UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE & ENGINEERING

GECoS UofT
Graduate Engineering Council of Students
University of Toronto

UNIVERSITY OF TORONTO RESEARCH CONFERENCE

August 27, 2024

Myhal Centre for Engineering Innovation and Entrepreneurship

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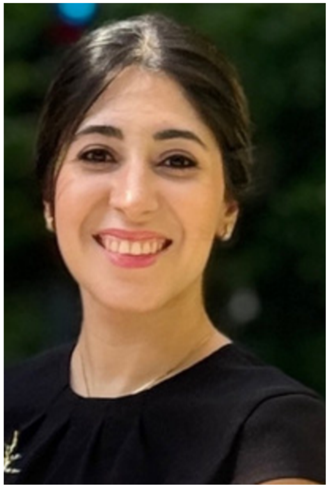
Welcome Message



Fatemeh Bagheri

UTERC Chair

It is our absolute pleasure to welcome you to the University of Toronto Engineering Research Conference (UTERC) 2024! We are all very eager to meet in person at the Myhal Centre for Engineering Innovation and Entrepreneurship.

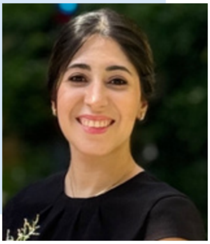
UTERC provides students, researchers, and industry professionals with opportunities to engage with the work of our graduate students while learning more about the leading research done at the Faculty of Applied Science & Engineering (FASE).

This year's theme is ***Collective Innovation***, with the ultimate purpose of providing networking opportunities, to encourage collaborative problem solving, and to continue to build the community of students and alumni from U of T.

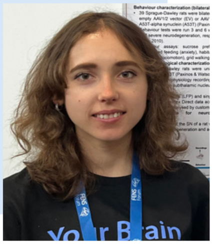
As a leading research faculty, the Faculty of Applied Science & Engineering is pushing the limits and pioneering initiatives in this increasingly digital world. Embracing the spirit of collective innovation, we recognize the importance of coming together to keep our community connected and meet the evolving needs of our students. Through innovation and collaboration, what we can achieve together is truly boundless.

We hope you enjoy the conference!

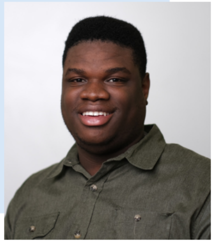
Our Team



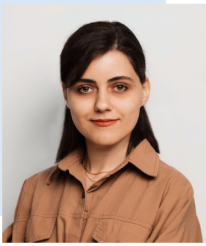
Fatemeh Bagheri
Chair



Laura Kondrataviciute
Logistics Lead

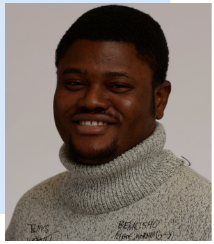


Reke Avikpe
Communications Lead

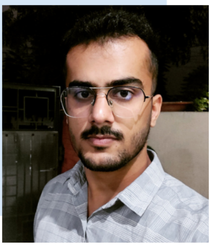


Faezeh Shahsavandi
Outreach Lead

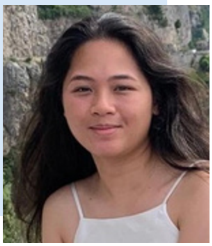
Elisa Guo
Logistics



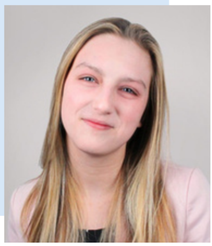
Stephen Kope
Logistics



Karanbir Singh Brar
Communications



Alyssa Apilan
Outreach



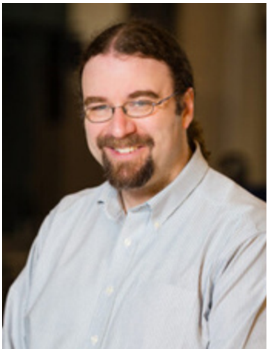
Saskia van Beers
Outreach

Schedule-at-a-Glance

All events are at the Myhal building

Time	Event Description	Location
9:00 AM - 10:15 AM	Registration Poster Setup Breakfast & Networking	Lobby
10:15 AM - 10:40 AM	Opening Remarks: Prof. Evan Bentz, Vice Dean, Undergraduate, FASE	MY150
10:40 AM - 11:00 AM	Keynote Speaker: Prof. Julie Audet, Vice Dean, Graduate, FASE	MY150
11:00 AM - 12:00 PM	Oral Presentations: Human Health and Biomedical Engineering Data Analytics and AI	MY330 MY320
12:00 PM - 1:00 PM	Lunch & Networking	Lobby
1:00 PM - 2:00 PM	Oral Presentations: Advanced Materials and Biomedical Engineering Sustainability, Design and Manufacturing	MY330 MY320
2:00 PM - 3:45 PM	Poster Presentations	Lobby
3:45 PM - 4:00 PM	Break Poster Take Down	Lobby
4:00 PM - 4:30 PM	Closing Remarks Prize Winners Announced	MY150

Opening Remarks



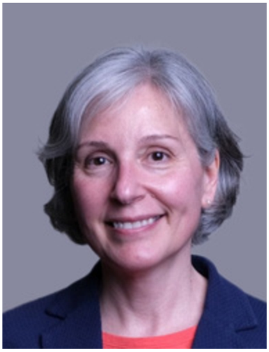
Prof. Evan Bentz

Vice Dean, Undergraduate Studies,
Faculty of Applied Science and Engineering
University of Toronto, ON

Professor Evan Bentz is a distinguished leader in structural engineering and a faculty member in the Department of Civil and Mineral Engineering at the University of Toronto. His expertise lies in the development of advanced structural analysis software and innovative approaches to structural design and repair. Professor Bentz is renowned for his work on the "Response" software, a revolutionary tool that has significantly influenced building codes across Canada, the United States, and Europe by enabling engineers to predict the behavior of structures under extreme conditions. His research includes using the U of T-designed Shell Element Tester, the only facility in Canada capable of full-scale shell element testing under all eight possible force components, to validate hypotheses on the mechanisms of building collapse.

As Vice-Dean of Undergraduate Studies in the Faculty of Applied Science and Engineering, Professor Bentz plays a pivotal role in shaping the educational experiences of undergraduate students. He is dedicated to integrating cutting-edge research with practical engineering applications, thereby equipping the next generation of engineers with the tools and knowledge necessary to enhance structural safety and resilience. Under his leadership, the faculty continues to advance the field of structural engineering, focusing on improving building assessment and maintenance, particularly in predicting structural safety following seismic events, ultimately saving lives and reducing costs.

Keynote Speaker



Prof. Julie Audet

Vice Dean, Graduate Studies,
Faculty of Applied Science and Engineering
University of Toronto, ON

Professor Julie Audet is a renowned expert in stem cell bioengineering and a faculty member in the Department of Biomedical Engineering at the University of Toronto. Since joining the department in 2003, her research has focused on the development of biological search algorithms to optimize stem and progenitor cell manufacturing processes. These algorithms incorporate machine learning to iteratively refine combinations of growth factors, inhibitors, extracellular matrix molecules, and biomaterials, accounting for the inherent variability of biological systems. This optimization process not only facilitates the discovery of defined culture conditions for precursor cells but also enhances the efficiency of cell manufacturing, reducing reagent use and labor costs while increasing cell yield and quality. Professor Audet's innovative work has garnered numerous accolades, including the 2023 Connaught Innovation Award and recognition from international organizations such as AABB and the Brain & Behaviour Research Foundation.

As Vice-Dean of Graduate Studies in the Faculty of Applied Science and Engineering, Professor Audet plays a critical role in advancing graduate education and research. She has been instrumental in developing a new Master of Engineering in Biomedical Engineering program, launched in 2016, with a focus on biomedical devices. She is currently overseeing the introduction of microcredential courses in Biomanufacturing, aimed at enhancing the skill set of students in the rapidly evolving field of biomedical engineering. Through her leadership, the faculty continues to push the boundaries of bioengineering, preparing students to meet the challenges of modern healthcare and biotechnology industries.

