol jet printing (AJP) is investigated as a new approach for creating flexible biomedical leads by depositing a metallic ink onto a substrate. Ink must be cured at a temperature high enough to evaporate solvents and time long enough to densify prints. In this work, an amorphous silicon carbide (a:SiC) film and nanoparticle silver ink were evaluated as a possible material pair for a flexible lead. Silver traces were printed onto an etched a:SiC film. Traces were tested at different curing temperatures (250 and 350°C) and times (3 and 4 hours) to find the combination that resulted in the lowest electrical resistance. Data from this study will help promote the development of a flexible printed lead.

Poster 4 - Optimization of Thermal Processing for Aerosol Jet Printed Silver Circuits

Peter Burdick

P Burdick[1], A Chen[2], JL Gbur[1]

[1]Materials Science and Engineering, Case Western Reserve University; [2]Biomedical Engineering, Case Western Reserve University

Aerosol jet printing (AJP), an additive manufacturing technique, allows for production of high-resolution microscale circuits with easily modifiable designs on non-planar substrates. While traditional, micro-fabrication relies on harsh conditions, AJP uses silver precursor ink, ensuring conductivity at lower temperatures and compatibility with soft polymer substrates. The optimization of thermal processing is necessary to achieve conductivity. In this study, a silver precursor ink offering high conductivity and low curing temperatures, was aerosol jet printed, onto a polyimide film substrate. The array of prints was sintered between 120-250°C maintaining consistent printing parameters. The prints were analyzed using optical microscopy, laser profilometry, and electrical measurements. Focused ion beam cross-sections investigated microstructural relationships based on sintering conditions. Visual conformity to design was analyzed using a custom MATLAB image analysis script. The findings will help determine optimal sintering times and temperatures for aerosol jet printed silver circuits.

Poster 5 - Testing and Analysis for Improving Inductive Wireless Power Transfer
Reilly Burhanna

R Burhanna[1], S Majerus[1,2]

[1]Electrical, Computer, and Systems Engineering, Case Western Reserve University; [2]Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center

Inductive wireless power transfer (WPT) is increasingly utilized as an alternative form of charging in various fields. It is particularly important in regard to medical implants, which benefit from non-invasive charging methods for increased safety of patients. Despite the continued application of inductive WPT, it still has numerous limitations and challenges. Some of these issues are explored in this work along with potential improvements such as closed loop charging and ferrite amplification. Using the Networked Neural Prosthesis(NNP) charging system, these challenges and potential solutions were explored. Temperature testing on the implant itself showed the complications of using a titanium enclosure due to Eddy currents. Studying feedback directly from the transmitter via a monitor coil shows possible benefits of using the monitor coil as feedback. Lastly other improvements to the system were explored, such as the application of ferrite sheets to increase coupling of the charging system.

Poster 6 - Investigating the Change in Bacterial Populations Following Sterile Brain Microelectrode Implantation
Grace Burkhart

GF Hoeferlin[1,2], S Grabinski[3], LN Druschel[1,2], JL Duncan[1,2], G Burkhart[1], GR Weagraff[2,4], AH Lee[1,2], C Hong[1,2], M Bambroo[1,2], H Olivares[1,2], T Bajwa[1,2], W Memberg[1,5], J Sweet[5,6], H Hamedani[2,7], AP Acharya[1], AG Hernandez-Reynoso[8], C Donskey[5,9], G Jaskiw[5,10], ER Chan[11], AB Ajiboye[1,5], HA von Recum[1,2], L Zhang[3,12], JR Capadona[1,2]

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Brain-machine interface performance is affected by the neuroinflammatory responses resulting partly from blood-brain barrier (BBB) damage following intracortical microelectrode implantation. Findings suggest that gut bacterial constituents penetrate the BBB and reside in brain regions of rodents and humans. Therefore, we hypothesized damage to the BBB caused by microelectrode implantation could amplify dysregulation of the microbiome-gut-brain axis. We found bacteria present in the brain of mice previously implanted with sterile silicon microelectrodes. Systemic antibiotic treatment of implanted mice resulted in differential expression of bacteria in the brain and a reduced acute inflammatory response compared to untreated controls, correlating with temporary improvements in recording performance. Further research using microelectrodes coated with antimicrobial Titania Nanotube Arrays will investigate the effect of TNA on the neuroinflammatory response at the implant site. These arrays serve as a novel platform for loading microelectrodes with drugs to impact the neuroinflammatory damage seen after implantation.

Poster 7 - Development of Pulsatile Phantom Towards Improvement of Optical Blood Pressure Sensors

Dario Cabal

D Cabal[1,2], S Majerus[1,3]

[1]Electrical, Computer, and Systems Engineering, Case Western Reserve University; [2]The MetroHealth System; [3]Louis Stokes Cleveland VA Medical Center

Photoplethysmography is a well published subject which involves the use of a photodiode and LED to observe changes in blood perfusion of surrounding tissue to determine heart rate and blood oxygenation. Among the developing usages for this style of technology is the implementation of photoplethysmography to estimate blood pressure which can be immensely helpful towards the continuous monitoring of health conditions such as autonomic dysreflexia. To test and improve on this technology, a pulsatile phantom was developed consisting of a SHURFLO water pump and a custom designed EcoFlex silicone rubber mold that mimics the optical properties of human tissue with underlying pulsatile activity. Testing of this phantom reveals initial success in the generation of a pulsatile waveform with pressure monitoring that mimic optical properties of human tissue. This phantom has also provided new insight towards testing of an experimental setup which aims to improve reliability of subcutaneous PPG data recording.

