



APT CENTER
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Third annual

2026 Spring i-Con

*Inspire
and
Connect*

Thursday, June 4, 2026; 1:00pm – 6:30pm
Thwing Student Center Excelsior Ballroom &
Second Floor Foyer
Case Western Reserve University

Cash awards for top poster presenters!

Agenda



Follow us on



1:00 p.m. Welcome & Opening Remarks

1:10 p.m. Maria Bennett, CEO, President & Founder, SPR

1:50 p.m. Career Panel Featuring:

Kiley Armstrong, Research Prosthetist-Orthotist at Northwestern University's Feinberg School of Medicine and CPO at Shirley Ryan Ability Lab

Maria Bennett, CEO, President & Founder, SPR

Michael Fu, Associate Professor, Department of Electrical, Computer, and Systems Engineering, Case Western Reserve University

Kristen Gelenitis, Clinical Science Manager at ONWARD Medical

Michael Moffitt, Associate Professor, Department of Biomedical Engineering, Case Western Reserve University

2:35 p.m. Break

2:45 p.m. Student Oral Presentations Featuring:

Mallika Singh: Activity-Based Neurorehabilitation, Case Western Reserve University, Biomedical Engineering

Sebastian Correa: Health Monitoring & Maintenance, Case Western Reserve University, Biomedical Engineering

Madelaine Blincoe: Neural Interfaces, Case Western Reserve University, Biomedical Engineering

Jacob Miller: Prosthetics and Orthotics, Case Western Reserve University, Mechanical Engineering

3:30 p.m. Trainee Poster Session

4:50 p.m. Break

5:00 p.m. Keynote Speaker: Ranu Jung, Distinguished Professor of Biomedical Engineering, University of Arkansas, "Time Unbound"

5:45 p.m. Q&A

6:00 p.m. Group Photo

6:15 p.m. Awards

6:25 p.m. Closing Remarks

Danny A. Werner

Service Through Science Award

Today, we are honored to present our top poster award in memory of Danny A. Werner, a proud Army Veteran, husband, father, grandfather, community member, and friend. Danny was drafted into the Army at the age of 18 and served in Vietnam, where he was seriously injured by a land mine and lost his leg below the knee. But Danny did not allow that injury to define the limits of his life. He went on to work, serve, build, encourage others, and later became a volunteer participant in pioneering VA research to help restore sensation in prosthetic limbs. Danny once explained his motivation simply: he knew he might not personally benefit from all of the research, but someone down the road would. That spirit: service beyond self, courage after sacrifice, and a willingness to help future generations is exactly what we hope this award will represent.

Poster 1 - Graphene-based Wireless Antenna Arrays to Transdifferentiate Mesenchymal Stem Cells into Schwann Cells in an Inflammatory Environment for Skin Tissue Engineering

Naomi Addai Asante

N Addai Asante¹, Hasan Erbil Abaci², and Metin Uz¹

¹Chemical and Biomedical Engineering, Cleveland State University; ²Dermatology, Columbia University Medical Center

Injuries that affect the peripheral nervous wiring of the skin present an alarming burden during regeneration as it involves healing the affected area and restoring sensitivity back to the damaged skin. These injuries trigger a robust inflammatory response. Schwann cells aid and promotes the regeneration of damaged nerves by providing neurotrophic factors that promotes nerve regeneration. However, the current methods in obtaining Schwann cells are limited by donor site morbidity, availability and the transdifferentiation protocols used are mostly chemical based and non-scalable. To solve this issue, in this study we present a wholistic wireless approach in obtaining Schwann cell-like phenotypes from ADP stem cells while considering the innate inflammatory injury response.

Poster 2 - Wearable Sensor-based SVM Classification of Gait Speed Intent Post-sci

Madelaine Blincoe **Selected for oral presentation*

M Blincoe^{1,2}, R Triolo^{1,2}, M Audu^{1,2}, and N Makowski^{1,2,3}

¹Biomedical Engineering, Case Western Reserve University; ²Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center, ³MetroHealth Medical Center

Neuromuscular Electrical Stimulation (NMES) can facilitate or enhance walking after incomplete Spinal Cord Injury (iSCI). However, developing a robust, intent-driven control method to vary gait speed remains challenging. This study investigates the use of a Support Vector Machine (SVM) to detect intent to change walking speed based on wearable sensor data. Kinematic data were collected from a volunteer with T4, AIS C paraplegia, walking with surface stimulation with baseline NMES patterns specified for slow, medium, or fast paces. During 10m walking trials, the participant attempted to match the pace of stimulation, speed up, slow down, or stop depending on the pattern. Center of mass velocity was derived from motion capture, and inertial measurement units measured acceleration of the trunk and lower limbs. The SVM demonstrated high-fidelity performance across optimal sensors, exceeding 80% accuracy. These results validate wearable-based machine learning for decoding speed intent, laying the groundwork for future user-driven neuroprostheses.

Poster 3 - Reliability of Peripheral Versus Cortical Stimulation to Restore Sensation in an Individual with Spinal Cord Injury

Rohit Bose

R Bose¹, P Bhat¹, M Abate¹, W Memberg¹, T Johnson¹, D Taylor¹, J Sweet², A Ajiboye¹, and E Graczyk¹
¹Biomedical Engineering, Case Western Reserve University; ²University Hospital

Peripheral nerve stimulation (PNS) and intracortical microstimulation (ICMS) can restore sensation in individuals with sensory deficits but have largely been studied in separate populations. Here, we implanted peripheral nerve cuff electrodes and intracortical microelectrode arrays in an individual with sensory-incomplete spinal cord injury (SCI) and evaluated percept reliability five years post-implantation. The intracortical arrays showed declining performance, with fewer electrodes evoking percepts over time compared to PNS. In contrast, PNS sensations were detected more consistently and produced more reliable perceived intensities. PNS also had higher discriminability compared to ICMS. These results highlight two important points: (1) PNS can offer a reliable long-term strategy to provide sensory feedback in people with sensory incomplete SCI, and (2) over a 5-year duration, PNS outperforms ICMS in terms of reliability and discriminability, which are key characteristics that determine the effectiveness and functionality of sensory feedback.