Presentation Schedule

Time		Human Health and Biomedical Engineering (MY 330)	Data Analytics and AI (MY 320)
Morning Oral Sessions	11:00 AM - 11:10 AM	#1 Yinghe Sun	#7 Cheng Chen
	11:10 AM - 11:20 AM	#2 Amel Sassi	#8 Craig Fernandes
	11:20 AM - 11:30 AM	#3 Aiman Fatima	#9 Nakul Upadhya
	11:30 AM - 11:40 AM	#4 Delaram Sadatamin	#10 Mojgan Faramarzi
	11:40 AM - 11:50 AM	#5 Gurnish Sidora	#11 Mohaddeseh Abdolhosseini
	11:50 AM - 12:00 PM	#6 Kamilla Aliyeva	#12 Saba Sadatamin
Time		**Advanced Materials and Biomedical Engineering (MY 330)**	**Sustainability, Design and Manufacturing (MY 320)**
Afternoon Oral Sessions	1:00 PM - 1:10 PM	#13 Minnie Menezes	#19 Dijuan Liang
	1:10 PM - 1:20 PM	#14 Shaghayegh Chavoshian	#20 Amanuel Goliad
	1:20 PM - 1:30 PM	#15 Rabeena Krishnasamy	#21 Kevin Marrs
	1:30 PM - 1:40 PM	#16 Zhi Yi Wang	#22 Mohammad Mahaninia
	1:40 PM - 1:50 PM	#17 Md Akibul Islam	#23 Faunas Bagchi
	1:50 PM - 2:00 PM	#18 Niher Ranjan Parker	#24 Laura Kondrataviciute
Time		**Presenter (Lobby)**	
Poster Sessions	2:00 PM - 2:10 PM	#1 Zhenying Yang	
	2:10 PM - 2:20 PM	#2 Naayaab Nagree	
	2:20 PM - 2:30 PM	#3 Jaturong Kongmanee	
	2:30 PM - 2:40 PM	#4 Davood Dadkhah	
	2:40 PM - 2:50 PM	#5 Ferdinand Reke Avikpe	
	2:50 PM - 3:00 PM	#6 Katrina Zaraska	
	3:00 PM - 3:10 PM	#7 Hugo Higueros	
	3:10 PM - 3:20 PM	#8 Peter Di Palma	
	3:20 PM - 3:30 PM	#9 Nadine Alzaghrini	
	3:30 PM - 3:40 PM	#10 Shih-Yang Cheng	

Human Health & Biomedical Engineering

Oral Presentations (11:00 AM - 12:00 PM, MY330)

#	Time	Title	Presenter
1	11:00 AM - 11:10 AM	Improving selective peripheral nerve recording classification through deep learning	Yinghe Sun
2	11:10 AM - 11:20 AM	Effects of Low-Magnitude High-Frequency Vibration on Prostate Cancer Progression and Bone Metastasis	Amel Sassi
3	11:20 AM - 11:30 AM	Folic Acid Degradation in Multiple Fortified Salt and Food	Aiman Fatima
4	11:30 AM - 11:40 AM	Design and Development of an e-textile for Heart Rate Measurement in Different Conditions	Delaram Sadatamin
5	11:40 AM - 11:50 AM	Estimation of flow rates from clinical pressure measurements for individualized cfd of cerebral venous stenotic disease	Gumish Sidora
6	11:50 AM - 12:00 PM	Microencapsulation of iron using three-fluid nozzle spray drying for tea fortification	Kamilla Aliyeva

Human Health & Biomedical Engineering

Oral Presentation (#1)

Improving selective peripheral nerve recording classification through deep learning

Presented by: Yinghe Sun

Abstract

Background & Objectives
Current prototype in peripheral nerve interfaces utilize neural networks to classify neural activities. Since the model makes classification based on spatiotemporal neural features that vary across subjects and the model is subject-specific, it would be great to cross-relate data from other subjects to improve the generalizability of the model. Therefore, the objective is to leverage data from across other subjects and investigate the impact of transfer learning on model performance in classifying peripheral nerve recordings in new datasets.

Methods
The study applied Extraneural Spatiotemporal Compound Action Potentials Extraction Network (ESCAPE-NET) to classify afferent neural activities corresponding to three different states of hindpaw—dorsiflexion, plantarflexion and pricking of the heel. The datasets used for this study are extraneurographic recordings sampled from sciatic nerves of 9 Long-Evans Rats through 7x8 multi-channel nerve cuff electrodes while mechanical stimuli were applied to the hindpaw. The ESCAPE-NET model was first trained on dataset from each rat as baseline. Then for each baseline model, they were re-trained starting from weights trained on one other rat. By excluding those trained again on their baseline dataset, 8x9 models were obtained. Mean accuracy and mean F1 score macro of these models in predicting the sensory or proprioceptive pathway associated with an nCAP were evaluated.

Results
a slight increase was found regarding the mean F1 score macro and the mean accuracy of the best performance of transfer learning models on each rat compared to the baseline performance respectively (+0.0173(2.3596%)) (+0.0167(2.1022%)).

Conclusions & Significance
The study concludes that by applying transfer learning method onto existing datasets within the same size, no significant improvements were found in terms of models' performance in classifying neural signatures. The study validates the potential effects that transfer learning may apply to similar-size datasets across subjects.

Human Health & Biomedical Engineering

Oral Presentation (#2)

Effects of Low-Magnitude High-Frequency Vibration on Prostate Cancer Progression and Bone Metastasis

Presented by: Amel Sassi

Abstract

Prostate cancer preferentially metastasizes to bone, which typically leads to bone pain and fractures. Notably, 80% of men who die from prostate cancer exhibit signs of bone metastases. To mitigate these effects, exercise is often recommended to cancer patients due to the beneficial effects on bone remodelling. However, physical activity may be challenging for elderly or bedridden patients. As such, vibration has emerged as a safe, effective, and easy to perform alternative therapy. Specifically, low magnitude high frequency (LMHF) has been shown to activate osteocytes and thereby reduce breast cancer cell migration. Nevertheless, the effects of vibration on prostate cancer progression and extravasation remains to be elucidated.

To study extravasation, a bone-metastasis-on-a-chip model composed of a PDMS chip plasma bonded to a glass slide with MLO-Y4 cells (osteocyte-like cells) seeded into the osteocyte channel and HUVECs (endothelial cells) and PC3s (prostate cancer cells) seeded into the lumen channel was utilized. Devices were placed on a custom-made vibration platform (0.3 g, 60 Hz, 1 hr/day) for 3 consecutive days. Additionally, to assess the direct effects of vibration on prostate cancer cells, an apoptosis, viability, and colony formation assay was carried out. LMHF vibration significantly reduced extravasation distance by approximately 37%. We also observed that 29% more PC3 cells remained adhered to HUVECs in static MLO-Y4 conditioned media (CM) when compared to vibration MLO-Y4 CM. Furthermore, a significant reduction in colony formation was observed following vibration treatment which was attributed to a reduction in cell growth as no changes in viability or apoptosis were determined. Results suggest that LMHF vibration may be effective at reducing the incidence of PC3 growth as well as extravasation due to soluble factors secreted by vibration stimulated osteocytes that decrease the adhesion of PC3 cells to the endothelial monolayer. These preliminary findings provide evidence for the potential use of LMHF vibration to alleviate additional prostate cancer growth and downstream bone metastases.

Human Health & Biomedical Engineering

Oral Presentation (#3)

Folic Acid Degradation in Multiple Fortified Salt and Food

Presented by: Aiman Fatima

Abstract

Micronutrient deficiencies are a cause of disease burden in low-income countries, especially in women and children. Women of reproductive age with folic acid deficiency are at high risk of giving birth to babies with neural tube defects. Balanced diet intake is a challenge in developing countries. Multiple fortified salt can potentially address this challenge in a cost-effective manner. Development of quintuple fortified salt (Q5FS), that is, fortification with iodine, folic acid (B9), iron, zinc and vitamin B12 is a viable solution to this problem. This research aims to develop method for folic acid quantification using UV-Vis spectrophotometry and understand mechanism of folic acid interaction with other micronutrient in fortified salt and food. Salts studied in this research were from Ethiopia, India and Canada, which contain different impurities. Methods used to quantify folic acid are (i) Extraction of folic acid from fortified salt by 0.1M Na_2CO_3 and measuring absorbance at 285nm using spectrophotometer, (ii) spectrophotometry-based coupling method (SBCM) involving various chemical reactions and taking absorbance at 460nm. First method, quantifies folic acid for concentration <50ppm in absence of iron; whereas second method does not work for Ethiopian salt due to impurities. Working on removal of iron from folic acid and analytical method development is in progress.