Poster 8 - Long-Term Home Use of a Wirelessly Connected Bidirectional Neuroprosthesis for Upper Limb Loss

Sedona Cady

S Cady[1], JM Lambrecht[1,2], C Cowen[2], EL Graczyk[1,2], DJ Tyler[1,2]

[1]Biomedical Engineering, Case Western Reserve University; [2]Louis Stokes Cleveland VA Medical Center

Despite advances in commercial upper limb prostheses, many users abandon prostheses due to limitations in function and sensation. To restore function and touch feedback, we developed a high-channel-count implantable device with wireless communication: the implanted Somatosensory Electrical Neurostimulation and Sensing (iSens) system. iSens activates peripheral nerves using extraneural cuff electrodes and records myoelectric signals using intramuscular electrodes. We hypothesized that iSens home use would improve psychosocial outcomes compared to a state-of-the-art prescribed prosthesis. One individual with a transradial amputation received iSens and used a DEKA/LUKE arm with force sensors, touch sensations, and 3 degree-of-freedom control during a 90-day home trial. Phantom limb length became more aligned with the intact limb. Psychosocial improvements were observed compared to baseline. Functional improvements across time suggest motor learning. This study shows the benefits of using iSens and may facilitate translation of bidirectional neuroprostheses.

Poster 9 - Determining Muscle Activation Timing During Exoskeletal-Assisted Walking with an Electrical Stimulation Subsystem

Mac Camardo

SK Hnat[1,2], MA Camardo[1,2], M Fitzpatrick[1,3], NS Makowski[2,4,5], RJ Triolo[1,2]

[1]Biomedical Engineering, Case Western Reserve University; [2]Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center; [3]Mechanical and Aerospace Engineering, Case Western Reserve University; [4]The MetroHealth System; [5]Physical Medicine and Rehabilitation, Case Western Reserve University

Adding surface electrical stimulation to robotic exoskeletons may enhance effectiveness of exercise for individuals with lower-limb paralysis beyond that achievable by either one in isolation, and thereby further reduce secondary health complications, such as muscle atrophy. We developed an algorithm that determines timing of electrical stimulation applied to hamstrings, gluteus maximus, and quadriceps based on inertial measurement units (IMUs) mounted on a commercially available lower-limb exoskeleton. The algorithm uses the IMU data as input and outputs neural stimulation timing as a Boolean for each time-step to indicate whether the muscle is activated (1) or not (0) throughout the gait cycle determined by thresholds on the IMU data and the direction of limb movement. Based upon preliminary testing, we found our algorithm outputted the correct muscle activation signals 97.8% of the time when the knee is extending and 93.5% of the time when the hip is extending.

Poster 10 - Characterizing Locations of Stimulation on Tibial and Sciatic Nerves in Relation to Location and Properties of Elicited Percepts

Srikanth Chavali

S Chavali[1], H Charkhkar[1], RJ Triolo[1,2]

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One of the significant challenges presented to users of lower limb prostheses in daily life is the increased danger of falls due to reduced sensory feedback from the prosthetic foot. Current explorations into restoring plantar sensation are limited primarily in the spatial resolution and ability to evoke continuous positional change in elicited percepts.

We aim to develop a system that restores granular and continuous plantar sensation across the foot. Our goal in this study is to identify contacts in implanted 16 C-FINEs that can be used to elicit percepts localized to several key regions across the plantar foot. Participants are asked to stand and shift their weight onto a specific part of the prosthetic foot while receiving 5 seconds of electrical stimulation of varying charge densities and describe the resulting percept. Stimulation from certain contacts resulted in consistent percepts localized to the toes, midfoot, heel, medial and lateral plantar foot.

Poster 11 - Assessing Spinal Reflex Excitability of Post-Stroke Stiff-Knee Gait During Locomotion

J. Sebastian Correa

JS Correa[1], R Siu[2], S Ramani[2], D Cunningham[2,4] J Sulzer[2,3,4]

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Stiff-Knee Gait (SKG) is a common disability following stroke often defined by a reduced swing phase knee flexion angle. A common hypothesis states SKG is caused by quadriceps reflex hyperexcitability. However, interventions aimed at reducing quadriceps activity are inconsistently effective, leading to questions about the spinal contributions towards hyperreflexia in SKG. The overall goal of this study is to assess the excitability of spinal circuits controlling quadriceps activation in people with SKG. To characterize such reflexes, we use three experiments to probe different circuits that allow us to make larger conclusions on pre-synaptic inhibition at rest and as it is modulated during gait. Preliminary results in non-disabled participants have shown feasibility of the methodology. Future work will investigate spinal reflexes in people with post-stroke SKG to help determine locomotion phase dependent spinal contributions of quadriceps spasticity.

Poster 12 - The Effect of Thermal Processing on Aerosol Jet Printed Silver Nanoparticle Ink for Flexible Electronics

Sylvie Crowell

S Crowell[1,2], JL Gbur[1,2]

[1]Materials Science and Engineering, Case Western Reserve University; [2]Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center

Aerosol jet printing (AJP) is an additive manufacturing technique that offers unique fabrication solutions for development of flexible, implantable microelectronics. Unlike conventional photolithographic microfabrication, AJP facilitates low-cost rapid prototyping of devices onto flexible, non-planar substrates. However, optimization of AJP thermal processing is necessary to achieve desirable properties such as high conductance and conformity to design. Two studies were conducted to investigate the effects of thermal sintering and a heated platen on silver nanoparticle ink AJP circuits. Printed specimens were thermally sintered in an oven between 125-250°C, and between 1-4 hours to determine effects on conductance, and focused ion beam sections were analyzed to study microstructure effects. Specimens were printed on a platen heated between 20-80°C and effects on conductance, deposition thickness, and visual conformity were investigated. The findings of this work are intended to aid in development of AJP flexible electronics for biomedical applications.