Poster 4 - Machine Learning-Based Detection of Urological Events from Vesical Pressure Signals: Development and External Validation

Syed Hassaan Ahmed Bukhari

HA Bukhari¹, V Abbaraju², J Patel^{3,4}, B Clarkson⁵, S Tyagi⁵, MS Damaser^{1,4,6}, and SJA Majerus^{3,4}
¹Biomedical Engineering, Cleveland Clinic Research; ²Electrical and Computer Engineering, Georgia Institute of Technology; ³Case Western Reserve University; ⁴Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center; ⁵Geriatric Medicine, University of Pittsburgh; ⁶Glickman Urology Institute, Cleveland Clinic

Introduction: The wireless urodynamic monitor (UM), developed in our lab, enables catheter-free ambulatory assessment of lower urinary tract dysfunction using single-channel vesical pressure (Pves) but lacks abdominal and detrusor pressures. Therefore, we developed a machine learning framework trained on labeled urodynamics (UDS) data for automated event classification and scalable analysis of UM recordings. **Methods:** We analyzed 118 annotated UDS traces from 76 patients across three datasets, extracting wavelet features from 0.8-s Pves segments. A two-stage multilayer perceptron (MLP) trained on Pves-only data classified VOID (voiding contraction) vs non-VOID and further distinguish ABD (abdominal) and DO (detrusor overactivity), with external validation on an independent dataset and proof-of-concept evaluation on UM ambulatory data. **Results:** The two-stage model achieved strong external performance (84-90% accuracy, AUC >0.85) and successfully detected key clinical events in UM data. **Conclusion:** Our Machine learning framework supports urological event detection from Pves, with future validation planned in at-home studies.

Poster 5 - Tunable Primary Side Coil Array for Magnetic Field Shielding and Enhancement in Location Dependent Implantable Devices

Reilly Burhanna

R Burhanna¹, MJ Fu^{1,3}, and SJA Majerus^{1,2}

¹Electrical, Computer, and Systems Engineering, Case Western Reserve University; ²Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center; ³Physical Medicine and Rehabilitation, MetroHealth Medical Center

Inductive Wireless Power Transfer (WPT) for medical implants is typically accomplished by driving a primary coil outside the body that couples with a smaller implanted coil. While sufficient for charging, this approach produces a uniform field distribution which is not adaptable to changes in implant position. Non-optimal spatial distribution of the magnetic field results in localized heating of tissues and coupling inefficiency. A tunable coil array capable of location dependent magnetic field shielding or enhancement offers a potential solution. Shielding can redistribute high concentrations of flux in the magnetic field to minimize excessive heating, while enhancement can enable flux redistribution to improve coupling. Paired with implant location sensing, magnetic field shielding and enhancement can reduce local heating and improve WPT efficiency. This work proposes a coil array tunable by open, short, and variable capacitance configurations for achieving the desired localized shielding and enhancement of the primary coil's magnetic field distribution.

Poster 6 - Robust Blood Pressure Estimation Using a Novel Implanted Photoplethysmography Sensor

Dario Cabal

D Cabal¹, DB Green², K Kilgore², V Thakkar², MJ Fu¹, and SJA Majerus¹

¹Electrical, Computer, and Systems Engineering, Case Western Reserve University; ²MetroHealth Medical Center

Photoplethysmography (PPG) is widely used to measure heart rate, blood oxygenation, and more recently, blood pressure. Implanted PPG systems offer the possibility to measure similar real-time measures of cardiovascular health; however, the detection method may vary due to a lack of capillary vessels for PPG sensors to observe in muscle tissue. To improve volumetric blood detection in large muscles, without relying on the capillary density of skin, a custom flexible PPG sensor was developed. The sensor includes multiple spacing of illuminating infrared (IR) light emitting diodes (LEDs) and a single IR photodetector. Two preliminary in vivo tests used adult rabbits to provide a preliminary robust analysis of blood pressure. This analysis was performed utilizing with an inverse nonlinear model and ranked based on metrics like RMSE and MAE. Of the six feature-extracted delay models that were analyzed for a given waveform, two hold comparable performance seen by similar models.

Poster 7 - Neural Representation of Artificial Tactile Feedback in Human Somatosensory Cortex

Oranatt Chaichanasittikarn

O Chaichanasittikarn¹, K Ding¹, R Bose², and L Osborn^{2,3}

¹Biomedical Engineering, Johns Hopkins School of Medicine; ²Human Fusions Institute, Case Western Reserve University; ³Biomedical Engineering, Case Western Reserve University

Artificial tactile sensation is an important component for enhancing a sense of embodiment toward external devices, such as prosthetic limbs or virtual bodies in immersive environments. Multimodal tactile feedback, including touch, vibration, and temperature, may further improve tactile perception, functional performance, and overall user experience. While haptic feedback has been shown to improve task performance and perception, temperature-based feedback remains relatively underexplored. Brain-computer interface (BCI) offers to measure cortical activity associated with tactile feedback in real time, particularly somatosensory evoked potentials (SEPs) have been reported to vary across different tactile modalities. In this study, we investigate cortical responses to multiple tactile feedback modalities to determine whether neural activity differs across input types. Two tactile feedback modalities were delivered to participants while neural signals were recorded. SEPs were analyzed to identify activation at specific brain regions and electrodes and characterize neural responses associated with different types of tactile stimuli.

Poster 8 - The Effect of Lower Limb Loss on Perception of Endpoint Position

Srikanth Chavali

S Chavali^{1,2} and H Charkhkar^{1,2}

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

Lower limb loss affects precise control of gait, and results in a loss of tactile sensation from the missing foot. However, the role of tactile sensation in locating the foot's position in space has not been established. To study the effect of limb loss and loss of plantar sensation on spatial accuracy, participants with lower limb loss reported the location of their foot across a 2-dimensional grid. Responses were gathered under 2 sensory conditions for their prosthetic and intact limb. Participants more accurately estimated foot position using their intact limb as opposed to their prosthesis. However, this accuracy did not improve when making plantar contact with the target. The difference in accuracy between prosthesis and intact side highlights deficits in spatial perception due to limb loss, likely due to the loss of sensation in the affected limb. Application of sensory restoration systems could potentially address this deficit and requires study.