Human Health & Biomedical Engineering

Oral Presentation (#4)

Design and Development of an e-textile for Heart Rate Measurement in Different Conditions

Presented by: Delaram Sadatamin

Abstract

Wearable technology has become popular in recent years due to its convenient ability to be integrated into our everyday lives. These tools can collect a wide range of data and help us to observe and manage various aspects of our health more closely. Smart clothing is a wearable that can track physiological signals, such as electrocardiogram (ECG) conveniently, remotely, and continuously. The quality of the captured ECG signal depends on various factors such as body posture and electrode placement. This study's main objective is to investigate these factors' influence on the ECG signal quality.

Three healthy adults participated in the study. ECG signal was captured with both gold standard gel electrodes and dry textile electrodes simultaneously. The heart rate (HR) values from both gel and textile electrodes were calculated in different body postures and with different electrode placements. Statistical analysis was done to see how accurately the textile captured ECG in comparison with the gold standard in different body postures and with different electrode placements. Furthermore, the absolute error between gel and textile measurements was calculated in different body postures and electrode placements to see which combinations give more accurate HR compared to the gold standard.

The early results indicate that electrode placement and body posture interact to affect HR measurement accuracy. Future work to gather more data is being done to achieve additional statistical power to draw definitive conclusions regarding the influence of electrode placement and body posture on ECG accuracy.

Human Health & Biomedical Engineering

Oral Presentation (#5)

Estimation of flow rates from clinical pressure measurements for individualized cfd of cerebral venous stenotic disease

Presented by: Gurnish Sidora

Abstract

Pulsatile tinnitus (PT) is a symptom characterized by sound perception without external stimuli, often stemming from venous abnormalities such as transverse sinus stenosis (TSS). While diagnostic techniques like computed tomography venography are common, understanding PT's pathogenesis remains debated. Computational fluid dynamics (CFD) offers insights, but challenges persist in obtaining patient-specific flow rates. In this study, we employed an iterative approach for back-calculating flow rates from invasive clinical pressure measurements, to enhance our understanding of cerebral venous hemodynamics. Using Bernoulli' principle, we first estimated flow rates for 10 TSS cases, and then used the resulting CFD pressures to correct those flow rates so CFD would match the clinical pressure drops. Corrected flow rates were up to 83% different from the assumed generic ones, with concomitant differences in the prediction of high-frequency flow instabilities, highlighting the importance of patient-specific flow rate estimation when possible. Interestingly, the trans-stenotic pressure drops estimated by the simplified Bernoulli formula were highly predictive (R2=0.97; slope=0.99) of those from the full CFD simulations, highlighting a promising avenue for non-invasive estimation of cerebral venous pressure gradients if flow rates are available.

Human Health & Biomedical Engineering

Oral Presentation (#6)

Microencapsulation of iron using three-fluid nozzle spray drying for tea fortification

Presented by: Kamilla Aliyeva

Abstract

Iron deficiency anaemia is a global health issue, affecting over 1.2 billion people and leading to significant health and economic impacts. Traditional solutions like supplementation and dietary changes are often not viable for low- and middle-income classes. This study explores an innovative and cost-effective solution: fortifying milk tea with iron through micro-encapsulation using a three-fluid nozzle spray drying technique. As the second most popular beverage globally, tea is an ideal vehicle for fortification.

In our study, we initially used a three-fluid nozzle spray drying technique. This involved using 3% (w/v%) Sodium Alginate and 2.39% (w/v%) Ferrous Sulfate Heptahydrate (FeSO4*7H2O) in the core liquid feed, with 0.69% (w/v%) Calcium Carbonate in the shell liquid feed for encapsulation. After obtaining the premix, we further processed it by dissolving it in a 0.5% (w/v%) Chitosan solution and applying a second spray drying step using a two-fluid nozzle to achieve double coating. This method was designed to enhance iron delivery in fortified tea. The optimized formulation maintained the tea's taste and appearance while achieving a significant increase in iron content, with 72.9% iron loading and minimal impact on the sensory properties of the tea (ΔE of 0.66). This presents a promising approach to combat iron deficiency anaemia.

Data Analytics & AI

Oral Presentations (11:00 AM - 12:00 PM, MY320)

#	Time	Title	Presenter
1	11:00 AM - 11:10 AM	Undergraduate Engineering Students' Perception of Academic Workload and Its Influencing Factors: Insights from Student Survey Data Analytics	Cheng Chen
2	11:10 AM - 11:20 AM	No More Throwing Darts at the Wall: Developing Fair Handicaps for Darts using a Markov Decision Process	Craig Fernandes
3	11:20 AM - 11:30 AM	NeurCAM: Interpretable Neural Clustering via Additive Models	Nakul Upadhya
4	11:30 AM - 11:40 AM	Synthetic Data Generation for Point Cloud Segmentation applications in Rock Fragmentation for Mining.	Mojgan Faramarzi
5	11:40 AM - 11:50 AM	Pitting corrosion in reinforced concrete structure - analysis and modelling	Mohaddeseh Abdolhosseini
6	11:50 AM - 12:00 PM	Optimizing MRgLITT Patient Monitoring through Time-series based Deep Learning Methods: A Comparative Study of ConvLSTM and U-Net	Saba Sadatamin

Data Analytics & AI

Oral Presentation (#1)

Undergraduate Engineering Students' Perception of Academic Workload and Its Influencing Factors: Insights from Student Survey Data Analytics

Presented by: Cheng Chen

Abstract

Every year, the Faculty of Applied Science and Engineering (FASE) at the University of Toronto (U of T) collects feedback from undergraduate students on university resource usage, personal skills development, overall student experience, and career aspirations through student surveys. The purpose of my summer research work is to understand the associations between students' expectations and perceptions of their academic workload and various possible influencing factors. Data-driven approaches, including statistical correlation tests and machine-learning-based classification analysis, were employed to measure the direction and strength of the correlations and to construct predictive models using the data collected from multiple years of welcome surveys and first-year exit surveys. Key findings indicate that influencing factors such as students' perception of work-life balance, involvement in non-academic activities, level of time management skills, level of planning skills, previous educational experiences, and interactions with academic advisors and professors demonstrate statistically significant associations with their perception of academic workload. The constructed classification models, evaluated using F1 score as the model accuracy measurement for ordinal variables, achieved best training and testing F1 scores that exceed 70%. This research reveals the relative importance of various influencing factors on students' perception of academic workload and demonstrates the predictability of this perception using correlated factors and appropriate models. The findings from this research will help engineering students reflect upon their perception of academic workload and inform FASE about the development of skills that contribute to better managing undergraduate students' academic workload.

Data Analytics & AI

Oral Presentation (#2)

No More Throwing Darts at the Wall: Developing Fair Handicaps for Darts using a Markov Decision Process

Presented by: Craig Fernandes

Abstract

Handicap systems are commonly used in sports to create a competitive balance between players with different skill levels, leading to a more inclusive and engaged sport. While the game of darts has existing methods for handicapping, they are based on heuristics with no guarantee of effectively balancing competition. In this paper, we develop a novel framework to model the game of darts as a Markov Decision Process (MDP) with a dynamic credit handicap system. Using real data from professional dart players, we identify and visualize the main sources of imbalance between players with different skill levels: their performance towards the end of the game. Moreover, we demonstrate that the current main handicap system has shortcomings and does not lead to parity. In response, we develop three "fairer" optimization-based handicap systems which equalize the expected number of throws required for each player to win. We validate our handicap systems via simulation and show that competitive balance can be achieved.