Poster 13 - Reconstructing Vagal Anatomy - REVA: Histology/Immunohistochemistry

Karim Elsharkawy

K Elsharkawy[1], Y Kim[1], E Cintron[1], J Coleman[1,2], O Rentsch[3], J D'Silva[1], N Pelot[4], A Shoffstall[1]

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The vagus nerve (VN) is a critical component of the autonomic nervous system, emerging as a target for neuromodulation therapies like vagus nerve stimulation (VNS). However, limitations exist in our understanding of VN anatomy, hindering optimal electrode placement specifically in the context of the treatment of epilepsy, which can cause disadvantageous side effects. The REVA project aims to bridge this gap by employing histological methods to validate and expand nerve morphology and characterization from other imaging modalities such as microCT. H&E staining will provide a structural analysis of the VN, including fiber organization and composition. Immunohistochemistry (IHC) will allow for targeted visualization of specific neuronal populations within the VN, enhancing our understanding of its functional organization. By reconstructing the VN's anatomy, REVA seeks to establish a comprehensive anatomical framework for VNS therapy, guiding the development of improved electrode designs and placement strategies, ultimately leading to more effective VNS treatment.

Poster 14 - A Hybrid Exoskeleton to Assist Walking for Stroke Survivors

Marshaun Fitzpatrick

M Fitzpatrick[1], L Lombardo[2], S Hnat[2,3], M Audu[2,3], R Triolo[2,3], R Quinn[1], N Makowski[2,4,5]

[1]Mechanical and Aerospace Engineering, Case Western Reserve University; [2]Louis Stokes Cleveland VA Medical Center; [3]Biomedical Engineering, Case Western Reserve University; [4]Physical Medicine and Rehabilitation, Case Western Reserve University; [5]The MetroHealth System

Poststroke hemiparesis can significantly limit walking ability. We have developed a unilateral, hybrid exoskeleton combining noninvasive neural stimulation and a motorized knee orthosis to enhance mobility after stroke. This study uses our hybrid exoskeleton to assess proof of concept in a stroke survivor to verify: (1) that the motor and transmission are sufficiently backdrivable to enable useful muscle-generated movements, (2) that the motor is capable of driving movement, and (3) that the combination of stimulation and motor generate beneficial kinematic changes exceeding that of stimulation or motor assistance individually. The device was evaluated on an ambulatory stroke survivor under four conditions: (1) without the device, (2) stimulation only while wearing the exoskeleton, (3) motor assistance only, and (4) hybrid assistance. Individually, neural stimulation and motor assistance resulted in improved gait kinematics and hybrid assistance saw greater improvement than each form of individual assistance.

Poster 15 - Impacts of Volitional Control on Adaptive Neuromuscular Electrical Stimulation

Ananya Sundararajan

A Sundararajan[1], J Golabek[2], M Audu[2], N Makowski[3]

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Neuromuscular electrical stimulation (NMES) has been shown to improve poststroke gait. Volitional control of walking is dynamic, which impacts the effectiveness of assistance. Assessing the impact of volitional control on adaptive NMES is necessary to improve assistance. A synergy approach was used to emulate volitional control. Muscles within synergies exhibit coactivation, following distinct activation patterns. Volitional control during the swing phase of gait was modeled using known able-bodied synergies, which produced activations and kinematics that matched measured swing patterns. Post-stroke impairments were modeled by introducing weakness in knee flexors/extensors, and hip extensors. Adaptive NMES is incorporated into the poststroke model to gain a preliminary understanding of how volitional control affects adaptive assistance. The next step will be to incorporate dynamic properties of volitional control. Understanding how adaptive NMES is impacted by a parallel model of volitional effort would inform potential application as an assistive device for stroke survivors.

Poster 16 - Sensitivity of Iterative Learning Control to Varying Initial Conditions for Gait Assistance

Justin Golabek

Justin Golabek[1], ML Audu[1], RJ Triolo[1], NS Makowski[2]

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Iterative Learning Control (ILC) is a promising method for adapting neuromuscular electrical stimulation to facilitate independent walking after upper motor neuron paralysis. However, assumptions made by conventional ILC methods, such as identical initial conditions for each iteration, are unsustainable in the case of human gait. In this study, we implement a musculoskeletal model of a single leg to analyze the consequences of variable initial conditions for data-driven ILC-based stimulation (DDILC) during swing phase of gait. We show that DDILC converges in all tested cases of initial hip angle variability, but that noise arises because of such variability. We also show that exploding gradients and instability eventually occur because of varying initial conditions, but that these can be mitigated with established techniques.

Poster 17 - Optimizing the Parameters of Aerosol Jet Printing Silver Ink onto Silicone

Anuvi Gupta

A Gupta[1,2], D Chirra[1,2], DB Shire[2], JL Gbur[1,2]

[1]Materials Science and Engineering, Case Western Reserve University; [2]Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center

Silicone (polydimethylsiloxane) is a common material in flexible point-of-care devices and wearable electronics. However, complex and expensive fabrication techniques hinder the development of these devices. One solution is aerosol jet printing, a method of aerosolizing a metallic ink or dielectric onto a polymeric substrate. In this work, the target application was a non-planar molded silicone insert for a medical device. It was characterized with digital optical microscopy and laser profilometry to collect surface information, which allows for understanding ink adhesion. Printing parameters for a silver precursor ink were developed, and an oven study was designed to determine optimal sintering procedures. The cured samples were characterized with digital optical microscopy and laser profilometry and then electrically tested to identify minimal resistance and overspray. Preliminary work provides data necessary to perform a larger optimization study with the aim of fabricating a high-density conductive array on a molded silicone insert.

Poster 18 - The Effect of High Frequency Sacral Root Stimulation on Lower Urinary Tract Function

Jia Han

J Han[1], B Hanzlicek[2], SJA Majerus[2,3], MS Damaser[2,4], DJ Bourbeau[2,5,6]

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Peripheral nerve stimulation at frequencies of 500-10,000 Hz is associated with reduction of muscle contraction. Reduction of urethral sphincter pressure may have the potential to promote bladder emptying without catheters. We implanted five healthy cats with nerve cuff electrodes bilaterally on sacral roots S1 and S2. Using wireless devices, we applied stimulation and measured bladder pressure and pelvic floor electromyogram (EMG). Stimulation was applied at frequencies of 20 Hz, 500 Hz, or 10 kHz, and amplitudes up to the tolerance limits of each animal. Stimulation at a frequency of 10 kHz was associated with significant reduction in EMG amplitude compared to stimulation at 20 Hz, suggesting blockade of the nerves that control the pelvic floor muscles. There was not a significant difference between EMG responses to 500 Hz and 20 Hz stimulation. These data indicate that high frequency sacral root stimulation has the potential to reduce pelvic floor activity.