Poster 9 - Towards the Clinical Evaluation of Post-Stroke Spasticity During Gait

Sebastian Correa **Selected for oral presentation*

JS Correa^{1,2}, N Sanchez³, D Lorenz¹, J Stahl¹, W Kozak², K Hansen², J Zakel², D Cunningham^{1,2}, and J Sulzer^{1,2}

¹Biomedical Engineering, Case Western Reserve University; ²Physical Medicine and Rehabilitation, MetroHealth Medical Center; ³Physical Therapy, Chapman University

Clinical practice lacks an assessment of how spasticity influences muscle activity during function. This gap may contribute to inaccurate spasticity diagnoses, despite limited adoption of alternative metrics. We investigated if the dynamic knee range of motion (ROM) can predict EMG-defined rectus femoris (RF) overactivity during gait. We hypothesized that the ROM would be more accurate than the Modified Ashworth Scale (MAS). To quantify overactivity, RF EMG was analyzed during gait and considered overactive if it exceeded values from 14 neurotypical participants. MAS scores were categorized, while the ROM was split using logistic regression to predict overactivity. Prediction accuracy was defined as each metric's ability to correctly classify participants as overactive. In 22 participants post-stroke, the MAS was more accurate (64%) than the ROM (43%). While our result indicates the MAS is a better predictor than kinematics, it is unlikely that the test can be relied upon within clinical practice.

Poster 10 - Few-layered Conductive Graphene Foams for Electrical Transdifferentiation of Mesenchymal Stem Cells into Schwann Cell-like Phenotypes

Tugce Dogruel

T Doğruel¹, EG Simsar¹, P Cheng², M Uz¹, and PR Kidambi³

¹Chemical and Biomedical Engineering, Cleveland State University; ²Chemical and Biomolecular Engineering, Vanderbilt University; ³Mechanical and Aerospace Engineering, University of Florida

Peripheral nerve injuries cause significant functional impairment. While mesenchymal stem cells (MSCs) can be transdifferentiated into Schwann cell (SC)-like phenotypes to support repair, traditional chemical induction methods are limited. This study investigates 3D conductive graphene foams (3D-GF) for the electrical transdifferentiation of MSCs into functional SC-like phenotypes without chemical agents. MSCs on 3D-GF were subjected to daily electrical stimulation (100 mV/mm, 50 Hz, 10 min) for 10 days. Outcomes were evaluated via ICC, qPCR, Western Blot, ELISA, and RNA-seq. The cytocompatible 3D-GF platform facilitated complex 3D network formation. The synergy of 3D-GF and electrical stimulation achieved ~90% transdifferentiation efficiency, surpassing standard chemical protocols. These SC-like cells expressed mature glial markers (S100 β , p75, MBP) and secreted neurotrophic factors (NGF, BDNF) that promoted neurite outgrowth. RNA-seq identified the MAPK signaling pathway as a primary mediator. Conductive 3D-GF is an effective, chemical-free bioelectronic platform for producing therapeutic SC-like phenotypes in peripheral nerve regeneration.

Poster 11 - Assist-as-Needed Control for Improved Foot Clearance in Poststroke Gait: A Simulation Study

Marshaun Fitzpatrick

M Fitzpatrick³, SK Hnat^{1,2}, ML Audu^{1,2}, RJ Triolo^{1,2}, RD Quinn^{1,3}, and NS Makowski^{1,2,4}

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

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Exoskeletons have emerged as rehabilitation devices to restore hemiparetic gait, with foot clearance a primary concern. In simulation, we implemented an assist-as-needed (AAN) controller for an exoskeleton to improve foot clearance, evaluated its stepping performance under simulated poststroke impairments, and quantified the effects of factors related to toe height estimation. The AAN controller was evaluated using maximum impairment level and foot clearance metrics across four conditions: (1) without the exoskeleton, and with the exoskeleton, (2) with assistance disabled, (3) using a finite state machine (FSM) controller, and (4) using the AAN controller. Successful steps were completed at an impairment level at least double that of other conditions when using the AAN controller, producing greater toe clearance but slightly shorter steps. Toe height estimation factors, such as sensor error, had a moderate effect on AAN controller performance, whereas segment length and ankle angle had little to no effect.

Poster 12 - Polar Angle-based Gait Phase Estimation with a Novel Complementary Filter

Justin Golabek

J Golabek¹, M Audu¹, R Triolo¹, and N Makowski²

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Assisting walking after stroke with a neuroprosthesis requires synchronization between stimulation and the user's gait cycle. Synchronization requires estimating the gait phase, which is typically done discretely using finite-state machines (FSMs). A promising alternative is to estimate gait phase as a continuous variable from 0-100%, using the polar angle of two sinusoidal signals in the phase plane. This approach has shown success in robotics; however, a limitation is its sensitivity to noise. In this study, we present a novel complementary filter to reduce this noise without distortion or latency. We validate our approach on two stroke survivors with different levels of impairment. The complementary filter improves the accuracy of gait phase estimation beyond conventional filtering approaches without added complexity or computational expense. This makes it an attractive method for neuroprostheses and other resource-limited applications.

Poster 13 - Systemic Nanoparticle Treatment to Address Intracortical Microelectrode-Associated Neuroinflammation

Francine Graham

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¹Biomedical Engineering, Case Western Reserve University, ²Advanced Platform Technology Center, Louis Stokes Cleveland VA Medical Center

Intracortical microelectrodes (IMEs) record neuronal signals, which is used as a therapeutic for motor-deficient patients and to promote understanding of neural activity.