Data Analytics & AI

Oral Presentation (#3)

NeurCAM: Interpretable Neural Clustering via Additive Models

Presented by: Nakul Upadhya

Abstract

Interpretable clustering algorithms aim to group similar data points while explaining the obtained groups to support knowledge discovery and pattern recognition tasks. While most approaches to interpretable clustering construct clusters using decision trees, the interpretability of trees often deteriorates on complex problems where large trees are required. In this work, we introduce the Neural Clustering Additive Model (NeurCAM), a novel approach to the interpretable clustering problem that leverages neural generalized additive models to provide fuzzy cluster membership with additive explanations of the obtained clusters. To promote sparsity in our model's explanations, we introduce selection gates that explicitly limit the number of features and pairwise interactions leveraged. Extensive experiments show that our model achieves performance comparable to black-box methods on tabular datasets while remaining interpretable. Additionally, we demonstrate the capacity of our model to perform text clustering that considers the contextual representation of the texts while providing explanations for the obtained clusters based on uni- or bi-word terms. Our results show that our approach significantly outperforms other interpretable clustering approaches on the text clustering task.

Data Analytics & AI

Oral Presentation (#4)

Synthetic Data Generation for Point Cloud Segmentation applications in Rock Fragmentation for Mining

Presented by: Mojgan Faramarzi

Abstract

The evolution of deep learning techniques has significantly impacted various industrial sectors, including rock fragmentation in mining. Despite these advances, a major challenge remains—the labor-intensive and time-consuming process of data collection and annotation, which is crucial for constructing labeled datasets. Although 2D image analysis has made strides with advanced segmentation tools, its effectiveness in rock fragmentation is limited by issues such as rock color and texture variations, shadowing, and inconsistent lighting conditions. These limitations are particularly pronounced in underground mining operations and during night shifts. This research introduces a novel approach that shifts away from traditional 2D image and photogrammetry methods by leveraging LiDAR technology for point cloud segmentation.

LiDAR technology has become a valuable tool for mining applications due to its ability to quickly and accurately capture high-resolution 3D data, even in low-light environments. This study aims to develop a robust framework for analyzing rock fragmentation using LiDAR data, specifically addressing challenges related to lighting and accessibility in underground settings. By training the SoftRock deep learning model on synthetic 3D datasets, this approach achieves precise rock instance segmentation in three dimensions, enhancing the accuracy of rock object representation and size distribution analysis.

To overcome the challenges of data collection and labeling, this research promotes the use of synthetic labeled datasets, supported by an automated platform for generating and scanning point clouds of rock piles. This method, which relies on coordinate data rather than RGB information, proves particularly effective in challenging environments where maintaining ideal lighting conditions is difficult. The proposed approach represents a significant advancement in rock fragmentation analysis, offering improved practices for diverse mining scenarios.

Data Analytics & AI

Oral Presentation (#5)

Pitting corrosion in reinforced concrete structure - analysis and modelling

Presented by: Mohaddeseh Abdolhosseini

Abstract

Reinforced concrete (RC) structures are vital to modern construction, providing strength and durability. However, they are vulnerable to corrosion, which is a significant factor in the deterioration of these structures. Among the various forms of corrosion, pitting corrosion is particularly detrimental in RC structures. This localized form of corrosion leads to the formation of small, deep pits on the surface of reinforcing bars, which, over time, results in a significant reduction in the cross-sectional area of the bars. The consequence of this reduction is a marked decrease in the load-bearing capacity of the structure. Moreover, pitting corrosion can lead to cracks, delamination of concrete cover, and eventually, the failure of the entire structure.

One potential solution is the use of stainless steel (SS) reinforcing bars, which offer better corrosion performance compared to traditional carbon steel. However, even SS bars are not entirely immune to pitting corrosion, especially in aggressive environments. Understanding the initiation and propagation of pitting corrosion in SS bars is crucial for improving the longevity and safety of RC structures.

This research focuses on investigating the mechanisms behind pitting corrosion in SS bars, utilizing both experimental data and machine learning (ML) models. By analyzing the conditions that lead to the initiation and propagation of pits, the study aims to develop predictive models that can accurately assess the risk of pitting corrosion in SS-reinforced RC structures. The findings from this research will contribute to the development of more effective corrosion prevention strategies, ultimately enhancing the durability and safety of RC structures.

Data Analytics & AI

Oral Presentation (#6)

Optimizing MRgLITT Patient Monitoring through Time-series based Deep Learning Methods: A Comparative Study of ConvLSTM and U-Net

Presented by: Saba Sadatamin

Abstract

Magnetic resonance-guided laser interstitial thermal therapy (MRgLITT) is a novel, minimally invasive therapeutic approach that leverages thermal ablation to treat drug-resistant focal epilepsy. Patient-specific heat sinks, such as blood vessels, complicate the planning of MRgLITT as it creates patient-level variability in how heat from the laser propagates, thus potentially undermining treatment efficacy. To simulate the MRgLITT outcomes, we developed a deep learning framework which can predict the next steps of the monitoring system to help the surgeons to figure out, how long they want to keep ablating. We evaluate the outcome using both spatial and temporal metrics. We demonstrate strong performance of our best framework, ConvLSTM, with a structural similarity index metric of 88\%, Dice score of 0.85\% and sensitivity of 0.77\% which shows that heat propagation predicted highly similar to the ground truth. Our findings can be used by neurosurgeons to improve the delivery of MRgLITT.

Advanced Materials and Biomedical Engineering

Oral Presentations (1:00 PM - 2:00 PM, MY330)

#	Time	Title	Presenter
1	1:00 PM - 1:10 PM	Identifying Challenges in the Operating Room through a Surgical Process Analysis of Orthopaedic Teams	Minnie Menezes
2	1:10 PM - 1:20 PM	Experimental Technologies for Estimating Shoe-Floor Coefficient of Friction: A review of the literature	Shaghayegh Chavoshian
3	1:20 PM - 1:30 PM	Understanding the fundamental mechanism for the stability of SARS-CoV-2 RNA in wastewater	Rabeena Krishnasamy
4	1:30 PM - 1:40 PM	Neutral Solid Polymer Electrolytes for Thin Film Transistors	Zhi Yi Wang
5	1:40 PM - 1:50 PM	Probing Atoms for Next Generation Electronics	Md Akibul Islam
6	1:50 PM - 2:00 PM	Leveraging Liquid Interfaces to Form Membrane Selective Layers Using a Custom-made 3D Printed Reactor	Niher Ranjam Sarker

Advanced Materials and Biomedical Engineering

Oral Presentation (#1)

Identifying Challenges in the Operating Room through a Surgical Process Analysis of Orthopaedic Teams

Presented by: Minnie Menezes

Abstract

Background & Purpose: Surgical performance is a key factor in the success of operative interventions, affecting patient outcomes and operating room (OR) efficiency. This is dependent on the skills of the individual surgeons, nurses, anesthesiologists, and radiation technologists and their interactions. However, the multidisciplinary nature of OR performance is often overlooked when studying surgical processes. Including interdisciplinary interactions and associated challenges may yield a more comprehensive workflow understanding. As such, the aim of this study was to conduct a multidisciplinary surgical process analysis of orthopaedic teams undertaking operative hip fracture repair.

Methods: We conducted an ethnographic study that incorporated observations and semi-structured interviews. The observations were of hip fracture fixation procedures, both in-person and via intraoperative recordings. Intraoperative recordings were captured using the OR Black Box, which includes audio, video (from five perspectives), and patient vitals, and then annotated. Semi-structured interviews were conducted with experts in four disciplines (surgery, anesthesia, nursing, and radiation technology). Two members of the research team analyzed the interview data inductively to identify themes. The researchers ensured intercoder reliability through dialogue and consensus.

Results & Discussion: A process analysis map was created from the intraoperative recording annotations and in-person observations, including phases, steps, and activities conducted by each discipline in chronological order. The intricacies of collaborations between disciplines and challenges in the OR were visually demonstrated on the map. Four themes were identified from the interview data that describes the surgical process: the main responsibilities of each discipline; system-level, case-specific, and interdisciplinary challenges; the impact/consequences of challenges on individual workflows; and a breakdown of the OR culture.