Poster 19 - Comparing Elicited Sensation Between Individuals with Lower Limb Loss

Lindsey Hauck

L Hauck[1,2], H Morgan[1,2], R Triolo[1,2], H Charkhkar[1,2]

[1]Biomedical Engineering, Case Western Reserve University; [2]Louis Stokes Cleveland VA Medical Center

Individuals with lower limb loss face many challenges, including increased risk of fall, abnormal gait, and decreased balance. To help address these deficiencies, our lab has developed a method to restore plantar sensation to these individuals through stimulating the nerves in the residual limb via Composite Flat-Interface Nerve Cuff Electrodes (C-FINEs) and an external stimulator. We have demonstrated that this interface can successfully restore functional sensation for two individuals with transtibial amputation and one individual with transfemoral amputation. The interface for each individual resulted in a high percentage of contacts successfully eliciting sensation, distinct regions of restored sensation in functional areas, and a wide variety of sensation modalities. In comparing between ILLAs, we demonstrated that plantar sensation can be restored with this interface regardless of amputation level. In addition, while there are inter-participant differences, there are key similarities in successfully restoring functional plantar sensation.

Poster 20 - Cerebral Tissue Oxygenation during Electrically Stimulated Cycling Exercise

C. Eric Heidorn

CE Heidorn[1,2], L Lombardo[1], J McDaniel[1,2]

[1]Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center; [2]Exercise Physiology, Kent State University

A spinal cord injury (SCI) can result in paralysis as well as autonomic dysfunction which can lead to reduced physical activity and increased risk for secondary health complications such as diabetes and cardiovascular disease. Electrically stimulated (ES) cycling is commonly used to exercise paralyzed muscles and has numerous reported benefits including metabolic and cardiovascular health, spasticity, and quality of life. However, little is known about its influence on cerebral oxygenation and health. Nine individuals with paralysis completed 5x2-minute interval ES cycling. Compared to resting values, interval ES cycling resulted in increases in cerebral oxygenated and total hemoglobin ($p<0.05$), heart rate (~17bpm) and cardiac output ($p<0.001$) while there was no change in blood pressure and a ~37% decrease in peak cycling power ($p<0.001$) by the last exercise bout. Results indicate ES cycling has potential to improve cerebral oxygenation acutely for individuals with SCI.

Poster 21 - The Impact of Post-Stroke Motor Overflow Modulation on Unilateral and Bilateral Asymmetric Force Production

Rifeng Jin

R Jin[1,2,3], P Tomko[1,2,3], S Ramani[1,2,3], DA Cunningham[1,2,3],

[1]Physical Medicine and Rehabilitation, Case Western Reserve University; [2]Physical Medicine and Rehabilitation, The MetroHealth System; [3]Biomedical Engineering, Case Western Reserve University

Bimanual activities involve dynamic load balance between homologous motor cortices. Coordinating asymmetry between limbs necessitates motor overflow modulation between hemispheres, where motor overflow refers to the unintentional activation of one hemisphere during the intended activation of another. Following a stroke, bilateral motor performance is compromised, and it remains unclear whether the deficits are specific to the ipsilesional hemisphere or are influenced by the contralesional hemisphere. We found that on the group level, the ipsilesional hemisphere can modulate the motor overflow during the bilateral tasks (i.e., reduced MEP amplitudes) compared to unilateral conditions across all force levels. Those individuals with poor motor overflow modulation (i.e., increased MEP amplitudes in the test hemisphere) also demonstrated poorer force stability while maintaining 5% and 30% MVC of the paretic hand. Post-stroke, individuals exhibiting inadequate modulation of motor overflow from the contralesional to the ipsilesional hemisphere may encounter more pronounced bilateral deficits.

Poster 22 - A Graphical User Interface to Improve Stimulation-Based Programming Efficiency and Approachability

Mahika Krishnamoorthi

M Krishnamoorthi[1], G Labrozzi[1,2], K Foglyano[2]

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Researchers working on walking restoration for individuals with spinal cord injury (SCI) use stimulation to control muscle activations and initiate steps. Current approaches adjust stimulation parameters via an off-line program. However, this method is inefficient and unapproachable, as changing a value requires editing code in Excel and subsequently in MATLAB. In total, the process to adjust a single value can take 15 minutes. Previously, other individuals have created graphical user interfaces (GUI) to solve similar issues. Therefore, we decided to develop a GUI to improve programming accessibility and efficiency by allowing changes in real-time. We incorporated a graphical representation of the stimulation patterns to visualize the parameter changes and organized the parameters (pulse width, amplitude, and on/off timings) per muscle channel to make it intuitive for the users. We plan to test the compatibility and accuracy of the GUI in a real-time study with individuals post SCI.

Poster 23 - Fuzzy Logic Control for Post-Spinal Cord Injury Gait

Gabrielle Labrozzi

G Labrozzi[1,2], M Audu[1,2], N Makowski[2,3], R Triolo[1,2]
[1]Biomedical Engineering, Case Western Reserve University; [2]Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center; [3]The MetroHealth System

Walking is an important movement for navigating life and benefiting health. Current approaches facilitate gait after spinal cord injury (SCI) with functional neuromuscular stimulation in a feedforward manner. However, these paradigms are often discontinuous and require extensive upper extremity effort, which result in rapid muscle fatigue and high metabolic energy expenditure. To approach neurotypical gait post-SCI requires a feedback controller that drives a continuous walking pattern. We propose a fuzzy logic controller (FLC) that regulates the transition between subpatterns of stimulation to accomplish each gait phase. We collected data from 5 nondisabled individuals to construct our system. For distinguishing between phases in silico, the FLC was 68.4% accurate with a sensitivity and specificity of 0.61 and 0.93 respectively. We plan to test the FLC in a real-time study with individuals post-SCI. The results will provide the framework for more automatic stimulation assisted gait after paralysis.