Neuroinflammation around the IME leads to early device failure. Macrophages infiltrate to the brain following implantation and recruit immune cells from circulation to the implant site, prolonging the inflammatory response. In this study, we targeted cluster of differentiation 14 (CD14), a conserved coreceptor of multiple toll-like receptors which activate immune cells toward an inflamed phenotype. We used lipid nanoparticles (LNPs) delivering a small interfering RNA (siRNA) to inhibit CD14 expression. By targeting CD14, we sought to prevent the self-propagating cycle of immune recruitment and activation which leads to eventual electrode failure. By systemically delivering Cd14-siRNA LNPs, we were able to effectively limit CD14 expression, reduce the presence of non-resident immune cells, and restrict the inflammatory response in the brain, as evaluated with flow cytometry and transcriptomics.

Poster 14 - Deep Brain Stimulation of Extrastriatal White Matter Tracts for Visual-Cognitive Function Modulation in Parkinson's

Aratrik Guha

A Guha², SS Nair^{1,2}, A Velez¹, and AG Shaikh^{1,2}

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

Subthalamic nucleus deep brain stimulation (STN-DBS) modulates visual search in Parkinson's disease, though individual responses remain heterogeneous. We investigated whether this variability reflects the engagement of specific white matter pathways within the stimulation field. In sixteen paired observations, no single tract independently explained behavioral changes. Instead, performance was best predicted by the co-activation of multiple pathways. Specifically, the joint recruitment of the ansa fasciculus and zona incerta Forel II complex predicted improved non-decision times. Multivariate modeling further demonstrated that the balance between motor and non-motor thalamic bundles explained both oculomotor metrics and cognitive load resilience. These bundles were central to most significant predictors. Our findings indicate that the integrated modulation of multiple thalamic relay territories, rather than any individual pathway, drives improvements in visual search. This suggests that clinical efficacy depends on the strategic balance of tract activation rather than isolated engagement.

Poster 15 - Elicited Plantar Sensation Modulates Residual Limb Muscle Activity During Treadmill Walking

Lindsey Hauck

L Hauck^{1,2}, RJ Triolo^{1,2}, and H Charkhkar^{1,2}

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Lower limb amputation disrupts sensorimotor function, leading to locomotor deficits. Individuals with lower limb loss (LLs) often have a high risk of falls, asymmetrical gait, and impaired balance. These difficulties are partly attributable to the loss of plantar sensation. In the absence of this feedback, LLs rely on compensatory strategies to maintain stability. Nerve cuff electrodes can electrically elicit plantar sensations perceived as originating from the missing foot, which has been shown to improve gait symmetry, locomotor adaptation, and stability. In this study, we investigated whether electrically elicited plantar sensation (EPS) alters residual muscle activity during walking. Two individuals with lower limb loss walked on an instrumented treadmill at self-selected speed for two minutes with and without EPS. Electromyograms (EMG) from residual limb muscles were recorded from intramuscular electrodes. Significantly different muscle activation patterns were found across the gait cycle in both the residual and intact limbs.

Poster 16 - How Many Trials Are Enough? Data-Driven Optimization of Trial Count for Reliable ICMS Threshold Estimation in Rats

Mahasty Khajehzadeh

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¹Biomedical Engineering, Case Western Reserve University; ²Biomedical Engineering, Duke University

Intracortical microstimulation (ICMS) provides sensory feedback for brain-machine interfaces. Perception threshold is a key metric for quantifying stimulation efficacy, electrode performance, and tissue–device interactions over time. We have developed a behavioral protocol to detect ICMS-induced perception in rats, but threshold estimation requires large numbers of behavioral trials, increasing experimental burden. Here, we investigate minimum number of trials required to obtain reliable threshold estimates. We performed a meta-analysis of prior rat ICMS datasets collected using our go/no-go behavioral paradigm. Perception thresholds were estimated using sigmoid fits, and systematic subsampling was applied to evaluate reduced trial counts. Reliability was assessed using error relative to full datasets and dispersion metrics across repeated subsamples. Our results demonstrate that using 50% of the original trials maintains low estimation error and reliable threshold values. These findings provide a data-driven framework for optimizing behavioral session design, reducing experimental time while preserving quantitative accuracy in ICMS studies.

Poster 17 - Machine learning to enhance the reliability of urine dipsticks in detecting the absence of urinary tract infections

Kaitlin Kim

K Kim¹, M Sargusingh¹, P Akella¹, and AG Hernandez-Reynoso¹

¹Biomedical Engineering, Case Western Reserve University

Urinary tract infections frequently interfere with bladder assessments such as urodynamics, using symptoms as exclusion criteria. However, after spinal cord injury symptoms are absent, requiring reliable screening: urine cultures provide accuracy but require 24–48 hours, whereas rapid dipstick tests are often unreliable. Here propose that the use of machine learning algorithms on dipstick results (blood, nitrites, pH, leukocytes) can improve reliability, using urine culture as ground truth (n=53). We trained and compared multiple machine learning algorithms. Our goal was to develop an accurate algorithm with high specificity. Dipstick analysis of pH yielded moderate accuracy (60%) and sensitivity (77%) but poor specificity (44%). Preliminary results for the best neural network achieved 70% accuracy, 78% specificity, and 62% sensitivity. These results suggest that machine learning could improve the trust on negative dipstick results so that urodynamics can be performed without waiting for culture results; whilst positive results can trigger further culture.

Poster 18 - Volume-Efficient Split Canted-Cosine-Theta Coils for Near-Field Data Transmission

Ben Kwiatkowski

B Kwiatkowski¹ and S Majerus^{1,2}

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

Transmitting devices that are deeply implanted suffer from attenuation in the body at high frequencies and their ability to communicate with external devices is limited by their directivity. To address these issues, the split quadrupole canted-cosine-theta (CCT) coil, derived from the split dipole CCT coil of previous work, is a nearly omnidirectional near-field magnetic transmitter with a relatively low operating frequency. Developed on a flexible printed circuit board, this coil is wrapped into a cylinder, and when in this configuration, it was hypothesized that the coil would concentrate magnetic flux along two orthogonal axes. By mapping the measured received power about this coil in a 24 cm sphere, it was found that the magnetic field pattern was similar to that of two solenoids with orthogonal central axes. Specifically, these results suggest that the split quadrupole CCT coil would be well-suited as a volume-efficient, near-omnidirectional transmitter wrapped around cylindrical implants.