Conclusion: We created a multidisciplinary surgical process map that demonstrates the interconnections and challenges present in the orthopaedic OR during hip fracture repair. Challenges identified will inform quality improvement initiatives and educational interventions, towards improving communication and reducing workflow disruptions.

Oral Presentation (#2)

Experimental Technologies for Estimating Shoe-Floor Coefficient of Friction: A review of the literature

Presented by: Shaghayegh Chavoshian

Abstract

Introduction: Ergonomics in footwear involves the design of shoes that prioritize both performance enhancement and injury prevention. Adequate shoe-floor traction is essential for preventing slips and falls by providing a secure grip between the foot and the walking surface. This traction, measured by the Coefficient of Friction (COF), can be evaluated using either mechanical devices in laboratory or field settings, or through human-centered testing.

Methods: A comprehensive search was conducted on scientific databases: Google Scholar, IEEE Xplore, PubMed, Web of Science, and Scopus. The keywords including ‘Outsole’, ‘Footwear friction’, ‘Slip-resistant’, and ‘Experiment’, and their synonyms were used in several combinations. Articles were screened based on the inclusion criteria: must be in English, discuss COF measurement estimations, and have been published within the last 10 years.

Results: We reviewed 10 articles that met our inclusion criteria. Various methods for evaluating footwear slip resistance include instrumented walkways and treadmills with force plates and ramp tests to measure slipping on inclined surfaces (e.g., Maximum Achievable Angle test). The fundamental behind all these methods are either 1) Ratio of Forces: the ratio of the horizontal force (frictional force) required to move an object across a surface to the vertical force (normal force) measured by force plates when dragging shoes in a straight line across a surface or rotating against a surface to simulate turning movements. Slip and fall simulations, SATRA tests, and spring-based sliding tests assess frictional forces to determine footwear performance under different conditions. Or 2) Tangent of Angle: the tangent of the inclination angle at which the object begins to slip on an inclined plane (e.g. ramp test).

Conclusion: Albeit useful, the described methods are limited to experimental purposes and need specific equipment, environmental control, surface preparation, material-specific variations, and safety.

Advanced Materials and Biomedical Engineering

Oral Presentation (#3)

Understanding the fundamental mechanism for the stability of SARS-CoV-2 RNA in wastewater

Presented by: Rabeena Krishnasamy

Abstract

Wastewater-based epidemiology (WBE) has become a cost-effective way to estimate the spread of SARS-CoV-2 in communities. The SARS-CoV-2 virus in faeces from virus carriers is shedded into municipal sewage systems and delivered into wastewater treatment plants (WWTPs), and is quantified in WBE. It is fascinating yet puzzling that SARS-CoV-2 RNA is extremely stable in wastewaters which contain large amounts of RNases. In this project, we will use a combination of molecular tools (e.g., RNA extraction and qPCR) and analytical chemistry means (e.g., column separation and LC-MS) to investigate the protein-viral RNA interaction which is proposed to contribute to the stability of SARS-CoV-2 RNA in wastewater.

Advanced Materials and Biomedical Engineering

Oral Presentation (#4)

Neutral Solid Polymer Electrolytes for Thin Film Transistors

Presented by: Zhi Yi Wang

Abstract

The increased demand for lightweight wearable technology for health monitoring requires thin and flexible devices capable of low operation voltage. Conventional silicon based electronics are bulky and rigid, and require a high driving voltage due to the low dielectric constant of silicon dioxide. Neutral pH solid polymer electrolytes are promising alternatives to those traditional dielectric materials; the high dielectric constant of these aqueous based electrolytes enables the electrolyte gated field effect transistors (EGFETs) to operate at low voltage, while also facilitating integration into flexible and wearable devices.

This study shows the integration of a solid polymer electrolyte with printed electronics create an EGFET device patterned on a flexible polymer substrate. The compatibility of the electrolyte dielectric with the electrode and semiconductor material was assessed in a capacitor platform before the electrolyte was integrated into a transistor. Fabricated EGFET devices demonstrated good transistor behaviour with ~103 ON/OFF ratio at < 1.2 V operation, and minimal performance degradation over at ambient condition for three days. Overall, the solid polymer electrolyte showed good integration with thin film transistors, with the potential to replace the conventional dielectrics in flexible and wearable electronics.

Advanced Materials and Biomedical Engineering

Oral Presentation (#5)

Probing Atoms for Next Generation Electronics

Presented by: Md Akibul Islam

Abstract

Tuning electrical properties of two-dimensional materials through mechanical strain has predominantly focused on n-type 2D materials like MoS_2 and WS_2, while p-type 2D materials such as WSe_2 remain relatively unexplored. Here, we study the impact of controlled mechanical strain on the electron transport characteristics of both mono and bi-layer WSe_2. Through coupling atomic force microscopy (AFM) nanoindentation techniques and conductive AFM, we demonstrate the ability to finely tune the electronic band structure of WSe_2. Our research offers valuable mechanistic insights into understanding how WSe_2's electronic properties respond to mechanical strain, a critical prerequisite for the development of flexible photoelectronic devices. We also observe that under high pressure, the AFM tip/monolayer WSe_2/metal substrate junction transitions from Schottky to Ohmic contact, attributed to significant charge injection from the substrate to the WSe_2. These findings are significant for designing efficient metal/semiconductor contact in thin and flexible PMOS (p-type Metal-Oxide-Semiconductor) devices.

Advanced Materials and Biomedical Engineering

Oral Presentation (#6)

Leveraging Liquid Interfaces to Form Membrane Selective Layers Using a Custom-made 3D Printed Reactor

Presented by: Niher Ranjan Sarker

Abstract

A novel lab scale apparatus has been developed and fabricated using 3-D printing technology to enable the fabrication of thin-film composite (TFC) membranes with a variety of materials. The apparatus is cost-effective, simple to use, and allows for the formation of supported nanofilms as membrane selective layers. We can demonstrate the use of the apparatus to form variety of polyamide thin films via interfacial polymerization for reverse osmosis desalination application, PDMS layers via potting mix and hexane dissolution, and polysulfone films via chlorinated solvent evaporation for uses in gas separation. Characterization of the TFC membranes were done by scanning electron microscopy (SEM), atomic force microscopy (AFM) and refractometer. This research provides a new and accessible method for the fabrication of high performance thin-film composite membranes for a variety of applications, demonstrating the potential of 3-D printing technology for membrane research.

Sustainability, Design and Manufacturing

Oral Presentations (1:00 PM - 2:00 PM, MY320)

#	Time	Title	Presenter
1	1:00 PM - 1:10 PM	Meeting U.S. light-duty vehicle fleet climate targets under critical battery material supply constraints	Dijuan Liang
2	1:10 PM - 1:20 PM	Investigation of Microplastic Fiber Shedding on Hand-Washed Polyester	Amanuel Goliad
3	1:20 PM - 1:30 PM	4-O-methylglucaric acid: Synthesis, downstream processing, and performance as a bio-based detergent additive	Kevin Marrs
4	1:30 PM - 1:40 PM	Bio-based vitrimer polymers with self-healing properties	Mohammad Mahaninia
5	1:40 PM - 1:50 PM	Biomass-based Redox-Active Composites for Capacitive Energy Storage	Raunaq Bagchi
6	1:50 PM - 2:00 PM	A53T alpha-synuclein overexpression rat model of Parkinson's disease: behaviour and electrophysiology phenotyping	Laura Kondrataviciute

Sustainability, Design and Manufacturing

Oral Presentation (#1)

Meeting U.S. light-duty vehicle fleet climate targets under critical battery material supply constraints

Presented by: Dijuan Liang

Abstract

Meeting climate targets requires large-scale deployment of electrified vehicles, which may lead to critical material supply challenges. Given that material supply growth may lag behind demand, optimally allocating critical materials across different electrified powertrains is crucial. Many earlier studies focused on mitigating transport greenhouse gas (GHG) emissions did not consider critical material constraints when simulating or optimizing technological pathways, resulting in proposed trajectories that could be at risk due to critical material supply challenges. In the few studies that did account for critical material supply issues, these either did not consider costs, or assumed infinite material supply under specific prices, and thus failed to properly capture the trade-offs among GHG emissions, costs, and material demand at the fleet level. This study examines how the U.S. light-duty vehicle (LDV) fleet can meet climate targets under critical battery material supply constraints. We first compare GHG emissions, costs, and material demand across various electrified powertrains and battery chemistries. We then construct an optimization model to determine the cost-minimal technology mix for the U.S. LDV fleet to meet 1.5 or 2 °C climate targets under various critical battery material supply scenarios. Preliminary results indicate that lithium could be a key factor determining whether the fleet can meet climate targets and the resulting optimal fleet mix. In a scenario with low material supply, allocating more battery materials to plug-in hybrid electric vehicles (PHEVs) could mitigate larger GHG emissions at the fleet level. This is because a PHEV has typical life cycle GHG emissions that are only slightly higher than a battery electric vehicle (BEV) but with a much lower battery material intensity. Preliminary results suggest that PHEVs could serve as a transitional technology until such a time when critical material supply could catch up with the demand for larger batteries for full BEVs.