Poster 24 - Vagal Pathways and Branches from the Brainstem to Abdomen: Co-Registered 3D Tracing in CT-Based Body Models

Valerie Lam

VH Lam[1], NB Nuzov[1], B Brunsman[2], N Ogrinc[2], L Lunasco[2], K Workman[2], S Bokhari[2], J Zhang[1], NA Pelot[3], AR Crofton[2], AJ Shoffstall[1]

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The vagus nerve contains an estimated 75% of all parasympathetic nerve fibers in the human body and affects nearly all visceral organ systems. Vagus nerve stimulation (VNS) has FDA-approved therapeutic applications in conditions such as epilepsy, depression, and migraines, and isbut has been implicated for many more through functional animal studies. Side effects of this treatment are prevalent throughout the body due to anatomical variation between individuals and non-selective vagal stimulation. To account for anatomical variation, 3D tracing of the vagus nerve was performed after dissection and co-registered to a CT-derived body model using shared anatomical landmarks. This noninvasive visualization of vagal branching specific to each individual inside an appropriately scaled body model can provide crucial information for identifying neuromodulatory targets and mitigating organ-specific side effects.

Poster 25 - Sensory Neuroprosthesis Improves Recovery From Treadmill-Induced Stumbles

Suzhou Li

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Over 50% of individuals with lower limb loss (idLLL) report fear of falling and avoid daily activities partly due to a lack of plantar sensation. Two idLLLs received a sensory neuroprosthesis (SNP) that provided direct somatosensory feedback corresponding to prosthesis foot-floor interactions. Participants walked on a treadmill and received perturbations involving a brief increase in treadmill speed. Perturbations were initiated at heel strike and randomly delivered to intact and prosthetic sides with active or inactive SNP. With SNP active, participants exhibited decreased peak trunk flexion angular velocities during recovery. For prosthetic side perturbations, peak ground reaction force magnitudes (GRFmag) decreased. For intact side perturbations, peak GRFmag on the prosthetic legs' first recovery step increased. This suggests participants utilized sensory feedback from the SNP to improve their sensorimotor control of maintaining stability. So, restoring plantar sensation in idLLLs could lead to reduced risk of falling by improving recovery from trips.

Poster 26 - A Novel, Accessible Body-Weight Support Device

Dana Lorenz

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The vagus nerve contains an estimated 75% of all parasympathetic nerve fibers in the human body and affects nearly all visceral organ systems. Vagus nerve stimulation (VNS) has FDA-approved therapeutic applications in conditions such as epilepsy, depression, and migraines, and isbut has been implicated for many more through functional animal studies. Side effects of this treatment are prevalent throughout the body due to anatomical variation between individuals and non-selective vagal stimulation. To account for anatomical variation, 3D tracing of the vagus nerve was performed after dissection and co-registered to a CT-derived body model using shared anatomical landmarks. This noninvasive visualization of vagal branching specific to each individual inside an appropriately scaled body model can provide crucial information for identifying neuromodulatory targets and mitigating organ-specific side effects.

Poster 27 - Histological Outcomes of a Novel Engineered Sling for Stress Urinary Incontinence

Tejasvini Malakalapalli

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A novel polytetrafluoroethylene (PTFE) sling, engineered to minimize microporosity while maintaining compliance and tensile strength comparable to standard polypropylene (PP) slings, was evaluated in a stress urinary incontinence (SUI) rat model to mitigate postoperative complications arising from large mesh pores in PP mesh slings. Inflammatory response, assessed using a 3-point scoring on H&E stained tissue sections, and fibrotic reaction, quantified by collagen infiltration area in Masson's Trichrome stained sections, were compared at 1 and 6 weeks post-implantation. At 1 week, both PP and PTFE induced higher inflammation compared to sham, while at 6 weeks, PTFE exhibited the highest inflammation level. Collagen infiltration at 6 weeks was elevated in PP, PTFE, and positive control groups compared to sham. Both types induced similar histologic changes, suggesting the potential of PTFE slings to enhance SUI treatment with other advantages compared to the PP sling, as evidenced in other adhesion tests.

Poster 28 - Development of a VR Assessment and Training Platform for Convergence Insufficiency

Luis Mesias

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Half of Veterans with mild traumatic brain injury (TBI) report blurred vision with near viewing. One cause of near vision impairment is convergence insufficiency (CI), the inability to fuse left and right eye images. This can result in blurring, impaired distance perception, and difficulty reading. CI is diagnosed by measuring the near point of convergence (NPC), the closest point that can be foveated by both eyes. Laboratory equipment measures NPC most accurately but is not available to most clinics, and clinical exams are less precise. We developed an approach to assess and train CI using eye-tracking virtual reality (VR) headsets. We recruited veterans with TBI and healthy adults without TBI or near vision symptoms. Using an NPC cutoff of 32, 9/16 TBI veterans and 1/12 health adults had CI. In 3 TBI veterans, we pilot tested a novel VR game to evaluate its feasibility to train convergence.

Poster 29 - Creating an Instrumented Pressure Sensing Prosthetic Liner using Aerosol Jet Printed Electronics

Lexi Miskey (*Poster posted, not presenting due to NCAA Softball Championships*)

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The fit of a prosthetic socket defines the comfort and usability of the device. An ill-fitting socket can lead to skin breakdown including abrasions and sores. High-pressure areas could correlate with an increased likelihood of skin breakdown. Thus, an instrumented prosthetic liner that can identify high-pressure regions within the socket can be used by a prosthetist to improve the fit. Instrumentation of the liner requires that the electronics to be thin and flexible as well as robust to sustain the donning and doffing of the liner over time. Aerosol jet printing (AJP) offers a novel approach to creating custom flexible sensors. Ongoing development of ink and substrate exploration will be presented along with an update of printing capabilities. Data collected will lead to the integration of AJP sensors into prosthetic liners with real-time pressure measurements and provide a valuable tool for prosthetic management.