Poster 19 - Effort-based Decision-Making in Post-Stroke Gait: A Feasibility Study

Dana Lorenz

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¹Physical Medicine and Rehabilitation, MetroHealth Medical Center and Case Western Reserve University;

²Health Sciences, Physical Therapy, University of North Carolina at Chapel Hill; ³Biomedical Engineering, Johns Hopkins University School of Medicine and Kennedy Krieger Institute

Conventional stroke therapy focuses on reducing physical impairments, but movement decisions significantly impact recovery. This study explores the feasibility of assessing effort-based decision-making during walking post-stroke. Initially, five neurotypical participants cleared obstacles of varying heights while wearing a knee immobilizer to simulate reduced knee flexion. They rated their perceived effort and completed an effort choice paradigm. In a second experiment, five individuals with stroke followed a similar protocol without immobilizers on a harnessed treadmill. Results showed that perceived effort increased with obstacle height across all participants, and individuals could recall obstacle heights accurately. Notably, subjective effort value rose with knee immobilization in the control group. We conclude that assessing effort-based decision-making in walking contexts for people post-stroke is feasible.

Poster 20 - Putting the brain in direct control of muscle stimulators

Ziling Luo

Z Luo², J Tyler^{1,2,3}, and D Taylor^{1,2,3}

¹Neurosciences, Cleveland Clinic; ²Biomedical Engineering, Case Western Reserve University; ³Cleveland Functional Electrical Stimulation Center of Excellence, Louis Stokes Cleveland VA Medical Center

By integrating Brain-Machine Interfaces (BMIs) with Functional Electrical Stimulation (FES) systems, paralyzed individuals can mobilize their own limbs through thought alone. However, accurately decoding intended movements and determining the precise stimulation values needed to make that movement remain hard engineering problems to solve. The conventional approach to BMI-controlled FES is to first decode the desired movement from the brain and then determine what FES stimulation values will create the desired movement in real time. However, our brains are incredibly powerful neural networks designed to learn new tasks. Therefore, this research utilizes a computational arm model driven by both simulated neurons and real animal neural data to explore the feasibility of putting the recorded neurons in direct control of the muscle stimulators through a simple linear weight matrix and testing the brain's ability to learn to make arm movements through this imposed linear mapping.

Poster 21 - Detection of Gait Perturbations After Incomplete SCI for the Development of a Balance Recovery Controller

Isabella McCollum

I McCollum^{1,2}, S Hnat^{1,2}, M Audu^{1,2}, R Triolo^{1,2}, and N Makowski^{1,2}

¹Biomedical Engineering, Case Western Reserve University; ²Advanced Platform Technology Center Motion Study Laboratory, Louis Stokes Cleveland VA Medical Center

Individuals with spinal cord injuries (SCI) experience limited functional mobility and volitional control of muscles below the level of injury, impacting their ability to react and recover to destabilizing events. Neuromuscular electrical stimulation (NMES) applied to peripheral nerves has enabled functional movements after SCI. However, these systems rely on fixed stimulation patterns that are unresponsive to destabilizing perturbations. To address this gap, I propose a control system that utilizes information about the individual's stability during walking to detect and respond to destabilizations, reducing the likelihood of falls walking with NMES. To evaluate wearable sensor signals for detection and classification of perturbations, a series of walking trials with and without perturbations were completed. Perturbations consisted of lateral pelvis pulls, trips, and slips. Deviations between perturbed and unperturbed walking signals were quantified using a threshold-based detection method. The accuracy and latency of the sensor signals were evaluated.

Poster 22 - From Lab to Hospital: A Pilot Deployment of an AI-Enhanced Robot-Assisted Feeding System

Jacob Miller **Selected for oral presentation*

C Foley¹, G Kubec², I Burkhart³, N Zingale^{2,4}, and E Scheerer⁵

¹Maxine Goodman Levin School of Urban Affairs, Cleveland State University; ²Occupational Therapy, Cleveland State University; ³North American Spinal Cord Injury Consortium; ⁴Human Fusions Institute, Case Western Reserve University; ⁵Physical Medicine and Rehabilitation, MetroHealth Medical Center, Case Western Reserve University School of Medicine

Assistive robots could help address caregiver shortages and increase independence for individuals with spinal cord injury (SCI), yet most systems lack evaluation outside controlled laboratory settings. This study evaluated the performance, usability, and workload of RAF-HI, an AI-enhanced robot-assisted feeding system deployed in an inpatient SCI rehabilitation unit. Two participants with SCI used the system to eat eight modified hospital meals in their units. Across meals, RAF-HI achieved a bite acquisition rate of 88.4% and a transfer rate of 87.4%, comparable to state-of-the-art benchmarks. Despite strong technical performance, usability and workload outcomes were poor (SUS 47.5; NASA TLX 42.9), and frequent researcher interventions were required. Participants identified limited adaptability and complex setup as key barriers to adoption. We argue that while AI may support technical performance in a clinical setting, greater situational awareness and human-inspired intelligence are needed for truly independent use.

Poster 23 - Multimodal Deep Learning for Predicting Outcomes in Congestive Heart Failure Patients Using Clinical Notes and Structured Data

Anika Mittal

A Mittal¹ and C Drummond¹

¹Biomedical Engineering, Case Western Reserve University

Congestive heart failure (CHF) remains a leading cause of mortality and hospital readmissions, highlighting the need for more accurate outcome prediction. Most existing models rely on structured electronic health record (EHR) data, such as labs and vitals, but often ignore unstructured clinical notes that capture important context about patient condition and clinician judgment. This scoping review explores how multimodal deep learning models combine structured data with clinical text to improve prediction of outcomes such as mortality, readmission, and length of stay. A systematic search across major databases identified studies using architectures such as transformer-based NLP models (e.g., ClinicalBERT) and tabular neural networks. Overall, multimodal models show clear improvements over traditional and single-modality approaches, largely due to the added value of clinical notes. However, issues like interpretability and real-world use still need to be addressed. These findings emphasize the potential of multimodal approaches to improve risk prediction and support better clinical decision-making in CHF care.