Sustainability, Design and Manufacturing

Oral Presentation (#2)

Investigation of Microplastic Fiber Shedding on Hand-Washed Polyester

Presented by: Amanuel Goliad

Abstract

The presence of microplastic fibers (MPF) in oceans is a major concern requiring the attention of the international community. The majority of MPFs are released into waterways during laundering. However, nearly all the research connecting laundering to MPF release has used machine laundering. And yet, two-thirds of the world does not have access to a laundry machine, highlighting a lack of inclusivity in this research area. Accordingly, this study focused on textile coatings that can minimize MPF release, specifically targeting laundering via hand washing.

Two different polyester fabrics (green and black with varying fabric construction) were laundered using a previously reported method for hand washing, and the amount of MPFs released was measured with and without the fabric coating. The environmentally friendly polydimethylsiloxane (PDMS) surface coating used was applied onto the polyesters to minimize the MPF release by reducing inter-fiber friction, based on a previous study. Three different water hardnesses were used for hand washing: deionized, tap, and water sourced from Lake Ontario, as hand washing is typically performed using the nearest body of water.

Our investigation indicated that hand washing using harder water releases more MPFs per wash regardless of whether that fabric was coated or uncoated. Further, when the fabrics were treated with the PDMS coating, 92%, 88%, and 77% less MPFs were released per gram of green polyester hand-washed in deionized, tap, and lake water, respectively, and 30%, 26%, and 37% less MPFs per gram of the black polyester. Further work will emphasize on material characterization and the relation between MPF release and water hardness by expanding the range.

Sustainability, Design and Manufacturing

Oral Presentation (#3)

4-O-methylglucaric acid: Synthesis, downstream processing, and performance as a bio-based detergent additive

Presented by: Kevin Marrs

Abstract

Glucaric acid is emerging in the field of detergent builders as an alternative to environmentally problematic phosphates. However, glucaric acid's production from glucose is low yielding, has large downstream processing costs, and results in environmentally damaging nitrogen oxide emissions. Herein is described a method to produce the structurally similar 4-O-methylglucaric acid, which is proposed as an alternative to glucaric acid, from an underutilized fraction of lignocellulosic biomass.

Sustainability, Design and Manufacturing

Oral Presentation (#4)

Bio-based vitrimer polymers with self-healing properties

Presented by: Mohammad Mahaninia

Abstract

In the recent years, the focus on composite manufacturing have shifted towards self-healing/recyclable polymers owing to their eco-friendly feature. The use of biopolymers as a matrix for fabrication of composites ensures biodegradability in the final products. Chitosan, as the second most abundant biopolymer play an important role in the future of the biodegradable polymers. Due to the presence of different functional groups (e.g., NH2, OH) in the structure of chitosan, it can be used for designing the variety of bio-based polymers. In Yan's group, chitosan has been used for synthesizing new types of CAN polymers that not only are biodegradable but also recyclable. CAN polymers are able to do covalent bond exchange which as a result they can repair themselves. These types of polymers can be used for diverse applications such as membranes, adhesives, resins, etc. Recently, we engineered set of chitosan-based CAN polymers capable of doing molecular recognition with potential to be used for fabrication of membranes. Lately, with employing of modular cross-linking technique, existing chitosan-based CAN polymers attained flame-retardancy. These class of materials, can be used inside of composite to make it flame retardant. These are only few examples that show how chitosan likely can be used to synthesis the biodegradable polymers with multifunctional capability. Therefore, while interest in application of biopolymers for fabrication of composite materials are growing, chitosan can be considered as one of the core concepts for designing/engineering them.

Sustainability, Design and Manufacturing

Oral Presentation (#5)

Biomass-based Redox-Active Composites for Capacitive Energy Storage

Presented by: Raunaq Bagchi

Abstract

The increasing demand for renewable energy, electrified transport, and portable accessories (e.g. Internet-of-Things) has spurred interest in electrochemical energy storage devices, such as electrochemical capacitors (ECs). Redox-active organic molecule-nanocarbon composite electrodes can provide high power and good energy storage in ECs. To advance the capabilities of the redox active species, the effects of surface functionalities such as carboxyl groups, and pore structure of the carbon substrates need to be investigated. These substrates can vary from expensive ordered carbon nanotubes to low-cost, highly porous, disordered activated carbons (ACs) from waste biomass. Lignocellulosic waste biomass-based ACs can leverage the ion transport properties already present in plant structures while also exploiting inexpensive, locally available waste biomass sources such as spent tea and pinecones. Hence, an investigation is needed to create composites with high-charge storage and fast charging/discharging, and to then achieve these gains with low-cost, sustainable, waste biomass carbon sources.

In this work, a systematic study was conducted on the effects of surface chemical species and surface structure on the redox activity of conducting polymer polyluminol-carbon composites to understand the interfacial interactions and increase the energy stored. Our approach was to develop and understand ordered nanocarbon-based composites and then translate the knowledge and performance gains to spent tea-based AC composites. The findings from this study can help guide surface modification and structural design for redox-active organic-carbon composites to improve energy storage and lower cost, contributing to a transition to a more sustainable future.

Sustainability, Design and Manufacturing

Oral Presentation (#6)

A53T alpha-synuclein overexpression rat model of Parkinson's disease: behaviour and electrophysiology phenotyping

Presented by: Laura Kondrataviciute

Abstract

Parkinson's disease (PD) is a neurodegenerative movement disorder characterized by the loss of midbrain dopaminergic neurons and the formation of alpha-synuclein (a-Syn) aggregates (Koprich et al., 2017). Patients diagnosed with PD exhibit a wide array of pathologies, such as motor impairment, depression, anxiety, anosmia, and altered neuronal activity in basal ganglia structures (McGregor & Nelson, 2019). The accumulation of a-Syn is central to PD pathology, but its precise role in pathogenesis remains unclear. Here, we investigated the emergence of motor and non-motor behavioural deficits and electrophysiological signatures of circuit dysfunction in rats overexpressing a mutant form of a-Syn linked to early-onset PD. Adult female Sprague-Dawley rats were unilaterally or bilaterally injected into the substantia nigra (SN) with adeno-associated virus (AAV) expressing either human mutant A53T a-Syn or empty vector (EV) . (Paxinos & Watson, 2013). Electrophysiological recordings including single unit and local field potentials were performed under isoflurane anesthesia from the subthalamic nucleus (STN) at 3 and 6 weeks post-unilateral injection. Behavioral experiments (sucrose preference, novelty suppressed feeding, habituation/dishabituation, open field, and grid walking) were conducted on a separate cohort of animals at 3 and 6 weeks post bilateral AAV injection. Post-morten immunofluorescence staining for tyrosine hydroxylase and a-Syn was performed to confirm neurodegeneration. The unilateral loss of dopaminergic neurons in the SN of A53T a-Syn expressing animals coincided with the gradual emergence of pathological oscillations in the STN. Concurrently, A53T a-Syn overexpressing animals exhibited tends in changing firing rates and bursting activity in the STN compared to healthy EV control animals. Rats with bilateral expression of A53T a-Syn exhibited progressive deterioration of motor function, accompanied by a diminished responsiveness to palatable stimulation observed 6 weeks post-injection. These findings suggest that mutant a-Syn overexpression in the SN is sufficient to cause STN dysfunction, abberent circuit oscillations within the basal ganglia and motor impairments. The observed alterations highlight the suitability of the viral-mediated A53T a-Syn overexpression model for investigating not only dopaminergic neurodegeneration but also circuit dysfunction and non-motor behaviour which will have potentialvalue in the development of disease modifying therapeutics.