Poster 30 - Developing a Methodology to Study Sensory Nerve Stimulation and Tissue Health in Diabetes

Hannah Morgan

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Diabetes is the leading cause of lower limb amputations in the United States. Many of these amputations are a result of diabetic peripheral neuropathy (DPN), a loss of peripheral nerve fibers due to elevated blood glucose levels. Damaging sensory, motor, and autonomic nerves in the extremities, DPN contributes to difficulties with prosthesis use and poor residuum tissue health in this population, leading to poor functional and clinical outcomes. Sensory nerve stimulation has the potential to improve residual limb tissue health. We developed an experimental methodology and set of outcome measures to study this unexpectedly nuanced research question utilizing laser Doppler fluximetry to probe vasodilation reflexes in the skin. By combining this technique with sensory nerve stimulation we are investigating the role of sensation in regulating microvascular circulation necessary for keeping residual limb tissue healthy and preventing further amputation.

Poster 31 - Return to Upright Control with a Networked Neuroprosthesis

Matthew Morrison

MW Morrison[1,2], ME Miller[2], LM Lombardo[2], ML Audu[1,2], RJ Triolo[1,2]

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Trunk stability is necessary for performing many activities of daily living (ADLs) for people with spinal cord injury (SCI). Functional neuromuscular stimulation (FNS) is a promising method of assisting individuals with SCI to perform trunk motor tasks that would otherwise be difficult or impossible. The Networked Neuroprosthesis (NNP) is a fully implanted, modular FNS system capable of providing signals that can be used in controllers to coordinate the stimulation of motor nerves to generate useful body movements by activating paralyzed muscles. A feedback control system that used trunk tilt measurements derived from NNP module accelerometer signals was designed for stabilizing the trunk of an NNP recipient. Control of stimulation using the implanted NNP modules and their embedded sensors produced clinically relevant trunk movements that can improve seated stability for performance in ADLs by allowing for returning from a position of forward trunk flexion to be completed without assistance.

Poster 32 - Integration of Anti-Inflammatory Loaded Titania Nanotube Arrays onto Soft-Polymer-Based Intracortical Probes: Process Development and Assessment

Mali Ya Mungu Ocoko

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Intracortical microelectrode recording performance is often hampered by neuroinflammation in response to implanted probes. Our goal is to mitigate neuroinflammation using a soft polymer-based implant and sustained anti-inflammatory delivery from titania nanotube arrays (TNAs). Here, we developed a process for integrating dexamethasone (DEX)-loaded TNAs into a mechanically adaptive polymer-based substrate. To assess DEX stability post-exposure to thermal processes during device fabrication, we used UV-spectroscopy to compare absorption spectra of exposed and unexposed samples. Furthermore, TNA samples transferred to the polymer-based substrate were submerged in PBS at 37°C. Over four weeks, a stable interface was observed without delamination between the layers. Lastly, 50 µm-diameter TNA microsegments were formed using reactive ion etching in a CF4/O2 plasma with a photoresist mask. This work will enable assessment of mechanics and sustained drug delivery impact on long-term recording performance and neuroinflammatory response.

Poster 33 - Chronic Stability of Implanted Neural Interfaces in Lower Limb Amputees and Contributing Factors

Eileen Petros

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High density cuff electrodes have been successfully implemented in sensory restoration systems. In the lower extremity, such implanted systems face unique challenges with larger muscle groups and frequent joint movement. We evaluated the longitudinal performance of a multicontact nerve cuff system implanted above the knee in four participants with transtibial limb loss. The system featured composite flat interface nerve cuff electrodes (C-FINEs), connecting leads, an in-line connector, and percutaneous leads. Across 158 channels, we examined charge density at sensory thresholds and electrical impedance. Results showed 60% were stable, 37% partially responsive, and 3% unresponsive. Participants LL03 and LL04 featured the largest proportion of stable contacts (75%, 93%). These latter systems utilized smaller components and additional lead routing to minimize stress from frequent joint movement. Overall, the C-FINE systems were stable in the lower-extremity and employing strategies to reduce stress on transition points in the components improved performance.

Poster 34 - MATLAB Methods for Image Analysis of Aerosol Jet Printed Traces

Daniel Rakowsky

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Aerosol Jet Printing (AJP) is a manufacturing technique in which a metallic ink is aerosolized, carried and focused through gas flows, and deposited onto a substrate on a temperature-controlled platen. AJP is compatible with a large combination of inks and substrates, can print over curved or textured surfaces, and is inexpensive to use for prototyping and development at small scale. Process parameters of aerosol jet printing can vary over a wide range. Small changes to these parameters can significantly affect characteristics of the resulting traces. Optimal parameters for various ink and substrate combinations can differ significantly. An image processing and analysis method was developed in MATLAB to determine critical measurements of printed traces, including trace width, edge roughness, overspray density, and rectangularity of printed pads. This method will assist in identifying values of process parameters that produce precise and conductive prints.

Poster 35 - COSMIIC Open Source Commitment

Chris Rexroth

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Active implantable devices are an important means of treating disease and disability; however, limited access to this technology and related resources is a barrier to research progress and adoption. The goal of COSMIIC is to establish an open source implant system and community of collaborators to address this limitation.
The open source COSMIIC System is based on the modular implant known as the networked neuroprosthesis (NNP). This system has already achieved use in human studies under an Early Feasibility Investigational Device Exemption (IDE). The COSMIIC System consists of platform NNP components pulse generator and biopotential recording units as well as specialized components in-development.
We are seeking input from researchers to determine areas of greatest need. This feedback includes needs related to customer support for use and implementation and support for regulatory submissions. Further details of the open source community and resources to be released can be found at cosmiic.org.