Poster 24 - 3D Printing PDMS for Custom Prosthetic Interfaces: Nozzle Design and In Situ Curing Strategies

Tej Moradia

T Moradia¹ and C Cao¹

¹Mechanical and Aerospace Engineering, Case Western Reserve University

This work investigates extrusion-based 3D printing of thermoset materials, focusing on polydimethylsiloxane (PDMS) processing and in situ curing control. The study designs and evaluates nozzle architectures, including coaxial, needle based, and standard geometries, to achieve controlled thermal curing through integrated heating and water cooling. These designs address key limitations in thermoset additive manufacturing, including poor shape retention, limited geometric complexity, and slow curing kinetics. Building on advances in direct ink writing and in situ thermal curing, the work implements a PDMS-based material system adapted for continuous extrusion. Experimental characterization evaluates print fidelity, curing behavior, and mechanical performance. Results demonstrate improved structural integrity and process control, enabling fabrication of soft, biocompatible components such as prosthetic socket pressure sensors, soft robotic actuators, and patient-specific interfaces. These capabilities support scalable manufacturing of customizable rehabilitation and prosthetic devices, improving comfort, load distribution, and long term outcomes for veterans.

Poster 25 - Location-Dependent Differences in Microvascular Control After Peripheral Nerve Damage

Hannah Morgan

HS Morgan^{1,2}, RJ Triolo^{1,2}, and H Charkhkar^{1,2}

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

Protective mechanisms in the skin rely on the nervous system to rapidly adjust skin blood flow when exposed to stress. These mechanisms are crucial to tissue health and may be impacted by damage to peripheral nerves. The effects of different etiologies of peripheral nerve damage on the control of skin blood flow are poorly understood. This study characterized reflexive vasodilation of the skin microvasculature in locations affected by peripheral nerve damage in individuals with lower limb amputations and individuals with diabetic peripheral neuropathy. The skin was heated in three stages and perfusion was measured using laser Doppler flowmetry. Microvascular control was compared between areas of interest and corresponding unaffected areas. Statistically significant effects of location were found at all three phases of heating, indicating changes involve multiple physiological mechanisms. These results indicate that there is a link between damage to peripheral nerves and microvascular control that is location dependent.

Poster 26 - Sensor Combination for Robust Estimates of Trunk Tilt

Matthew Morrison

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Feedback control of functional neuromuscular stimulation (FNS) can restore some function for individuals with spinal cord injury (SCI)-related trunk paralysis. Recent studies using the Networked Neuroprosthesis (NNP) suggest that accurate estimates of trunk tilt can be derived from randomly oriented, fully implanted sensors as a control signal for maintaining trunk posture and balance. However, the accuracy of these estimates is dependent on sensor location, with distal sensors – those near the hips – exhibiting higher position errors. A sensor fusion algorithm was developed to generate a more robust control signal by making distal sensor signals redundant to those from proximal sensors, and was tested in eight neurotypical individuals donned with wearable NNP modules. The results suggest that accurate estimates of trunk tilt can be derived from distal sensors using this method. Further investigation of tuning the algorithm parameters is required to optimize the results as a feedback signal for trunk control.

Poster 27 - Egocentric Vision-Based Detection of Trunk Compensation in Simulated Stroke Reaching

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Individuals with stroke often employ compensatory trunk movements during reaching, hindering long-term motor recovery if left unaddressed. While identifying and mitigating these behaviors is a goal of rehabilitation, monitoring performance in ecological settings is often constrained by feasibility. Egocentric video via smart glasses technology offers a uniquely accessible way to monitor compensation. This study evaluates whether egocentric vision can detect compensatory trunk engagement during reaching. Healthy participants performed tasks with and without simulated upper-extremity impairment while wearing first-person video glasses. We then trained machine learning models to classify each motion as “compensatory” or “non-compensatory.” Preliminary results suggest this methodology can reliably identify when individuals with stroke compensate during a reach by engaging the trunk. Integrating this algorithm with future automated feedback is a promising path to a low-cost, at-home remote rehabilitation tool to promote proper kinematics and improve functional outcomes.

Poster 28 - Effect of Lower Limb Loss on Anticipatory Postural Adjustments during Gait Initiation

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When voluntarily initiating gait, there are characteristic movements known as anticipatory postural adjustments (APAs) that shift the body's center of pressure (COP). APAs provide forward propulsion and move body weight off the swing leg. They are disrupted in individuals with lower limb loss where gait initiation takes longer and overly relies on the intact limb. One factor behind these changes is the lack of cutaneous sensation which normally provides information about the support surface and modulates APAs. A sensory neuroprosthesis (SNP) that provides somatosensory feedback via an implanted peripheral nerve interface could alleviate these deficits. We evaluated the SNP's effect on gait initiation in three individuals with limb loss and measured the COP and timing of APAs. Results showed a difference in APAs between the intact and prosthesis side without a significant effect of the SNP. Future work will explore how the SNP may affect APAs under more complex conditions.

Poster 29 - Implantable Multimodal Sensor Array for Hemodynamic Monitoring

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Reliable hemodynamic sensors are essential for monitoring a patient's cardiovascular condition. Sudden and complex changes to one's hemodynamic state are often overlooked or misrepresented by standard single sensor modalities. By combining reliable sensors into a time-aligned multimodal sensor, physiological activity can be represented in a more holistic manner. As we progress through the era of machine learning, innovations in multimodal sensors can serve as the basis for future complex pattern recognition, allowing us to identify key physiological states with higher precision. We propose a multimodal sensor consisting of a photoplethysmogram sensor, hemodynamic microphone array, and a flexible extravascular strain gauge to capture waveforms associated with optical absorption, hemo-acoustic bruits, and vascular distention. Through benchtop testing in different flow conditions, promising time-aligned waveforms were acquired. With further analysis, key features in these waveforms can be extracted, compared, and aligned with an associated hemodynamic state.