Posters

Presentations (2:00 PM - 3:45 PM, Lobby)

#	Time	Title	Presenter
1	2:00 PM - 2:10 PM	A Solid-state Aerosol Deposition Technique: From Fine Particles to Dense Ceramic Coatings	Zhenying Yang
2	2:10 PM - 2:20 PM	Blotting Method to Determine Oil Content in Mustard Seeds	Naayaab Nagree
3	2:20 PM - 2:30 PM	Unsupervised Early Sampling Helps Focus Human Expertise in Active Learning of Anomalies	Jaturong Kongmanee
4	2:30 PM - 2:40 PM	Long-term Analysis to Elucidate the Origins of Ultrafine Particles in a Major City	Davood Dadkhah
5	2:40 PM - 2:50 PM	Modeling the Growth Dynamics of Human Pluripotent Stem Cells in Suspension Culture	Ferdinand Reke Avikpe
6	2:50 PM - 3:00 PM	Design and Fabrication of an Anthropomorphic Brain Phantom for Mid-field Strength MRI	Katrina Zaraska
7	3:00 PM - 3:10 PM	Long-term Renal Fibrosis Evaluation Through Implantable Multimodal Device	Hugo Higueros
8	3:10 PM - 3:20 PM	Characterization of Aerosol Deposition In The Human Respiratory System	Peter Di Palma
9	3:20 PM - 3:30 PM	Allocating limited battery capacity across light-duty vehicles market segments to increase GHG mitigation - A scenario-based analysis of the U.S. fleet	Nadine Alzaghrini
10	3:30 PM - 3:40 PM	Numerical Investigation of NAPL Depletion and Back Diffusion Mitigation through Persulfate Oxidation	Shih-Yang Cheng

Posters

Presentation (#1)

A Solid-state Aerosol Deposition Technique: From Fine Particles to Dense Ceramic Coatings

Presented by: Zhenying Yang

Abstract

Aerosol deposition (AD) can produce dense nanocrystalline ceramic films at room temperature, offering key advantages over traditional coating methods. These include low-temperature deposition, which minimizes thermal damage to sensitive substrates, and the capability to deposit a wide range of materials, making AD suitable for aerospace, automotive, electronics, and biomedical applications. Studies to date have generally employed flat substrates with a range of hardness levels and surface roughness. Potential applications in micro-devices will require deposition on structured or patterned surfaces. This work presents the fabrication and characterization of dense alumina coatings on flat metal and ceramic substrates, as well as micropillar-patterned silicon substrates using AD. To understand the mechanisms of coating formation, we characterized cross-sections using scanning electron microscopy, x-ray diffraction, and high-resolution transmission electron microscopy. Through both experimental and numerical methods, we performed in-depth interfacial analysis that highlighted the formation of amorphous regions at particle boundaries and coating-substrate interfaces, contributing to dense and well-adhered coating formation in AD. These findings demonstrate uniform coatings on both flat and micropatterned substrates, opening new possibilities for AD applications, particularly in surface sealing and 3D microelectronic devices.

Posters

Presentation (#2)

Blotting Method to Determine Oil Content in Mustard Seeds

Presented by: Naayaab Nagree

Abstract

Determining oil content in mustard seeds is a time consuming and expensive process, often inaccessible to the common farmer. The proposed oil blot methodology has the potential to be used in low income, remote settings as a first estimate of the oil content in the mustard seed crop. Oil blots were formed by pressing oil out of the seed onto an adsorptive surface using a repeatable force from a vise grip. The area of the blots was an indicator of oil content. While the oil blot methodology would not replace industry standard methods such as Soxhlet extraction, it serves as an accessible, non-specialized method to provide a first-estimate result. This was proved using a Pearson Correlation test ($r = 0.95$) and t-statistic comparison. The positive significance values show a strong, positive linear correlation between oil content and blot areas. It was determined that the ideal tool for the oil blot methodology was a vise grip due to its repeatability, portability, and low bulk cost. The total cost of the kit was $0.90 with low recurring costs. The extreme simplicity, low capital, and operating cost, make the oil blotting method a valuable tool for small mustard seed producers for estimating the fair value of their crop, reducing their potential exploitation by middlemen.

Posters

Presentation (#3)

Unsupervised Early Sampling Helps Focus Human Expertise in Active Learning of Anomalies

Presented by: Jaturong Kongmanee

Abstract

Detecting anomalously evolving and rare patterns in data requires investigation and annotation by human experts who provide ground truth labels, thereby reducing the high number of false alarms that may occur with purely automated methods. Active learning (AL) aims to improve human labeling efficiency by selecting samples for labeling that speed up the rate at which machine learning (ML) models learn from training data. However, anomalies are infrequent and ambiguous, and the resulting datasets are highly unbalanced, with a large majority of negative instances. Thus, the AL sampling strategy should adapt to the amount of information that a ML model has about the distributions of normal and anomalous samples, to minimize the chance of overlooking anomalies. In this work, we emphasize unsupervised exploration of data distribution in the early stages of AL, with an increasing proportion of expert-provided labels being added as the training progresses. We add a parameter in this hybrid AL process for experts to choose the rate at which samples switch from predominantly unsupervised to mostly supervised labeling. This approach results in an adaptive AL sampling strategy that captures the underlying prior data distribution and model uncertainty, while also profiting from labeling by human experts. We show that (1) the model benefits from a batch of representative and informative instances of both normal and anomalous samples, and (2) unsupervised anomaly detection plays a useful role in building the model in the early stages of training, when relatively few labels are available. Using three highly unbalanced UCI benchmarks, and one real-world proprietary redacted email data set, our AL sampling strategy for anomaly detection outperformed existing AL approaches in terms of the area under the precision-recall curve (AUPRC) and the anomaly discovery rate.

Posters

Presentation (#4)

Long-term Analysis to Elucidate the Origins of Ultrafine Particles in a Major City

Presented by: Davood Dadkhah

Abstract

Ultrafine particles (UFP), less than 100 nm in diameter, originate from human activities like traffic emissions and natural sources such as nucleation events, where photochemical reactions form particles in the atmosphere. Nucleation events can produce a large number of particles over a region lasting for a few hours, while traffic emissions can affect a more local area and create large UFP spikes that last for a few minutes. Both sources adversely affect human health and the environment. In this study, our aim was to find a better understanding of the origins of UFP, especially during the day. UFPs were studied in an urban setting by analyzing particle size data collected between 2006 and 2021 near a busy roadway in downtown Toronto. The days were classified into five categories: Strong Nucleation, Midday Pollution, Traffic Pollution, Baseline, and Mixed. Strong Nucleation days showed prolonged nucleation events (>3 hours) with an average particle number concentration of 3.1±0.10×104 #/cm^3 around noon. Midday Pollution days also exhibited elevated particle concentrations around noon, averaging 3.3±0.06×104 #/cm^3. Traffic Pollution days showed a concentration peak during the morning rush hour without a midday increase, with an average UFP concentration of 2.1±0.20×104 #/cm^3. Baseline days had lower particle number concentrations throughout the day with minimal but observable traffic emission influence in their diurnal pattern. Mixed days showed UFP concentrations higher than Baseline days around the morning rush hour or midday. These days were characterized by a combination of traffic pollution, nucleation events, or midday processes, without a single dominant source. The analysis of other pollutants indicated that UFPs on Midday Pollution days were primarily from vehicle emissions, enhanced by reactions within the exhaust plumes. This study showed that elevated midday UFP concentrations were not only due to nucleation events, Midday Pollution processes can also be a strong contributor.