Poster 36 - From Pixels to Pathways: Unraveling the Complexity of Vagal Nerve Networks with MicroCT Imaging

Megan Reynold

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Stimulating Peripheral Activity to Relieve Conditions- otherwise referred to as “SPARC” is a program funded by The National Institutes of Health (NIH). This new and exciting project works with Case Western Reserve University and the University of Duke in hopes to achieve vagal nerve mapping to create advancements in nerve stimulation and surgical procedures. A large factor of the project involves the 3D imaging technique known as Microcomputed tomography (MicroCT). This technique uses x-rays to take slice by slice images of the vagal nerves that are removed from the human cadavers in the study. The information we can obtain with microCT cannot be obtained by any other non-destructive technology. The factor of this technology being non-destructive is important because it will not change or alter the nerves after scanning. The use of microCT should assist in the study of the interior structures with the cut samples. These 3D images will also assist with allowing the measurement of different parameters.

Poster 37 - Tactile Percept Integration during Peripheral Nerve Stimulation for Touch Restoration

Leah Marie Roldan

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Neural interfaces such as composite flat interface nerve electrodes (C-FINEs) have restored touch to upper and lower extremity amputees, changing how they grab objects and interact with others around them. The relationship between stimulation paradigms and sensation at a single point of perception with a single channel of stimulation has been extensively studied. However, there remains a significant gap in the understanding of multiple channel stimulation, which is critical to object feature extraction, stereognosis, and improved manual dexterity. We present data from stimulation trials showing integration of multiple perception points, or percepts, to test two main hypotheses: 1) multi-contact stimulation will result in multiple distinct intensities being perceived at once and 2) multi-contact stimulation will result in non-linear addition of the tactile dimensions of sensation.

Poster 38 - Evoking Spinal Reflexes of the Gluteus Medius and Rectus Femoris Through Transcutaneous Spinal Cord Stimulation

Ricardo Siu

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Post-stroke gait impairments may present in the form of Stiff-Knee Gait (SKG), where the knee is unable to appropriately bend during the swing phase of gait, increasing the risk of falls. Previous research showed increased coupling between the rectus femoris (RF) and gluteus medius (GMed) muscles in computational models of SKG during a mechanical perturbation, but not in non-SKG controls. Thus, we hypothesize that abnormal reflex coupling between these muscles causes movement that has been interpreted as hip circumduction in individuals with post-stroke SKG. Our goal is to experimentally validate this finding at the level of the spinal cord using spinally evoked potentials. We leveraged computational and experimental studies to determine stimulation electrode placement and pulse parameters that would reliably elicit measurable evoked potentials of the RF and GMed muscles in able-bodied volunteers during gait. We are currently in the pilot phase of the trial.

Poster 39 - Assessment of stored blood hemolysis using a novel dielectric microsensor as a quality measure for transfused blood

Si young Song

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Transfusion of stored red blood cells (RBCs), which are used to treat various patient populations, are approved for cold storage up to 42 days in the United States. However, prolonged storage can lead to storage lesions including generation of fragile and smaller RBCs as well as hemolysis with release of free hemoglobin (Hb) and heme. Concerns arise regarding the efficacy and safety of older RBC units, yet diagnostic modalities to assess the quality of stored RBCs remains challenging as current methods involve invasive and labor-intensive processing. Here, we present a novel approach utilizing a point-of-care (POC) dielectric microsensor to assess hemolysis during storage. We observed significant differences in dielectric parameters of blood with increasing storage time that correlated with standard hemolysis assessments. Our platform demonstrated the ability to noninvasively and rapidly evaluate stored RBC quality, potentially improving transfusion protocols and patient outcomes.

Poster 40 - Under Pressure

Justin Storn

J Storn[1]

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In the US, 48% of adults have hypertension, which puts stress on the heart and can lead to a heart attack or stroke [1]. In order to detect this before it becomes a serious issue, clinicians regularly check patients' blood pressure (BP). However, if the arm is below the heart, the BP can be misestimated by roughly 12 mm/Hg on average [2] [3]. Additionally, if the arm is not completely supported, BP may increase due to the muscles engaging in involuntary isometric exercise (engaging muscles without movement) [3]. Therefore, when BP measurements are taken, the arm of the patient must be at the same height as their heart and at rest to get an accurate reading. To achieve this, we are developing an adjustable arm rest which can be installed onto commercially available, standalone blood pressure monitors.

Poster 41 - Using Surface Stimulation on the Dorsum of the Foot to Prevent Toe Curling

Bridget Gagnier

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Many stroke survivors experience claw toe while walking. This causes pain that affects a person's ability to walk. This proof of concept study uses surface electrical stimulation on the dorsum of the foot to prevent the toes from curling while walking. Data were collected from one stroke survivor. Four six-minute walks were recorded. Two were with additional leg stimulation and two with only stimulation on the foot. Applying stimulation to the foot decreased the rating of pain by 20-40%. The perceived effort was lower when using the foot stimulation. The BORG ratings were 15-16 without any stimulation, and 11-12 with foot stimulation only. With the additional leg stimulation, the rating was 12 and with both additional and foot stimulation the rating was 10-11. This study shows that stimulation on the dorsum of the foot can reduce pain and effort while walking with claw toe.

Poster 42 - Design and Validation of Wireless Catheter-Free Bladder Measurement Device

Sumaiya Tharif Jahan

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Urodynamics (UDS) is pivotal for assessing lower urinary tract function but is hindered by specialized equipment and patient discomfort. To address this, a wireless, catheter-free bladder measurement device was developed, promising increased comfort and enhanced physiological data. However, initial data revealed reproducible artifacts not reflective of true bladder pressure. This study aimed to replicate these artifacts in a benchtop bladder model and assess the impact of compression and temperature. The model accurately simulated bladder dynamics, including filling and voiding processes, and replicated observed artifacts. Filling artifacts showed decreased pressure at fill initiation, while voiding artifacts exhibited positive pressure spikes post-void. Tests compared device data with standard pressure transducer readings, highlighting artifact reproduction, and explored temperature and compression effects. This comprehensive study deepened understanding of device-measured artifacts during benchtop experiments, providing valuable insights into addressing challenges associated with UDS and improving the accuracy of bladder pressure measurements.