Poster 30 - Models of Cafe Style Vocational Rehabilitation

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People with developmental disabilities often participate in community-based transition programs when they reach adulthood with the aim of placing individuals into the workforce. Over the past decade, Northeast Ohio has become a leader in a specific type of community-based transition program that uses a public cafe as a model for job training. In this poster, we compare and contrast four different programs in Northeast Ohio that offer this “cafe-style” community-based transition program. These programs differ in terms of the services provided, the participants, and the financial model among other factors. We offer suggestions for what might be best practices for these models as well as discuss the unmet needs of the disability community. We note that the community-facing nature of cafe-style transition programs connects the disability community to the world and serves as more than just vocational training.

Poster 31 - SafeCath: An At-Home System for Bladder Pressure-Volume Monitoring

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Neurogenic bladder in spinal cord injury (SCI) patients can lead to elevated bladder pressures and serious complications, including renal damage. Current monitoring via annual urodynamic studies (UDS) is invasive and limits routine assessment. SafeCath is an at-home system designed to estimate bladder pressure during intermittent catheterization by analyzing drainage dynamics. The device integrates a high-flow pressure sensor, solenoid valve for pressure isolation, strain gauge for volume measurement, and microcontroller for automated data collection. Benchtop validation and a phantom bladder system demonstrated high accuracy, with pressure bias of -0.15 ± 0.65 cmH₂O (0–100 cmH₂O) and volume bias of 0.24 ± 2.5 mL (0–500 mL). Preliminary clinical data analysis is ongoing, with early observations suggesting agreement between SafeCath-derived pressure trends and UDS measurements and the ability to identify elevated pressure profiles. These results support SafeCath's potential as a non-invasive screening tool for early detection of high-risk bladder conditions.

Poster 32 - Micro-computed Tomography and Immunohistochemical Analysis of the Swine Carotid Sinus Nerve

Julie Savage

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Hypertension occurs in nearly half of US adults and was a contributing cause of over 600,000 deaths in 2023. Baroreflex activation therapy (BAT) uses an implanted device to deliver electricity to the carotid sinus to modulate neural activity, harnessing the body's baroreceptor reflex to lower blood pressure. However, BAT has shown mixed results, mainly due to difficulty in avoiding nearby nerves. While the basic anatomy of the CSN is known, it is very small and multifasciculated and is difficult to investigate by dissection alone. Its size and proximity to nearby nerves makes clinical device design complicated. Preclinical BAT studies are often performed in pig models. Swine CSNs have not been well documented or described. We have combined microdissection, μ CT imaging with contrast and histology to identify and analyze the swine CSN, its branching, and its interaction with nearby anatomy. This anatomical study will inform clinical device development.

Poster 33 - Bioproduction of Neural Stem Cells Derived Extracellular Vesicles Using Electrical Stimulation

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Neural stem cells (NSCs) secrete regenerative extracellular vesicles (EVs) with immense potential for central nervous system therapies, yet scalable biomanufacturing remains a critical limitation. To address this, we engineered a flexible, biocompatible graphene-based interdigitated electrode (IDE) platform to deliver programmable electrical stimulation (ES). By modulating alternating current (100–200 mV, 50 Hz), we achieved deterministic control over NSC behavior while maintaining >99% viability. The platform operates as a voltage-dependent, biphasic morphogenic switch. Moderate ES (100–150 mV) maximizes small EV biogenesis and miRNA encapsulation. Conversely, elevated field strengths (200 mV) trigger G2-phase arrest, suppress EV secretion, and initiate targeted neurogenesis with mature synaptic machinery upregulation, confirmed via transcriptomic profiling and immunocytochemistry. By tuning electrical parameters, this graphene array serves as an advanced bioreactor for scalable EV biomanufacturing and an active scaffold for precision neural tissue engineering.

Poster 34 - Automated Quantification of Perineurium Morphology in Human Vagus Nerve Histology for Improved Neurostimulation Modeling

Mallika Singh **Selected for oral presentation*

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Vagus nerve stimulation (VNS) is an established therapy for epilepsy and depression, yet computational models guiding electrode design often assume a uniform perineurium, the primary electrical barrier surrounding fascicles. Because perineurium thickness directly influences current penetration and fiber activation thresholds, inaccurate representation of this structure directly distorts predictions of which nerve fibers activate, undermining therapeutic precision. We developed an automated deep learning pipeline to segment human vagus nerve histology from whole-slide H&E-stained images and quantify perineurium thickness as a spatially resolved, circumferential profile for each fascicle. Across 898 fascicles spanning cervical and thoracic regions, we observe that perineurium thickness scales with fascicle size and exhibits substantial intra-fascicular variability, particularly in larger cervical fascicles. These results demonstrate that perineurium morphology is highly heterogeneous and cannot be adequately represented by a single value. Incorporating spatially resolved perineurium structure into computational models may improve predictions of fiber recruitment and stimulation selectivity—advancing the precision of VNS therapy.

Poster 35 - Early Adaptation to a Novel Pediatric Gait Trainer: A Case Series Study

Jake Stahl

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Cerebral palsy (CP) affects musculoskeletal development and limits daily activities, making gait training essential for children with CP. The RooWalk is a novel prototype gait trainer designed with a partial weight support system and motorized wheels to enhance independence and mobility. This study evaluated the early adaptation to the RooWalk in eight children with neuromuscular disorders, focusing on gait quality, exploration, and assistance levels compared to traditional gait trainers. Results indicated that the RooWalk encouraged greater independent exploration, reduced assistance needs, and improved maneuverability. Participants also showed better posture while walking, although some exhibited slower or less symmetric gait patterns. This pilot study suggests that even a single day with the RooWalk can provide positive benefits, though additional training may be needed for optimal adaptation. Further research is necessary to assess long-term advantages of the RooWalk.