Posters

Presentation (#5)

Modeling the Growth Dynamics of Human Pluripotent Stem Cells in Suspension Culture

Presented by: Ferdinand Reke Avikpe

Abstract

Rationale & Objectives: Computational models have become essential for understanding complex biological processes in tissue engineering, especially regarding human pluripotent stem cells (hPSCs). While traditional in vitro and in vivo techniques have significantly contributed to our knowledge of hPSCs and helped build foundational data for computational models, these methods often require substantial resources and time. Computational techniques provide a complementary, cost-effective, and efficient solution that accelerates research and boosts productivity. This study aims to fill an important gap in stem cell research by developing a comprehensive computational model that accurately predicts the growth patterns of hPSCs in response to their biochemical environments.

Methods: By combining experimental design protocols, mathematical statistics, and optimization principles, we employed a system of ordinary differential equations (ODEs) to predict the growth patterns of hPSC populations. This model uses ten parameters derived from optimally designed in vitro experiments. Important factors like initial cell density, aggregate size, nutrient levels (glucose), and waste product concentrations (lactate) were included in the model. These factors are represented in the ODEs through source/sink terms and modulation terms, which are based on constant, linear, and Michaelis-Menten mathematical expressions.

Results: The validated computational model can predict hPSC proliferation patterns, capturing both the observed experimental magnitudes and trends. Additionally, the model offers valuable insights into the threshold levels required for optimal hPSC growth, enabling the simulation of various experimental scenarios.

Conclusions & Significance: This model will be applicable for optimizing cell culture conditions and experimental protocols, thereby improving cell yield and reducing cost. Thus, the proposed model has significant potential to advance the development of regenerative stem cell therapies.

Posters

Presentation (#6)

Design and Fabrication of an Anthropomorphic Brain Phantom for Mid-field Strength MRI

Presented by: Katrina Zaraska

Abstract

Purpose: Mid-field strength MRI has opened up imaging opportunities for broader patient populations due to its decreased cost, reduced footprint and potential for improved compatibility for patients with active implants in comparison to higher-field systems. This increased compatibility may allow for improved care for patients with active implants such as deep brain stimulators. Ensuring safety for off-label imaging of patients with implants however, remains a barrier. Anthropomorphic (human mimicking) phantoms can help evaluate implant interactions (heating, imaging artifacts, etc.) better than current standard approaches, but there is a lack of validated methodologies for creating accurate multi-tissue brain phantoms. This study aims to develop a process for constructing a 0.5T MRI brain phantom with accurate T1 and T2 relaxation times, conductivity and anatomy.

Methods: Silicone, agar and agarose gels were prepared and imaged using the Synaptive 0.5T system at Toronto General Hospital using T1 and T2-weighted protocols. The signal data was fit to MRI signal equations in Python to select the ideal gel for mimicking human tissue. A white matter mold, based off MRI human geometry, was 3D printed in ABS and filled with gel. The ABS shell was dissolved off using acetone and then suspended in a grey matter silicone mold. The grey matter gel was poured and cured before being placed within a cadaveric human skull.

Results: Relaxometry scanning indicated that silicone and agar have T1 times below human thresholds, making them unfit for the phantom. Agarose had T1 times above human values and T2 below human values. The addition of Gadobutrol as a doping agent modulated the relaxometry properties of the agarose to within an acceptable range.

Conclusions: Agarose doped with Gadobutrol and NaCl emerged as a promising material for mimicking relaxation times and conductivity at 0.5T and function well within an anthropomorphic brain phantom for MRI.

Presentation (#7)

Long-term Renal Fibrosis Evaluation Through Implantable Multimodal Device

Presented by: Hugo Higueros

Abstract

Chronic kidney disease (CKD) is a high-mortality rate, irreversible pathology that affects 10–14% of the global population. Current clinical assessments lack sufficient diagnostic and characterization capabilities, which significantly hinder early intervention. In this work, we aim to develop a minimally-invasive implantable device that is able to assess and monitor kidney health via fibrotic load quantification and tissue hemodynamic biomarkers. We will incorporate state-of-the-art miniature microprocessors, highly sensitive biophotonic and bioimpedance sensors, as well as tailored biomaterials, to develop an implant capable of long-term, multimodal renal monitoring.

Posters

Presentation (#8)

Characterization of Aerosol Deposition In The Human Respiratory System

Presented by: Peter Di Palma

Abstract

Pulmonary delivery of medicine has become an increasingly attractive site for local and systemic treatment of diseases. This preference is due to the lung's large surface area and vascular network, which facilitates fast absorption and onset of action. Ingestion of drugs through the respiratory tract is facilitated through the inhalation of a drug supplied by a delivery device. Widely available inhalers include those that atomize liquid medicine, such as metered-dose inhalers (MDI) and nebulizers, as well as dry powder inhalers (DPI) that use solid particles. Optimal delivery of an inhaled drug is dependent on the particle size of the aerosolized medicine, as most particles >5µm are deposited in the trachea and do not reach the lower generations of the lung. Today, advancement of new inhaler technology relies on accurately measuring the size distribution of particles produced by an inhaler. Current practices for measuring this distribution include those that rely on filtration and inertial measurement, such as cascade-impactors and twin impingers. Although these methods are standardized and simple to use, they do not represent the complicated network of airways in the lung and can only characterize deposition as a function of size while not accounting for other important factors such as the particle velocity.

This research aims at developing a novel experimental setup for measuring and characterizing aerosol deposition in the human respiratory system. We are interested in understanding what physiological parameters and inhaler designs contribute to the effectiveness of drug deposition in the lung. To do this, we intend to create a representative-replica model of the human airways, including the trachea, bronchi, and alveoli, with a transparent material to enable in-situ measurement of particle size and velocity distributions at critical airway positions from a variety of inhalers using phase doppler particle anemometry (PDPA). crucial information of aerosol flow will allow us to calculate mass and momentum flux at specific locations in the lung to efficiently and effectively evaluate the performance of potential innovations in inhaler design.

Posters

Presentation (#9)

Allocating limited battery capacity across light-duty vehicles market segments to increase GHG mitigation - A scenario-based analysis of the U.S. fleet

Presented by: Nadine Alzaghrini

Abstract

In many countries around the world, vehicle electrification has become a cornerstone strategy for decarbonizing the light duty vehicle (LDV) fleet. This will place an increasing strain on associated supply chains. As supply chain bottlenecks are likely to remain, it will also be necessary to evaluate priorities for where electric vehicle deployment can have the greatest environmental benefits.

This study determines strategies for deployment of the world's limited battery capacity in the LDV sector to afford the largest reduction in lifecycle greenhouse gas (GHG) emissions from 2020 until 2050. The study evaluates the prospective life cycle GHG emissions of the LDV fleet using a bottom-up approach, accounting for often-neglected characteristics such as vehicle classes, trip types, drive cycles and background modified inventories impacting the production characteristics of various relevant sectors such as electricity, fuel and steel. Preliminary results show that a large tradeoff exists between efficient battery allocation and GHG reduction across electrified powertrains. This tradeoff is accentuated by geographical differences. Further, the stricter the battery capacity supply constraints, the greater the need for hybrid and plug-in hybrid electric vehicles. Future work will evaluate if fleet electrification is desirable in all contexts, or if a combination of technologies (i.e. hybrid electric vehicles and low carbon intensity fuels) might provide a more robust approach to reducing LDV fleet emissions.

Posters

Presentation (#10)

Numerical Investigation of NAPL Depletion and Back Diffusion Mitigation through Persulfate Oxidation

Presented by: Shin-Yang Cheng

Abstract

Persulfate, noted for its high oxidative potential and prolonged persistence, is increasingly being utilized for groundwater remediation purposes. A reactive transport model was utilized to evaluate the effectiveness of persulfate oxidation in NAPL depletion and back diffusion mitigation of trichloroethylene (TCE). The model, incorporating NAPL dissolution and persulfate chemistry, was validated against previously published experimental data and subsequently applied to two illustrative cases, which were used to examine the influence of various design parameters and soil oxidant demand (SOD) on contaminant removal. Findings indicate that high oxidant concentration and slow groundwater velocity ae preferred for both NAPL depletion and back diffusion mitigation. High temperature can benefit NAPL depletion while low temperature is suitable for back diffusion mitigation. Understanding site-specific SOD values is critical to evaluate ISCO performance. This study highlights the importance of optimizing design parameters and considering site-specific conditions to improve the effectiveness of TCE remediation efforts.

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