Poster 43 - Effects of Electrical Stimulation on Muscle Size and Function: Insights from Ultrasound Imaging

Patrick Tomko

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Echo intensity (EI) reflects muscle changes. We compare the impact of electrically stimulated (ES) contractions to force-matched voluntary (VOL) contractions. Sixteen healthy individuals (8 females) completed seven visits. ES involved 40 contractions with NMES (75Hz) at maximum intensity, while VOL was force matched. Peak strength was measured at 1-, 24-, and 48-h post-ES and VOL. Muscle size (mCSA) and EI of the rectus femoris (RF) and vastus lateralis (VL) were assessed, specific force (SF) was calculated. Peak force and SF were lower post-ES compared to VOL ($p < 0.001$). RF and VL showed larger mCSA post-ES ($p < 0.01$). RF corrected EI was higher only at 48H post-ES ($p = 0.002$). VL corrected EI differed between ES and VOL in males at all time points ($p < 0.001$). ES induced changes in mCSA and EI compared to VOL showcasing ultrasound's potential as assessment tool.

Poster 44 - Development Aerosol Jet Printing on PMMA for of Sensorized Contact Lenses

Tyler Vu

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Real-time health monitoring through wearable technologies represents an approach to personal health management. Detecting various conditions via eye fluid holds the promise of revolutionizing preventive healthcare. We are developing sensorized contact lenses using aerosol jet printing (AJP) to apply conductive and dielectric inks on contact lens platforms. This process integrates sensors, circuits, and encapsulation into lenses using polymethyl methacrylate (PMMA). Our focus includes evaluating ink adherence to PMMA and the electrical characteristics of printed circuits post-sintering. A vital aspect of this work is understanding how well the printed circuits adhere to the PMMA substrate and their physical and electrical characteristics after sintering at different times and temperatures. By optimizing printing parameters and assessing the electrical resistance of printed traces, we aim to ensure sensor reliability. Future efforts will adapt AJP to curved surfaces and refine sintering parameters to establish a proof-of-concept for wearable health monitoring technology.

Poster 45 - Distance-Segmented Proteomic and Transcriptomic Analysis of the Neuroinflammatory Response to Microelectrode Array Implantation in the Cortex

Jaime Wang

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Microelectrode arrays (MEAs) are devices implanted into the cortex of the brain that are used to record neural signals, which can be utilized to operate brain computer interfaces. However, MEAs currently fail over chronic timepoints, largely due to the neuroinflammatory response following implantation. MEA implantation breaks the blood brain barrier, damages neurons, and activates local glial cells. This leads to formation of a glial scar and diminished recording quality over time. There is currently no successful method for mediating post-implantation inflammation, in part because the nuances of the biological response are not yet fully understood. This project analyzes the differential expression of 83 neuroinflammatory proteins as well as the full mRNA transcriptome around the MEA implant site. Regions were segmented into 0-90, 90-180, and 180-270 μm from the implant in order to better understand how protein and mRNA expression is affected by distance from the implant site.

Poster 46 - Analog Interface Amplifiers for Sub-mm Broadband Polymer Intravascular Ultrasonic Imaging

Ruiyan Wang

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Intravascular ultrasonic (IVUS) is widely used for coronary artery operative assessment. This work advances the development of sub-mm IVUS catheters that have greatly improved resolution using broad-band polymer transducers. The high impedance of these transducers prevents direct attachment to standard 50 micro-coaxial cables, and requires high voltage excitation (50-100 V typically). To enable broad-bandwidth IVUS in a small catheter, a custom analog front end (AFE) interface ASIC was developed. AFE demonstrated a typical signal-to-noise ratio of 33.3 dB, over a 105 MHz imaging bandwidth. Pulse recovery to >230-Vpp excitation was measured between 325 and 450 ns, allowing imaging as close as 0.5 mm from the transducer face. Example imaging using a 0.8-mm, 40 MHz transducer mounted on a PCB tower showed sufficient resolution for detection of individual stent struts within a simulated artery with wall thickness of 0.35 mm.

Poster 47 - Optimization of Aerosol Prints on Silicone Glove

Jerry Yang

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Aerosol jet printing (AJP) provides an avenue to manufacture gloves equipped with strain gauges for applications including prosthetics, rehabilitation, and training. This is enabled by three-axis control and a standoff height between the print head and substrate. For initial development, a silver ink manufactured by Electroninks, EI-616, was aerosol jet printed onto flat sections of silicone. Platen temperature and sintering were studied to understand adhesion and correlate thermal processing to conductivity. Preliminary surface roughness characterization using a Keyence VK-X3000 profilometer indicated that a parylene-C coating and an argon plasma etching of silicone both increased ink adhesion to the substrate by increasing surface roughness. Microscopy with a Keyence VHX-7000 digital optical microscope and average step height measurements from the profilometer were used to evaluate print and substrate characteristics. This work will aid in identifying AJP parameters for fabrication of a sensorized silicone glove.

Poster 48 - Mechanical Characterization of Cardiovascular Pacing Leads

Justin Zimmerman

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Bipolar endocardial pacing leads are used with pulse generators for long-term cardiac pacing. Numerous complications may necessitate the removal of pacing leads. During these extractions a number of conditions including lead age, mechanical stress and fatigue, surgical instrumentation and procedure, and adhesion growth, may compromise the integrity of the lead, requiring more invasive correction. To better understand and further standardize the influences of these conditions, particularly lead aging, it is vital to first understand fundamental mechanical properties of the as-received leads. Five specimens each of Boston Scientific FINELINE II STEROX 4456 and 4457 implantable leads were tested in uniaxial tension with a universal tensile testing machine and imaged under digital optical and scanning electron microscopes. Of the 10 specimens, half underwent preconditioning in phosphate-buffered saline at 37°C for at minimum 10 days to compare lead strength and insulation degradation. This preliminary work will guide future testing conditions.