Poster 36 - PCB Design Improvements for Ultrasonic Tibial Nerve Stimulator

Amit Thusay

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Peripheral neuromodulation is used to treat symptoms of conditions like peripheral and diabetic neuropathy, overactive bladder syndrome, and chronic pain. The least invasive route for neuromodulation is TENS or transcutaneous electrical nerve stimulation; however, it can accidentally stimulate unintended nerves. An emerging alternative to conventional electrical neuromodulation is the use of low intensity focused ultrasound (LIFU); this method uses ultrasonic modulation to reduce the activation threshold for peripheral nerves. A device that uses this method of neuromodulation is the Steerable Ultrasonic Nerve Stimulator (SUNS). This project focused on improving the current device and adding TENS stimulation; PCB prototypes were developed to improve the precision of the phased array and the device's form factor. Using achieved real-time control, we will pair a clinical grade electrical stimulator to work synchronously with the device. To test the effectiveness of this setup, we plan on using an agarose gel phantom media with embedded sensors.

Poster 37 - Evaluation of Dox-loaded PLGA Nanoparticles in Elastogenesis for Pelvic Organ Prolapse (POP) Treatment: A Preliminary Study

Duong Tam Nghi Tran

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Introduction: Pelvic organ prolapse (POP) involves disruption of the extracellular matrix (ECM) homeostasis and impaired elastin. Current treatments are limited and have high recurrence rates, highlighting the need for better therapies. This study aims to identify the optimal, low-cytotoxicity concentration of doxycycline-loaded PLGA nanoparticles (Dox-PLGA) for future in vivo evaluation of elastin restoration. **Methods:** Nonepithelial vaginal cells (NEVCs) were isolated from mice and human tissues using enzymatic digestion and were cultured. Cells were treated with blank PLGA, Dox-PLGA at varying concentrations (0.5, 0.2, 0.1, 0.05, and 0.01 mg/mL), or were untreated. Cytotoxicity and viability were assessed using Live/Dead staining. **Results:** Both PLGA and Dox-PLGA showed acceptable biocompatibility; however, Dox-PLGA demonstrated improved cell viability. Lower positive surface charge reduced toxicity, while higher concentrations increased cytotoxicity. Among tested concentrations, 0.1 to 0.01 mg/mL showed the best cell viability. **Conclusion:** Dox-PLGA shows promise for future studies targeting elastin regeneration as a POP therapy.

Poster 38 - Quality Assessment of Peripheral Nerve Histology

Quan Tran

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Vagus nerve stimulation (VNS) treats epilepsy and is being developed for other conditions, but off-target activation can cause hoarseness, cough, throat discomfort, and shortness of breath, limiting therapeutic utility. Selective VNS design requires accurate knowledge of vagus nerve morphology, often reconstructed from histological images using segmentation-based workflows. However, these pipelines are vulnerable to artifacts from tissue processing, sectioning, and imaging. Here, we evaluated AI-based strategies for detecting artifacts in routine hematoxylin and eosin (H&E) peripheral nerve histology. We framed artifact detection as a binary classification task distinguishing clean tissue from samples degraded by blur, folds, or perineurial threading, a nerve-specific artifact in which disrupted perineurium resembles fascicular boundaries. We compared handcrafted features, ResNet50 fine-tuning, foundation model embeddings, and hybrid handcrafted-foundation model features. The hybrid approach achieved the best held-out performance (AUC = 0.842), establishing an initial benchmark for artifact screening in peripheral nerve histology.

Poster 39 - A Flip-chip-integrated Focused PVDF-TrFE PMUT Microsystem for High-resolution Intravascular Ultrasound Imaging

Ruiyan Wang

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Cardiovascular diseases remain the leading cause of death worldwide, with atherosclerosis as a major underlying pathology. Accurate plaque assessment is therefore critical, motivating high-resolution intravascular imaging. In this work, we present a miniature IVUS microsystem that integrates a focused broadband PVDF-TrFE piezoelectric micromachined ultrasonic transducer (PMUT) with a flip-chip-bonded analog front-end ASIC on a catheter-scale printed circuit board. The PMUT is formed from a freestanding gold-coated PVDF-TrFE film, shaped spherically by differential pressure and fixed with conductive epoxy that also provides backside contact and acoustic backing. To overcome the low sensitivity and high output impedance of PVDF-TrFE transducers, a high-voltage-tolerant AFE-ASIC was co-designed for local amplification and 50 Ω buffering. The integrated system achieved center frequencies above 40 MHz, a -6 dB bandwidth of 92%, ~20 μm axial resolution, 75 μm lateral resolution at 2.4 mm focus, and up to 5 mm penetration in rotational IVUS imaging.

Poster 40 - Assessing the Visual Consistency of Printed Circuits for a Smart Prosthetic Liner

Cindy Xu

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To address skin breakdown caused by unequal pressure in prosthetic sockets, this research evaluates Aerosol Jet Printing (AJP) for fabricating low-profile, embedded sensor arrays. AJP is an additive manufacturing, direct-write process that deposits aerosolized metallic ink to create micron-scale, flexible circuits. Two studies were performed, which assessed print consistency: drift (deviation of print quality over a four-hour session) and repeatability (consistency of print quality across five separate days). The printed geometries—comprising pads and connecting traces—were analyzed via optical microscopy and image analysis using a custom MATLAB script to quantify rectangularity, trace width, and overspray. Validating AJP's reliability is a prerequisite for the next phase: testing printed sensors under load and embedding them directly into socket linings. By mapping real-time data at the limb-socket interface, prosthetists can gain insights into spatial force distribution. This data-driven approach allows for highly personalized socket adjustments, significantly improving comfort and long-term mobility for amputees.

Poster 41 - Development of a ride-on car therapy gaming platform for children with neurological impairments

Leyi Yu and William Kozak

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Children with cerebral palsy (CP) or traumatic brain injury (TBI) often experience combined motor and cognitive impairments that limit participation and therapy progress. Existing interventions lack intensity, engagement, and accessibility outside the clinic, leaving a large portion of a child's week without meaningful goal-directed training. We propose a modular ride-on therapy gaming platform integrating customizable 3D-printed hand controls, adaptive driving games targeting motor and cognitive skills, and haptic feedback. The system retrofits existing ride-on cars, enabling both indoor training and outdoor mobility. A prototype with multiple control interfaces and games has been developed. Upcoming pilot testing will evaluate its feasibility and effects on hand function, cognition, and reducing caregiver burden.